

# EXPLORE

Newsletter for  
the Association  
of Exploration  
Geochemists



NUMBER 102

JANUARY 1999

## PRESIDENT'S MESSAGE

Welcome to the final year of this century and the millennium! It is the perception of many members that AEG has been around a long time. Yet it was only founded in 1970, a very short twenty-nine years ago. In fact, modern geochemical principles were not routinely applied to exploration until early in this century. Tremendous growth and progress in the industry and AEG have been made since then. During this time we have observed individuals who have made significant contributions, not only to the organization, but, to the science. Many of these individuals have been acknowledged by AEG through various awards. For some, the only rewards have been the satisfaction of a job well done. I would like to **THANK ALL OF YOU** who have given of your time and energies on behalf of AEG — it is very much appreciated by all who reap the benefits.



Erick Weiland

Exploration Geochemistry projects have changed significantly since 1970. Now every exploration project must also consider the environmental aspects of the exploration and development of the resource. In the United States, as well as many other countries, governmental agencies control the exploration process through regulation. This trend is likely to continue, if not increase, especially in the financially emerging countries.

Many difficulties arise from the cyclic nature of the industry and changes in the laws within various countries which occur routinely. These cycles and changes have forced many to change the direction of their careers. AEG has helped to provide a foundation for the development of geochemists through the Journal, short courses, symposia, and the Distinguished Lecture Series, as well as **EXPLORE**. I challenge each of you to continue in this fine tradition and to advance the application of geochemistry and, in this process, help AEG grow by providing a solid forum from which to exchange ideas and communicate advancements.

AEG has made several major changes this past year. This will be the last year that Elsevier will publish the official AEG journal (The Journal of Geochemical Exploration). As of January 1<sup>st</sup>, 2000 there will be a new publisher of the journal under a new name (**GEOCHEMISTRY: Exploration, Environment, Analysis**). It will be critical for members to support this transition by supplying papers and seeing that local libraries subscribe to the new journal. Additionally, the new journal provides AEG members with a chance to focus on the current developments within exploration as well as the environmental and analytical aspects that impact exploration geochemistry.

There are many challenges facing AEG. One of the biggest is to maintain communications between individual members

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## PAST-PRESIDENT'S MESSAGE

The past year did not benefit from any major meetings, however several important issues appeared ripe for resolution as they concerned the publication of the *Journal of Geochemical Exploration* (JGE) and the future scientific direction of the AEG. Both of these topics have been widely aired and discussed in **EXPLORE** by previous Past Presidents Bill Coker and David Garnett and by Eion Cameron, the Past Editor of the JGE. The debate, although necessary and important to involve and advise members of the AEG, has had the effect of consuming much effort and time on the part of the AEG Council, which we would have preferred to spend on more constructive issues such as planning future activities. The opportunity thus provided by the gap between major scientific meetings was therefore taken to address these issues constructively and to seek, if possible, a resolution which would be acceptable both to the AEG and to Elsevier Science. On this occasion the AEG was equipped through these previous discussions with a very clear sense of the objectives to be achieved by negotiation and had established milestones which were considered essential to the future development and success of both the AEG and the JGE. Unfortunately however, it was not possible to close the gap by negotiation, between the AEG objectives and those of Elsevier Science, and an amicable parting of the ways was agreed, with the AEG commencing publication of its own new Official Journal on 1 Jan 2000 which is entitled:



Peter Simpson

### GEOCHEMISTRY: Exploration Environment Analysis

The AEG journal will be relaunched under new not-for-profit management. The opportunity will be taken to offer it to libraries at a greatly reduced charge, while not significantly increasing costs to the AEG membership. This is designed to help to maintain and increase the number of library subscriptions in the future and to ensure the widest possible readership for the journal among members and non-members alike. It is anticipated that the lower cost of the new journal to libraries

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## Information for Contributors to EXPLORE

**Scope** This Newsletter endeavors to become a forum for recent advances in exploration geochemistry and a key informational source. In addition to contributions on exploration geochemistry, we encourage material on multidisciplinary applications, environmental geochemistry, and analytical technology. Of particular interest are extended abstracts on new concepts for guides to ore, model improvements, exploration tools, unconventional case histories, and descriptions of recently discovered or developed deposits.

**Format** Manuscripts should be double-spaced and include camera-ready illustrations where possible. Meeting reports may have photographs, for example. Text is preferred on paper and 5- or 3-inch IBM-compatible computer diskettes with ASCII (DOS) format that can go directly to typesetting. Please use the metric system in technical material.

**Length** Extended abstracts may be up to approximately 1000 words or two newsletter pages including figures and tables.

**Quality** Submittals are copy-edited as necessary without re-examination by authors, who are asked to assure smooth writing style and accuracy of statement by thorough peer review. Contributions may be edited for clarity or space.

All contributions should be submitted to:

### EXPLORE

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## Information for Advertisers

**EXPLORE** is the newsletter of the Association of Exploration Geochemists (AEG). Distribution is quarterly to the membership consisting of 1200 geologists, geophysicists, and geochemists. Additionally, 100 copies are sent to geoscience libraries. Complimentary copies are often mailed to selected addresses from the rosters of other geoscience organizations, and additional copies are distributed at key geoscience symposia. Approximately 20% of each issue is sent overseas. **EXPLORE** is the most widely read newsletter in the world pertaining to exploration geochemistry. Geochemical laboratories, drilling, survey and sample collection, specialty geochemical services, consultants, environmental, field supply, and computer and geoscience data services are just a few of the areas available for advertisers. International as well as North American vendors will find markets through **EXPLORE**. The **EXPLORE** newsletter is produced on a volunteer basis by the AEG membership and is a non-profit newsletter. The advertising rates are the lowest feasible with a break-even objective. Color is charged on a cost plus 10% basis. A discount of 15% is given to advertisers for an annual commitment (four issues). All advertising must be camera-ready PMT or negative. Business card advertising is available for consultants only\*. Color separation and typesetting services are available through our publisher, Vivian Heggie, Heggie Enterprises.

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## President's Message

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and between members and the Council/Executive. The primary function of the Council/Executive is to handle the affairs of the Association for the members and provide long-term stability. However, for this to work, the Council/Executive must know what is on the minds of the members. Your attention is focused on your job, as it should be. However, reading **EXPLORE** will keep you informed on events within AEG. It is important to keep current on AEG activities and to let the council know your feelings. **Council NEEDS TO hear from you!** The attendance at the 1998 Annual General Meeting was very disappointing. Every member of the organization had the opportunity to be involved and join us for this short conference call meeting (details of how to be connected were published in **EXPLORE**). I know some members were traveling or inaccessible, however, as it was there were only 14 members represented. To facilitate and encourage effective ongoing communication between members and the Council/Executive the email, phone, and fax numbers for all Council/Executive are published at the end of this issue of **EXPLORE**. Help us to make AEG the very best that it can be. Remember that this is **YOUR** organization — you decide through **YOUR** participation (or lack thereof) what direction AEG will go and if it will be successful.

Thank you for the opportunity to represent you — the members. As President of AEG, I promise to do my best, on your behalf, to advance the Association at every chance that I have. I look forward to meeting with those of you who can join us in Vancouver. For those who cannot, please do not hesitate to drop me, or a council member, a note or email with your visions for AEG.

Sincerely,

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## Past President's Message

*continued from page 1*

will result in increased visibility and accessibility, supplemented by electronic publication, which will attract high quality articles and therefore help to sustain this publication in the future.

The new title and subtitle are also designed to help resolve the issue raised by Past President Bill Coker and others, concerning the recognition that environmental exposure to metals resulting from mineral exploration and development is increasingly becoming a matter of interest to many of our members, readers, sponsors and society at large. Many of our members have important scientific and commercial interests in environmental science in which their knowledge, expertise and skills in exploration geochemistry provide the right blend of professional and scientific experience to deal with the many complex scientific, economic and environmental issues arising from mineral development. It is anticipated that an increased content of papers addressing environmental issues will help to maintain a more consistent level of publication during periods of boom and bust to which the exploration industry is inevitably exposed.

It is gratifying to note that even after a very difficult year for the exploration industry the plans for the 19<sup>th</sup> International Geochemical Exploration Symposium in Vancouver from April 11-16, 1999 are now complete and it is anticipated that this will be a popular and successful meeting located in the newly renovated Hotel Vancouver situated in the heart of Vancouver.

It remains for me to note the several important changes due to the retirement of Eion Cameron as Editor in Chief after a lifetime's work on behalf of the JGE, who has been replaced by Gwendy Hall at the Geological Survey of Canada. Likewise Sherman Marsh has retired as Secretary after many years of service and has been replaced by David Smith at the U.S. Geological Survey. My thanks are due to all members of the Council and Executive, including the Regional Councillors, for their support and work on behalf of the AEG and to Betty Arseneault, our Business Manager and Marcia Scrimgeour the Editorial Assistant for the JGE. I thank Erick Weiland for his support as First Vice President in 1998 and send him my very best wishes for a successful year as President of the AEG in 1999.

### Peter Simpson

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## Member discounts on Elsevier Publications

Members should contact the AEG business office for the purchase of geochemistry books and back issues of Journal of Geochemical Exploration, published by Elsevier. Member discounts listed in **EXPLORE** will continue through 1999.

## MEETING NOTICE

### AEG Annual General Meeting

**Place: 19th IGES**

**Vancouver, BC**

**Tuesday, April 13, 1999**

**at 5:00pm**

**Members and Fellows**

**Urged to Attend**

**Participate in planning**

**the future of AEG**

## AEG COUNCIL ELECTION

The Council election for the 1999-2000 term has been completed. Ballots were sent to 311 Fellows in good standing and 157 valid ballots were returned. Two ballots were determined to be "spoiled" because they were not signed and did not include the member number. It is important that you sign your ballot and include your member number because this is the only way we can verify that the ballot was sent by a fellow of the AEG. We also had one ballot from last years election, the first time that has happened! This year we had a 57% participation, better than last year's 51% but there is still room for improvement.

The new Council is composed of 6 Councillors; 2 are returning for a second term, 3 are newly elected, and our *ex officio* President, Peter Simpson. The two returning Councillors are Steve Day and Shea Clark Smith. The new Councillors are Mary Doherty, Graham Taylor (a Past President) and Steve Amor. Congratulations to the new Council and welcome!

We would like to thank all those Fellows who were nominated and agreed to stand for election to Council. Although not everyone can win we greatly appreciate your participation.

**Erick Weiland, President**

**Dave Smith, Secretary**



## ANNUAL GENERAL MEETING

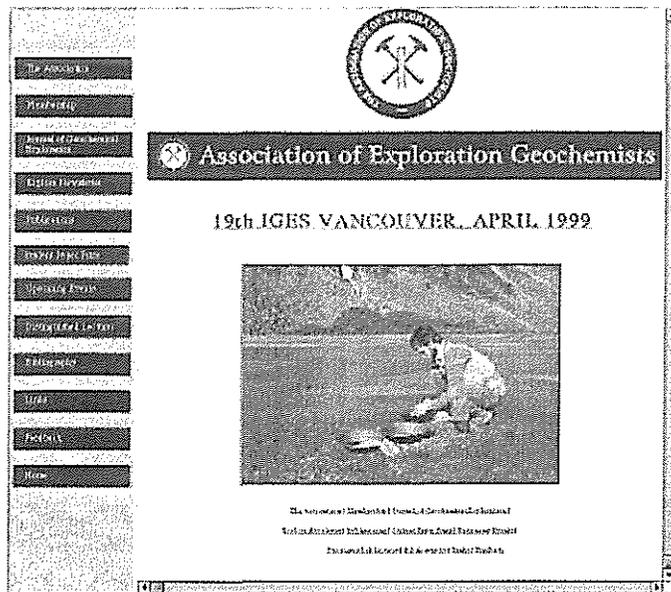
The 1999 Annual General Meeting (AGM) of The Association of Exploration Geochemists will be held during the 19<sup>th</sup> International Geochemical Exploration Symposium in Vancouver, BC, Canada. It will be held on Tuesday, April 13 at 5:00 PM. The place will be announced at the meeting. All members attending the 19<sup>th</sup> IGES are encouraged to attend.

Fellows who are unable to attend the AGM may appoint an attending Fellow to act as his or her proxy. All proxies must be received by the Secretary prior to the AGM. If you are a Fellow, are unable to attend the AGM, and want to be able to vote then please assign your proxy.

**David Smith, Secretary**



## NEW AEG WEB SITE



The new AEG web site is now up and running at <http://www.aeg.org/>. The site is a convenient source of information about the AEG. It includes a current listing of the AEG executive and the various AEG committees and their members, along contact information.

Details about important AEG activities, including the upcoming 19th International Geochemical Exploration Symposium in Vancouver 1999, the Student Paper Prize, and the Distinguished Lecturer are posted and updated regularly.

The web site also provides information on AEG publications, the **EXPLORE** newsletter, membership, and the AEG bibliography. All AEG members are encouraged to surf the site and send any feedback or new material to be posted on the web site to the AEG Web Manager, Beth McClenaghan, at [bmcclena@nrca.gc.ca](mailto:bmcclena@nrca.gc.ca).

In answer to some recent inquiries, the AEG logo on the home page spins fast enough to prevent the full test tube of mercury from spilling out.

### Beth McClenaghan

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## TECHNICAL NOTE

### The Effect of Soil Composition on Weak Leach Solution pH: a Potential Exploration Tool in Arid Environments

by Barry W. Smee

#### Introduction

Weak chemical extractions on soils are being promoted throughout the exploration world as a method for detecting mineralization that is concealed (Clark, 1993, Mann, et al, 1995). These techniques are being used in a wide variety of geological and climatic terrains, with apparently little regard for geological substrate or changing soil conditions.

Early studies with weak extractions showed that the geological substrate influences the type and form of chemical response, and resulted in warnings from some authors (Bradshaw, et al, 1974, Fletcher, 1981) that these important factors should not be ignored. The recent resurgence of weak extractions has prompted similar warnings from experienced analysts and geochemists. The recently published Special Issue of the *Journal of Geochemical Exploration on Selective Extractions* contained a warning from Gwendy Hall (Hall, 1998a) that unbuffered extractions such as Enzyme Leach will be sensitive to changing soil pH. Neutralization of the extractant by the soil will cause a change in the amount of element extracted. Similar problems and warnings were made in the same volume by Gray et al (1998), and Fonseca and da Silva (1998). These warnings also form part of the Distinguished Lecture talks given by Hall, as reported in the recent issue of *Explore* (Hall, 1998b).

The Selective Extraction volume also contains results from a study I did in 1994 (Smee, 1998) over two buried epithermal gold occurrences in the semi-arid desert of Nevada, U.S.A. The two gold occurrences are known as the 5 North deposit, overlain by about 30 m of alluvial valley fill, and the 8 North deposit, covered by about 100 m of alluvium. That work compared a number of chemical extractions, including aqua regia (AR), hydroxylamine hydrochloride (HYDHCl), sodium acetate/acetic acid (NaOAc), and enzyme leach on surface soils. The soils were classified as typical aridisols, containing little to no discernable horizon development, with the exception of a poorly developed pedogenic carbonate layer. The pH of the soils was strongly alkaline. The reader is referred to that paper for the deposit location, geological setting, and details of sampling and analysis.

Both of the deposits studied showed an increase in Ca in soils on the margins of the underlying mineralization, thus creating a double-peak or "rabbit-ear" pattern of Ca distribution. This pattern was seen in all chemical extractions used. The results of that study lead to the presentation of a hypothesis to explain these patterns. This hypothesis called for the mobilization of near-surface Ca over oxidizing mineralization in response to the release and upward movement of H<sup>+</sup>. Supporting evidence for this mobilization of Ca from above the mineralization and the re-precipitation on the margins of mineralization came from the ratio of weakly bound Ca to total Ca (as derived from the acetic acid/sodium acetate soluble Ca divided by the aqua regia soluble Ca). It was assumed that re-mobilized

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## Technical Note *Continued from Page 4*

and re-precipitated Ca would have a slightly different composition, i.e. contain less impurities, than that of ambient pedogenic Ca and therefore would be more easily dissolved by the weaker extraction. Positive residuals from this ratio should coincide with the "rabbit-ear" pattern. This positive residual pattern did occur over both deposits.

These same samples have recently been reanalyzed using much improved ICP-MS techniques that offered lower detection limits and a larger number of elements than in the initial study. Chemex Labs of Vancouver donated the analysis as part of the up-coming I.G.E.S. field trip to Nevada, where comparative selective extraction data from a number of buried and blind deposits will be shown. The reanalysis included the same analytical extractions used in the initial study, with the exception of the enzyme leach method. As part of this reanalysis, Brenda Caughlin, Director, Laboratory Services, had the foresight to measure the pH of the leach solution for each sample after leaching had been completed but before analysis. These pH measurements were reported with the normal analytical data.

### Results

The hydroxylamine hydrochloride (HYDHCl) extraction is designed to dissolve iron and manganese oxy-hydroxide species, similar to enzyme leach, but a bit stronger. HYDHCl also has a very low neutralization potential, and should be sensitive to changes in pedogenic  $\text{CaCO}_3$ . The HYDHCl leach solution pH was plotted against AR Ca (Figure 1a) and HYDHCl Ca (Figure 1b) to determine what effect, if any, a change in Ca concentration had on the leach solution strength.

The effect of a change in soil Ca concentration was dramatic. A change of only 0.5% AR Ca, from 0.5% to 1%, raised the pH of the HYDHCl leach solution from 2.7 to nearly 5, at which point the rate of increasing pH begins to flatten with increasing Ca. An almost identical pattern occurs for HYDHCl soluble Ca. This change in leach solution pH possibly explains the inverse relationship found between enzyme leach Sr (a substitute for Ca), and Fe reported in the initial study (Smee, 1998). It is apparent that the soil substrate plays an important, and possibly controlling, role in the concentration of elements leached from a soil if a low neutralization potential leach is used. Spurious element distribution patterns, completely unrelated to underlying mineralization, are probably formed where ever the concentration of alkaline soil compounds change.

The possibility that the leach solution pH is influenced to a greater degree by easily dissolved pedogenic Ca was tested by plotting the ratio of HYDHCl Ca/AR Ca against the HYDHCl leach solution pH as shown in Figure 2. A direct relationship between the Ca ratio and leach solution pH occurs over the two deposits. This clearly linear relationship raises an interesting possibility: if pedogenic carbonate is being mobilized and re-precipitated in response to buried or blind sulphide mineralization, can a simple leach solution pH measurement be used to detect this mineralization? If so, an inexpensive and rapid field technique could be used to detect mineralization in semi-arid and arid environments.

This theory was tested by plotting the Ca ratio and the HYDHCl solution pH together along the four test lines over the 5 North and 8 North deposits as shown in Figures 3 a-d. The correlation between the two variables is remarkable. The solution pH is as good or better an indicator of underlying

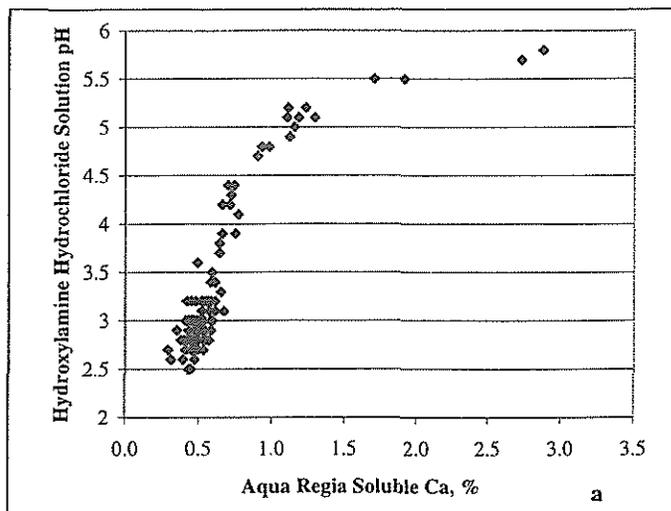


Figure 1: The relationship between aqua regia soluble Ca (a), hydroxylamine hydrochloride soluble Ca (b), and hydroxylamine hydrochloride leach solution pH after the leach has been completed but before solution analysis.

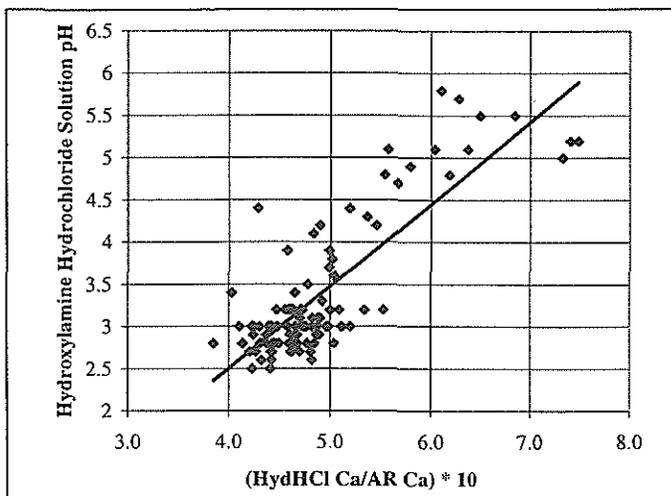
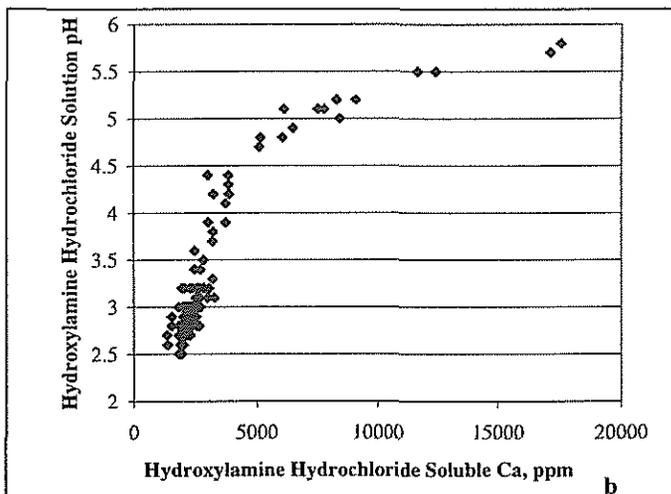


Figure 2: A linear relationship between hydroxylamine hydrochloride leach solution pH and easily leached soil Ca, as indicated by the ratio between weakly bound hydroxylamine hydrochloride soluble Ca and "total" (aqua regia soluble) Ca.

## Technical Note

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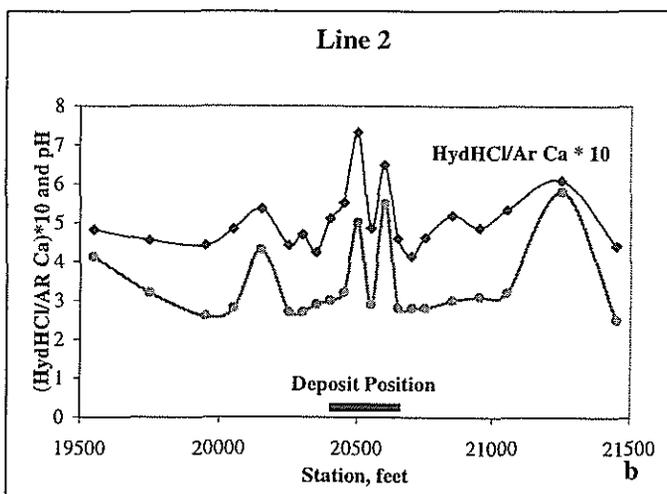
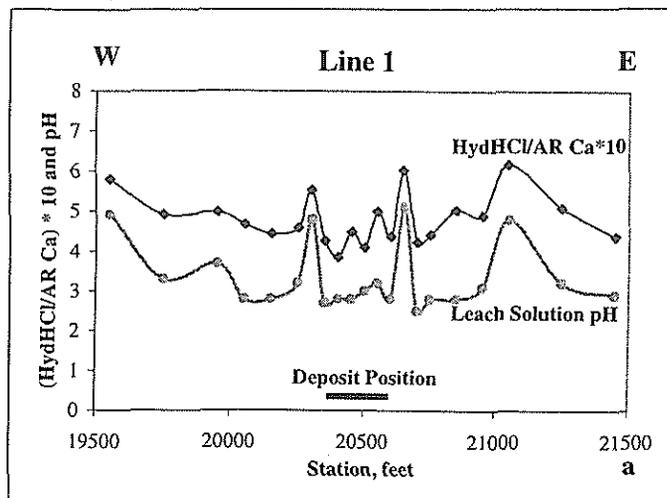
mineralization as is the Ca ratio. Each line has a clear "rabbit-ear" response on the margins of mineralization. Lines 1 and 2, over the 5 North deposit each show a single positive response on the western and eastern end of the lines. These responses are thought to occur in the vicinity of faults that bound the mineralized block (Leinz, et al, 1998). The solution pH reveals the location of the 8 North deposit through nearly 100m of alluvial fill much better than does the Ca ratio on Line 3. Line 4 is located over a thicker portion of the 8 North deposit, but is also covered by nearly 100m of overburden. Both the Ca ratio and solution pH produces unambiguous responses over the margins of the mineralization.

### Conclusions

Soil chemistry, particularly the Ca content, is clearly influencing the pH of poorly buffered weak leach solutions. Changes in soil Ca will produce corresponding changes in leached element concentrations that may be unrelated to mineralization. A large amount of time and money is probably being wasted in following up "anomalies" that are, in fact, simple changes in soil conditions. Anyone using weak leach methods should insist on being provided with the pH of the leach solution after the leach has been performed but before the analysis. All weak leach analysis should include the elements Ca or Sr as a check on soil variability.

These data suggest that leach solution pH may itself be a useful tool to detect covered sulphide mineralization in semi-arid to arid environments. Much more research should be done

Figure 3: A comparison of the spatial responses of the Ca ratio and hydroxylamine hydrochloride leach solution pH over: (a) and (b) the 5 North deposit (approximately 30m of alluvial cover); and (c) and (d) the 8 North deposit (approximately 100m of alluvial cover).



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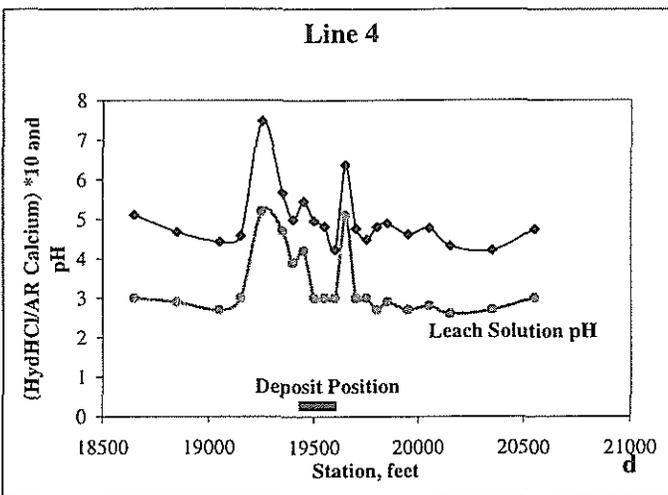
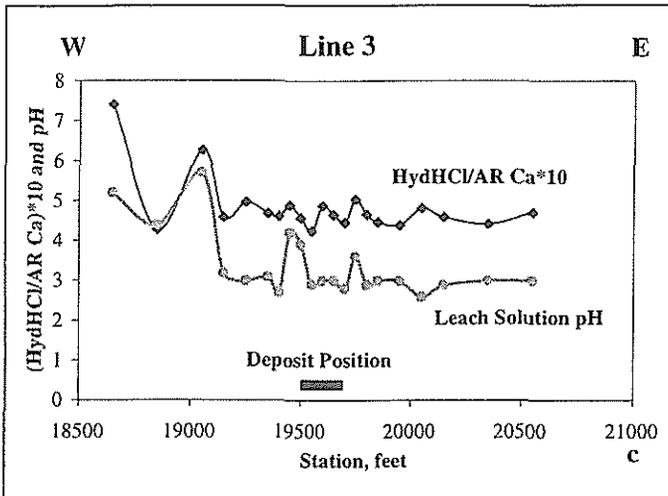
in this regard, however the cost for conducting field tests is small in comparison with analytical costs now being charged by companies providing proprietary leach analysis. A simple soil scoop, a bottle of distilled water (no buffering capacity), a test tube and a pH meter may be all that is necessary to detect blind mineralization in desert environments.

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## TECHNICAL NOTE #2

### Gold Ore Reference Materials: A Quality Assurance Tool for Geologists

by Malcolm Smith

In an ideal world a geologist could send samples away to a laboratory and receive back a set of results that properly represented the true values of the elements of interest in the samples. The results would also be very cheap and received within days of sample submission. Unfortunately we do not live in an ideal world and the above situation does not happen very often. There are many steps involved in the preparation and analysis of mineral samples and there are lots of opportunities for things to go wrong along the way. Good laboratories know this only too well and take steps to monitor and control their analytical procedures. One of the ways in which they do this is to analyse Reference Materials (RMs) together with samples and compare the actual RM results with their certified values.

#### Reference Materials - What are they?

A Reference Material is defined in ISO Guide 35: 1989 (E) as *A material or substance one or more properties of which are sufficiently well established to be used for the calibration of an apparatus, the assessment of a measurement method or for assigning values to materials.* All sorts of properties can be reflected in Reference Materials, which can range in type from gas mixtures to vaccines. Of course the ones of interest to geologists and mining laboratories are of geological origin and contain known quantities of various elements. Reference Materials are used in many industries and are the subject of several ISO Guides. Two important ISO Guides are ISO Guide 35 *Certification of reference materials - General and statistical principles* and ISO Guide 34 *Quality system guidelines for the production of reference materials.*

#### Important Properties of Reference Materials

##### *Accuracy of Assigned Value*

There are several ways in which a Reference Material can be characterised but a common way for geological materials is to use interlaboratory testing in which a number of recognised, competent laboratories analyse portions of the same material. The value and confidence intervals are then calculated after *statistical analysis of all results.* How close the calculated value is to the "true" value is determined by the degree of skill of each laboratory and the accuracy of the analytical procedures that are used.

##### *Homogeneity*

It is essential that the portion taken for analysis is the same as any other portion in the entire RM production batch. This may be only 1 gram for some base metal analyses so it is easy to see just how thoroughly the batch must be mixed. ISO Guides stipulate that homogeneity tests be carried out on Reference Materials after they have been packaged in their final form in order to ensure that no differentiation occurs during the

*Continued on Page 8*

## Technical Note

Continued from Page 7

packaging process. It would obviously not be practical to attempt to make a gold ore Reference Material from rock that contained coarse gold particles since it would be unlikely to have the same number of particles in each portion taken for analysis.

### Stability

The assigned value is expected to remain constant with time. This is generally so with geological material although sulphides can oxidise when exposed to humid air causing a change in weight and hence a change in the concentration of the certified elements. Fine powders also tend to change weight due to moisture pick-up and release as humidity and temperature changes. Vibration occurring during transport of Reference Materials may cause heavy particles to separate from light particles. This can be a problem with gold and gold ore Reference Materials should be made in such a way that gold would not settle out if exposed to transport vibrations.

### Certificate

A Reference Material should be accompanied by a certificate that specifies all of the relevant details of the validation process. ISO Guide 31 details the contents of RM certificates as does ASTM standard E 1831 - 96 - *Preparing Certificates for Reference Materials Relating to Chemical Composition of Metals, Ores and Related Materials*.

## Sources of Reference Materials

Several companies supply geological Reference Materials to laboratories. These may be used on an occasional or every batch basis by the laboratory as one of the tools they use to monitor the quality of their analytical procedures. Unfortunately geologists do not usually get to see the results of the RM analyses so they may not know just how well, (or how badly) the laboratory they use is performing.

### New Product Available

Rocklabs Ltd have produced a batch of Reference Materials with the geologist in mind. They have all the expected features of a Reference Material but are also packed in small weather-proof sachets. Each sachet contains just enough material for 1 analysis. (There are 2 sizes - 30g and 50g so that the geologist can submit the weight usually used by the laboratory for his/her samples). If one RM sachet is included with every batch of samples, or with every 30 samples for large batches, much information can be gained if the geologist plots the results received. Charting Reference Material results is a practice carried out by most laboratories but many geologists do not get to see these results and even if they do it will not always be clear which results relate to their own samples.

### Information to be Gained by Plotting RM Results

The accompanying chart showing consecutive results from analyses of a Reference Material containing 1.50 ppm gold illustrates various groupings of results that can occur. If the significance of these groupings is understood a better understanding of the laboratory's performance can be obtained.

#### Values 1 - 10

All results except one exhibit good precision (values are close together) and good accuracy (average of results is close to the RM Recommended Value). One result is far too high. The problem will not lie with the Reference Material for the essence of a good quality RM lies in the certainty the user can have in its consistency of value. When a geologist receives such an abnormally high result then the laboratory should be asked to investigate. Was there a problem only with the analysis of the Reference Material or are the results for the accompanying batch of samples also unacceptably high?

#### Values 11 - 20

These results have a greater spread than most results from the previous group but their average would still compare well with the recommended value. Why has the precision deteriorated? The precision obtained on the samples will certainly be no better and if the samples contain spotty gold it will be worse! Will the laboratory improve the precision of their own accord or do they need a reminder?

#### Values 21 - 30

The RM results are showing a trend towards an increase in value. The laboratory should be asked to investigate. Prompt attention to remedy the cause of the trend can prevent the need for re-assaying whole batches of samples later on when the bias becomes unacceptable.

#### Values 31 - 40

The results may be precise but they are not accurate. The samples, too, will exhibit this high bias. There could be a

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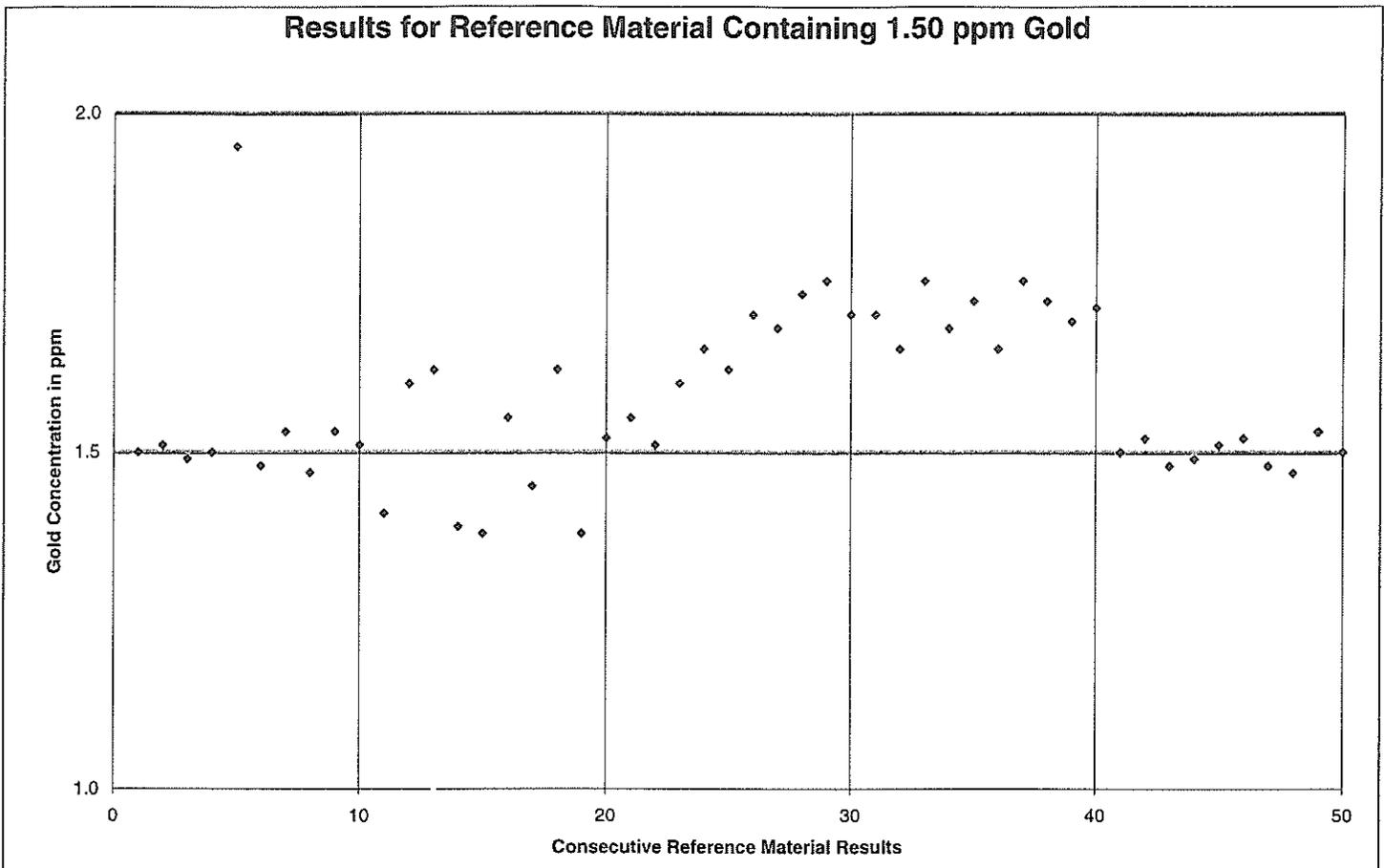
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**Sample preparation:** Flin Flon (Manitoba), Saint John (N.B.), Yellowknife (N.W.T.), Tumeremo (Venezuela), Medellin (Colombia), Ulaanbaatar (Mongolia)

**Laboratories:** Ecuador, Bolivia, Brazil, Chile, Ghana, Zimbabwe, Kazakstan, Europe and elsewhere.

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### Results of Reference Material Containing 1.50 ppm Gold

logical explanation for these high values – perhaps a new set of calibration standards have been prepared but have not been made accurately. Again, if the problem is brought quickly to the attention of the laboratory then remedial action can be taken.

#### Values 41 – 50

The results which everyone likes to see. All results are accurate and precise. This gives the geologist confidence in the laboratory and enables him/her to demonstrate that reasonable care has been taken to ensure that the results, which are being presented in his/her report, have been carried out with built-in quality assurance. Of course, if the samples being submitted have an unusual matrix then it can not be assumed that good results on the Reference Materials also mean accurate results for the samples. In this situation a wise geologist would send representative sub-samples to a different laboratory of good repute to check that there is concordance with the first laboratory's results. But do not forget to use Reference Materials with these samples too!! If the 2 sets of results differ the Reference Materials may indicate which set is the more reliable.

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[Note from editors: The Technical Note by Malcolm Smith is published to provide useful suggestions to our readers, but neither the Editors nor AEG endorse the commercial product mentioned by Smith. To provide additional information, and an alternate professional point of view, we include the following technical comments on reference materials taken from a the peer review of Smith's note by Steve Wilson. Steve is a USGS research chemist on a cooperative program with the U.S. National Institute of Standards and Technology (NIST) developing new geologic reference materials. JTN]

## Some General Comments on Reference Materials and Their Use

by Stephen Wilson

The paper by Smith points out some very important information about the use of reference materials for quality assurance, but readers would benefit from additional information that is not mentioned. A key aspect to this topic is the concept of measurement uncertainty. Without delving into a detailed statistical discussion, readers should remember that although the recommended total element concentration is important, also critical is the uncertainty of the measurement when a reference material (RM) is used for quality assurance/quality control (QA/QC) purposes. For instance, figure 1, above, would be more informative if the users choice of uncertainty (95 percent confidence interval, one standard deviation, etc) were shown.

## General Comments *Continued from Page 9*

One of the problems associated with the use of prepared RMs is that a laboratory may identify the QC sample as a special sample and analyze it with extra care. In doing so, the chemists may arrive at the correct answer for the QC sample but not for the other samples. A better approach is to physically prepare all samples to be submitted prior to transport so that the lab can not identify the RMs. This double blind approach increases the likelihood that all samples are treated equally.

Another important consideration is the different purpose and level of quality of RMs. The highest level are those from a reputable agency such as NIST. These are expensive and are not designed for QC purposes. Materials from national labs such as the U.S. Geological Survey or Geological Survey of Canada are considered to be either primary or secondary, are not cheap but are affordable for limited use in QC. Materials from commercial vendors are at a third level, and their low cost makes them appropriate for QC. A fourth level of RMs are those that the submitter makes from previously analyzed materials. Grinding this material to an appropriate size, blending, and packaging for multiple analyses makes inexpensive material that can be selected to matrix match the submitted samples. Submitting this material in an ongoing geochemical program can quickly create a database of values that can be used to estimate a recommended value, and most importantly track a lab's performance using a matrix that matches the new samples.

While selecting RMs, physical properties and related properties should be considered. Matters such as sample

particle size and amount used for analysis bear on the analytical results. Homogeneity of the RM obviously is important, as is stability of the material during storage. This is a well known problem for materials having a mixture of grains with widely differing densities. Careful mixing of the RM is recommended, such as by end-over-end methods in bottles with ample head space to promote mixing.

The key factor that RM and QC materials are designed to measure is data consistency. While one would like to have the reported value for gold or other elements match the certificate values, it is just as important that the reported values be consistent. Consistently biased values (eg, +10 percent) are more useful than values that are randomly erratic but yield a mean that matches the recommended value.

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## RECENT PAPERS

This list comprises titles that have appeared in major publications since the compilation in **EXPLORE** Number 101. 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 (Bull CIM), Transactions of Institute of Mining and Metallurgy, Section B: Applied Earth Sciences (Trans. IMM). Publications less frequently cited are identified in full. Compiled by L. Graham Closs, Department of Geology and Geological Engineering, Colorado School of Mines, Golden, CO 80401-1887, Chairman AEG Bibliography Committee. Please send new references to Dr. Closs, not to **EXPLORE**.

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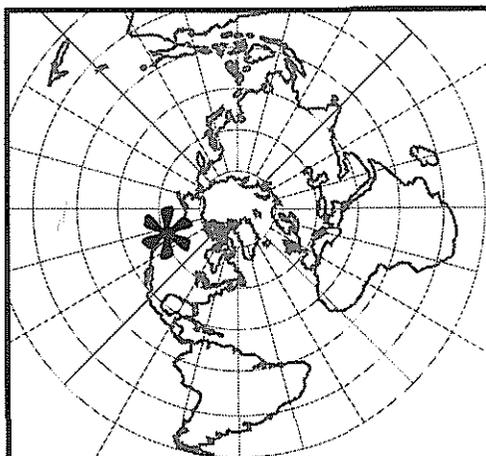
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■ March 1-3, 1999, **Annual meeting of Society for Mining, Metallurgy, and Exploration (SME)**, Denver, Colo. INFORMATION: Donald Taylor, BHP Minerals, 1597 Cole Blvd., St. 250, Golden, CO 80401, TEL 303-235-4414, Fax 303-235-4435. E-mail: taylor.don.dr@bhp.com.au.

■ March 15-16, 1999, **South-central Section, GSA**, Lubbock, TX. INFORMATION: James Barrick, Dept. of Geosciences, Texas Tech University, Lubbock, TX 79409-1053, TEL. 806-742-3107. E-mail: ghjeb@ttu.edu.

■ March 21-25, 1999, **American Chemical Society Annual Meeting**, Anaheim, Cal., INFORMATION: American Chemical Society Meetings Department, 1155 Sixteenth Street, N.W., Washington, D.C. 20036, (202) 872-4396, Fax: (202) 872-6128, E-mail: natlmtgs@acs.org.

*Continued on Page 14*

## Calendar of Events *Continued from Page 13*

■ March 22-24, 1999, **Northeastern Section, GSA**, Providence, Rhode Island. INFORMATION: Anne I. Veeger, Dept. of Geology, University of Rhode Island, 8 Ranger Rd., St. 2, Kingston, RI 02881, TEL. 401-874-2187. E-mail: veeger@uriacc.uri.edu.

■ March 25-26, 1999, **Southeastern Section GSA**, Athens, Georgia. INFORMATION: Mike Roden, Dept. of Geology, University of Georgia, Athens, GA 30602, TEL. 706-542-2416. E-mail: mroden@gly.uga.edu.

■ April 8-10, 1999, **GSA Rocky Mountain Section Meeting**, Quality Inn Pocatello Park Hotel, Pocatello, Idaho. INFORMATION: Paul Link, Dept. of Geology, Idaho State University, 785 South 8th Ave., Pocatello, ID 83209-8072, 208 236-3846, linkpaul@isu.edu.

■ April 11-16, 1999, **19<sup>th</sup> International Geochemical Exploration Symposium**, Vancouver, Canada. INFORMATION: Venue West Conference Services Ltd., #645-375 Water Street, Vancouver, BC, Canada V6B5C6, TEL. 604-681-5226, FAX 604-681-2503, email: congress@venuest.com.

■ April 22-23, 1999, **GSA North-Central Section Meeting**, Chancellor Hotel and Conference Center, Champaign-Urbana,

Illinois. INFORMATION: C. Pius Weibel, Illinois State Geological Survey, 615 Peabody Dr., Champaign, IL 61820, (217) 333-5108, e-mail: wiebel@isgs.uiuc.edu.

■ May 26-28, 1999, **Geological Association of Canada-Mineralogical Association of Canada Joint Annual Meeting**, Sudbury, Ontario, Canada. INFORMATION: Dr. P. Copper, Dept. of Earth Sciences, Laurentian University, Sudbury, Ontario P3E 2C6, TEL. 705-675-1151 (ext. 2267), FAX: 705-675-4898, e-mail: gacmac99@nickel.laurentian.ca.

■ June 2-4, 1999, **GSA Cordilleran Section Meeting**, University of California, Berkeley, California. INFORMATION: George Brimhall, Dept. of Geology & Geophysics, University of California, Berkeley, CA 94720-4767, (510) 642-5868, brimhall@socrates.berkeley.edu [Note: several special sessions on mineral exploration and mine-related environmental geochemistry]

■ June 26-July 1, 1999, **Clay Minerals Society 36th Annual Meeting**, Purdue University, West Lafayette, Indiana. INFORMATION: Patricia Jo Eberl, Clay Minerals Society, P.O. Box 4416, Boulder, CO 80306, (303) 444-6405, fax 303-444-2260, e-mail: peberl@clays.org.

*Continued on Page 16*



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Contributors' deadlines for the next four issues of  
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Issue	Publication date	Contributor's Deadline
103	April 1999	February 28, 1999
104	July 1999	May 31, 1999
105	October 1999	August 31, 1999
102	January 2000	November 30, 1999

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—	GEOEXPO/86, Proceedings of an exploration symposium focussing on Cordilleran environments held in Vancouver May 12-14, 1986 (ed. I.L. Elliot and B.W. Smee)	US \$25.00	US \$25.00	_____
—	Reviews in Economic Geology Volume 3. Exploration Geochemistry; Design and Interpretation of Soil Surveys (ed. W.K. Fletcher). This volume was co-sponsored by the SEG.	US \$20.00	US \$25.00	_____
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—	17th IGES Extended Abstracts from "Exploring the Tropics", 15-19 May, 1995, Townsville Australia (for airmail add \$20)	US \$50.00	US \$65.00	_____
—	A Global Geochemical Database for Environmental and Resource Management, Recommendations for International Geochemical Mapping, Final Report of IGCP Project 259. (A.G. Darnley A. Bjorkland, B. Bolviken, N. Gustavsson, P.V. Koval, J.A. Plant, A. Steinfeld, M. Tauchid and Xie Xuejing; with contributions by R. Garrett, and G.E.M. Hall).	US \$20.00	US \$20.00	_____
—	Geochemistry in Mineral Exploration (second edition, published 1979) (A.W. Rose, H.E. Hawkes, and J.S. Webb) - airmail US\$10.00/International \$20.00 additional	US \$60.00	US \$80.00	_____
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- July 7-10, 1999, **Geocongress '98**, University of Pretoria, South Africa. INFORMATION: P.O. Box 798, Pretoria, 0001 South Africa, fax: 012-841-1221, e-mail: [caucamp@geoscience.org.za](mailto:caucamp@geoscience.org.za).
- August 22-25, 1999, **Society for Geology Applied to Mineral Deposits 5<sup>th</sup> Biennial Conference**, London, UK. INFORMATION: Dr. Chris J. Stanley, Associate Keeper of Mineralogy, Department of Mineralogy, Natural History Museum, Cromwell Rd., London, SW7 5BD, UK, Tel 44-171-938-9361. E-mail: [cjs@nhm.ac.uk](mailto:cjs@nhm.ac.uk).
- October, 25-28, 1999, **Annual Meeting of the Geological Society of America**, Denver, Colo. INFORMATION: TEL 1-800-472-1988, [meetings@geosociety.org](mailto:meetings@geosociety.org).
- March 6-9, 2000, **Annual meeting of Society for Mining, Metallurgy, and Exploration (SME)**, Salt Lake City, Utah. INFORMATION: Shaffer Parkway, P. O. Box 625002, Littleton, Colo., 80162-5002, 303-973-9550. E-mail: [smenet@aol.com](mailto:smenet@aol.com).
- April 24-28, 2000, **5<sup>th</sup> International Symposium on Environmental Geochemistry**, Cape Town, South Africa. INFORMATION: SISEG, Department of Geological Sciences, University of Cape Town, Private Bag, Rondebosch, 7701, South Africa, FAX 27-21-650-3783. Email: [5iseg@geology.uct.ac.za](mailto:5iseg@geology.uct.ac.za).
- May 15-18, 2000, **Geology and ore deposits 2000: The Great Basin and beyond**, Reno/Sparks, Nevada, USA. INFORMATION: Geological Society of Nevada. 702-323-3500, ax 702-323-3599, e-mail: [gsnsymp@nbgm.unr.edu](mailto:gsnsymp@nbgm.unr.edu).
- August 6-17, 2000, **31<sup>st</sup> International Geological Congress**, Rio de Janeiro, Brazil. INFORMATION: Secretariat Bureau, Casa Brazil 2000, Av. Pasteur, 404 Urca, Rio de Janeiro-RJ-Brazil, CEP 22.290-240, phone 55 21 295 5847, fax: 55 21 295 8094. E-mail: [31igc@31igc.org](mailto:31igc@31igc.org), <http://www.31igc.org>.
- December 14 - 19, 2000, **Pacificchem 2000**, Honolulu. INFORMATION: Congress Secretariat, c/o American Chemical Society, 1155 16th St. N.W., Washington, D.C. 20036, fax: 202-872-6128. E-mail: [pacificchem@acs.org](mailto:pacificchem@acs.org).

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

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## MEETING NOTICE

**AEG Annual General Meeting**

**Place: 19th IGES**

**Vancouver, BC**

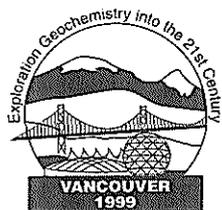
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### **Technical Sessions**

Technical Sessions will be held on April 12-13, 15-16. The sessions will include the following topics.

- Exploration for Buried Deposits
- Advances in Drainage Geochemistry
- Exploration in Tropical Terrain
- Exploration in Glaciated Terrain
- Litho-geochemistry in Exploration
- Data Presentation and Interpretation
- Environmental Geochemistry applied to Mining

### **Short Courses**

Short courses will take place April 10th–11th before the symposium

- Drift prospecting in Glaciated Terrain
- Geoanalysis with emphasis on Selective Extractions
- New advances in Diamond exploration
- Quality Control in Mineral Exploration

### **Field Trips**

Field trips will take place after the meeting, starting April 17th.

- Applied Geochemical Methods
- Environmental Geochemistry
- Geochemical Exploration Techniques for Buried deposits

### **Trade Show**

An Exhibition of Geochemical Exploration services and products from around the world will be held in areas adjoining the technical sessions and will take place on April 12 - 13 and on April 15 - 16.

### **Accompanying Persons Program**

A full program of tours to local places of interest, including Victoria and Whistler will be arranged.

### **Tour and Social Programs**

*A welcoming reception is planned for Sunday, April 11th. A symposium dinner will be held on Thursday April 15th. The mid Symposium break on Wednesday April 14th will give delegates and guests the opportunity of enjoying the many attractions and spectacular scenery of the Vancouver area.*

### **Further Information**

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*Continued on Page 19*



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# AEG APPLICATION FOR NON-VOTING MEMBERSHIP\*

to the Association of Exploration Geochemists  
 Please complete the section relevant to the class of membership sought and supply your address on this form.  
 Mail the completed application, together with annual dues, to the address below.

## MEMBER

I \_\_\_\_\_ wish to apply for election as a Member of the Association of Exploration Geochemists. I am presently employed by:

\_\_\_\_\_ as a \_\_\_\_\_  
 (employer) (employment title)

I am actively engaged in scientific or technological work related to geochemical exploration and have been so for the past two years. Upon receipt of the Code of Ethics of the Association I will read them and, in the event of being elected a Member, agree to honour and abide by them. Witness my hand this \_\_\_\_\_ day of \_\_\_\_\_ 19 \_\_\_\_\_.

(Signature of applicant)

## STUDENT MEMBER

I \_\_\_\_\_ wish to apply for election as a Student Member of the Association of Exploration Geochemists. I am presently engaged as a full-time student at \_\_\_\_\_, where I am taking a course in pure or applied science. Upon receipt of the Code of Ethics of the Association and in the event of being elected a Student Member agree to honour and abide by them. Witness my hand this \_\_\_\_\_ day of \_\_\_\_\_ 19 \_\_\_\_\_.

(Signature of applicant)

Student status must be verified by a Professor of your institution or a Fellow of the Association of Exploration Geochemists. I certify that the applicant is a full-time student at this institution.

(Signature)

(Printed Name and Title)

## NAME AND ADDRESS

(to be completed by all applicants)

Name: \_\_\_\_\_  
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 \_\_\_\_\_

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## Annual Dues

All applications must be accompanied by annual dues. Select one or two below:

- |   |   |      |              |       |
|---|---|------|--------------|-------|
| 1 | 1998 member dues  | US\$ | 70           | _____ |
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|   | If you require a receipt, include a self-addressed envelope and add |      | 2            | _____ |
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Name: \_\_\_\_\_ Signature: \_\_\_\_\_

Please note: Your completed form should be mailed to the Business Office of the Association and will be acknowledged upon receipt. The Admissions Committee reviews all applications and submits recommendations to Council, who will review these recommendations at the next Council Meeting or by correspondence. If no objection is raised the names, addresses and positions of candidates will be listed in the next issue of the Association Newsletter. If after a minimum of 60 days have elapsed following submission of candidate information to the membership no signed letters objecting to candidates admission are received by the Secretary of the Association from any Member, the Candidate shall be deemed elected, subject to the receipt by the Association of payment of required dues. Send completed application, together with annual dues to:

Association of Exploration Geochemists, P.O. Box 26099, 72 Robertson Road, Nepean, Ontario, CANADA K2H 9R0  
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\*Application for voting membership requires the sponsorship of three voting members. Request a voting member application from the Association office.

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