

EXPLORE

The Association of Exploration Geochemists Newsletter

NUMBER 69

SEPTEMBER 1990

PAST-PRESIDENT'S MESSAGE

As I write this final message to the membership, I note on the calendar that about one week from now (August 31) I will hand over the stewardship of the Association to my successor, Dr. Don Runnells. My term has passed quickly and by the time you read this I should be lying on an exotic beach contemplating why I did not accomplish all my goals as your President. Our organization has built into the By-Laws the required precautionary procedures to insure that all important items must be fully reviewed by Council before action can be approved. Some actions also require approval of membership. Thus, many projects or action items are inherited by each successive President until approval, amendment, or rejection is achieved. A fair system but one which sometimes appears to be inordinately slow to the Membership.



This brings me to the subject of my message. In the June, 1990 issue of EXPLORE, I stated that my goals are communications and efficiency and I discussed communications in that issue.

EFFICIENCY — producing the maximum effect with the minimum effort or expense — perhaps an Utopian concept, but one which we all wish we could accomplish. To complete each task in a single effort without complication or later modification, such as writing an important scientific communication, would provide us with enough extra time to do more research, enjoy more leisure, etc.

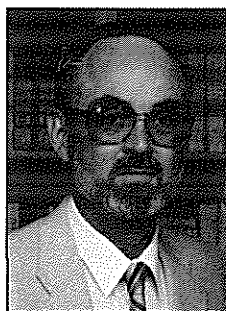
How does this apply to the AEG? No organization operates at maximum efficiency — there is always room for improvement. Your Association operates almost entirely on a volunteer basis. Most of your Executive and Council are employed on a full time basis or must compete aggressively as consultants, and must use part of their "leisure" time to accomplish their obligations to AEG. Fortunately most corporations, universities, and government agencies encourage participation in scientific organizations — the consultant, of course, can use up valuable income-earning time on AEG business. Some, such as your Business Manager, Secretary, Treasurer and members of the Explore team spend an extraordinary effort and invest many hours per week on Association items. These persons are what make your organization function and, because none of these volunteers can devote their full-time, the apparent efficiency of the organization appears to lag.

The appointment of a Business Manager to coordinate the business functions of the AEG is an important step in increased efficiency. In this role, Dr. Stan Hoffman, a past President of the Association, and a tireless and dedicated member will continue some of the duties he has been conducting for some time and will additionally interact with all business functions to ensure continuity and efficiency.

We are continually trying to improve the efficiency of AEG. At this time, we are investigating ways of improving and perhaps consolidating those functions which concern applications, annual dues, membership listing, etc. An examination of our By-Laws, with the intent of modernization and increased efficiency is in progress.

continued on page 2

PRESIDENT'S MESSAGE



This message, the first of my term as your new president, is being written in a United Airlines jet somewhere over the Atlantic. I am returning from the 14th AEG International Symposium, held in Prague, Czechoslovakia, August 25-31, in association with the 5th Geochemical Prospecting Symposium of the International Association of Geochemistry and Cosmochemistry. It was a particularly interesting time to be in Czechoslovakia, as that country struggles toward democracy after 42 years of communism.

From my personal observations, the symposium seemed very successful. A final tally isn't yet available, but I estimated that about 300 professionals were in attendance, with many coming from the Soviet Union. The organizing committee, under the direction of Frantisek Mrna of the Czechoslovakian Geological Survey, did a fine job. Most technical sessions at the symposium were well attended and the four major field trips were sold out. The three-day trip that I took to look at mines and prospects in Bohemia was extremely interesting, with a good mix of geochemistry, geology, history, and local color.

The Annual General Meeting of the AEG, held on Friday, August 31, was attended by about 40 members of your Association. I hope that each of you will be able to attend the next International Symposium and the Annual General Meeting of the AEG, to be held in late April, 1991, in Reno, Nevada. The organizing committee in Reno has a very special program outlined. A recurring theme at the Prague meeting was the emphasis now being placed on environmental geochemistry throughout the world. The dirty gray air that

continued on page 3

CONTENTS

Notes from the Editor.....2	Special Notes
Corrections.....2	Selection of a Geochemical Sampling Contractor.....15
Annual General Meeting.....3	Recent Papers.....16
Meeting Reports.....4	New Members.....18
1990 Directory.....4	1991 Dues Notice.....19
Technical Notes	Calendar of Events.....20
Exploration Geochemistry	Meeting Reports.....21
An Integrative Science.....5	Election Results.....21
Alkaline Cu-Au porphyries.....6	International Symposium
Some Relationships Between	15th International Geochemical
Exploration Geochemistry	Exploration Symposium.....22
and Environmental	15th IGES Registration Form.....23
Geochemistry.....10	List of Advertisers.....24
Pearl Harbor File.....14	
Gold Analysis of Soils	

Information for Contributors to EXPLORE

Scope This Newsletter endeavors to become a forum for late 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 illustrations where possible. Meeting reports may have photographs, for example. Text is preferred on paper and 5¼- or 3½-inch IBM-compatible computer diskettes with ASCII (DOS) format, which can go directly to typesetting. Please include 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 reexamination 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.

EXPLORE

Newsletter No. 69

SEPTEMBER 1990

Business Manager and Associate Editor: S. Clark Smith (702) 849-2235

Editor of Pearl Harbor File: Stanley J. Hoffman (604) 682-8345

Associate Editor: J. Howard McCarthy, Jr. (702) 784-5362

Assistant Editors: Stephen B. Castor (702) 784-6691

L. Graham Closs (303) 273-3856

Keryl L. Fleming (702) 784-6691

Gwendy E. M. Hall (613) 995-4521

Lloyd D. James (303) 741-5199

Paul J. Lechler (702) 784-6691

Richard Meeuwig (702) 784-6691

Frederick P. Schwarz (702) 826-3000

Frederick R. Siegel (202) 994-6194

FAX 702-784-1766, ATTN: J. Howard McCarthy, USGS

Advertising Rates

Advertising rates are on a per-issue basis.

Frequency discounts and rates for color separations are available.

Only camera-ready copy is accepted. Please direct advertising inquiries to P.O. Box 9777, University Station, Reno, Nevada 89507-9777.

Full Page	254h x 178w mm (10h x 7w in)	U.S.\$800
Half Page	124h x 178w mm (4 7/8h x 7w in)	U.S.\$440
	254h x 86w mm (10h x 3 3/8w in)	U.S.\$440
Quarter Page	124h x 86w mm (4 7/8h x 3 3/8w in)	U.S.\$240
	254h x 40w mm (10h x 1 9/16w in)	U.S.\$240
Eighth Page	60h x 86w mm (2 3/8h x 3 3/8w in)	U.S.\$150
	124h x 40w mm (4 7/8h x 1 9/16w in)	U.S.\$150
Business Cards*	50h x 86w mm (2h x 3 3/8w in)	U.S.\$ 60

*Business card advertising is restricted to individuals providing consulting or similar services.

The Editor reserves the right to insert the word "Advertisement" on all ads. Advertising submitted as a technical contribution is eligible for the following discounted schedule:

Full Page	U.S.\$560
Half Page	U.S.\$330
Quarter Page	U.S.\$200

EXPLORE is a trademark of the Association of Exploration Geochemists.

NOTES FROM THE EDITOR

Journal of Geochemical Exploration Volumes 37, numbers 2 and 3 and 38 numbers 1 and 2 have been issued since the last newsletter. Claims for missing issues are honored free of charge for three months after the date of issue — see under the back cover of the Journal. Back volumes are available at Dfl. 283 or \$US138.00. AEG members can save over \$350 a year for the 1987 through 1989 volumes by ordering through the Rexdale office.

Volume 37, numbers 2 and 3 contain 12 research papers on a variety of geochemical topics. Volume 38, numbers 1 and 2 is a special issue entitled "Soil and Rock Gas Geochemistry." This 245 page special issue contains 15 papers and is edited by Steven. E. Kesler.

EXPLORE Number 68 was distributed to 4000 professional including members of AEG, the Wyoming Geologic Society, American Geophysical Union, Geological Society of Alaska, the Tobacco Root Geological Society, Montana, Geologic Society of America, and over 100 libraries. Bulk shipments were made to Graham Taylor for Australia, John Forman for Brazil, and Stan Hoffman for Canada and Mexico. The remainder were dispersed at the 14th International Geochemical Exploration Symposium in Prague, Czechoslovakia. If you would be willing to distribute this newsletter to a local or regional meeting or to supply mailing labels of an association, please write to the editor.

CORRECTIONS

In issue 68 the formulas in the article by X. Xuejing, S. Ruiping, and W. Xueqiu were printed incorrectly. The correct formulas are printed below. Also in Table 2, the particle size in column 1 should read 20-40. We apologize for these errors.

Sherman P. Marsh

$$d_c = \sqrt[3]{\frac{\sum M_j d_j^3}{M}}$$

$$C = \sqrt[3]{\frac{\pi a^3}{6} \cdot d \cdot B / (A \cdot W)}$$

PAST-PRESIDENT'S MESSAGE *continued*

The purpose of improved efficiency are two-fold: first, to ensure that we have a smoothly operating organization which requires minimum input to operational functions and allows Executive and Council to dedicate their time to other issues and, secondly, to improve efficiencies in the operation of the AEG making it possible to better serve the needs of the membership.

A.E. Soregaroli
Past President

**"WHEN WORDS
ARE NOT ENOUGH!"**

Graphic Harmony

COMPUTER GENERATED
35mm PRESENTATION SLIDES
& OVERHEAD TRANSPARENCIES

(702) 322-5434
2590 E. 2nd ST. RENO, NEVADA 89502

DRAFTING AND BLUEPRINTING SERVICES ALSO AVAILABLE

ANNUAL GENERAL MEETING

On August 31, 1990 the Association of Exploration Geochemists held its Annual General Meeting (AGM) at the University of Agriculture auditorium in Prague, Czechoslovakia. The meeting was held in conjunction with the 5th International Association of Geochemistry and Cosmochemistry (IAGC).

1. Call to Order

The President called the meeting to order at 1:10 PM, local time, and established that a quorum of voting members was present.

2. Minutes of the 1989 Annual General Meeting

The President asked if there were any matters arising from the minutes of the 1989 AGM, as published in *Explore*. There were no matters arising.

It was moved (A. Coope) and seconded (G. Taylor) that the 1989 minutes of the Annual General Meeting of the Association of Exploration Geochemists, as published in *Explore* and filed with the Secretary, be approved. The President asked for a vote on the motion. Passed unanimously.

3. President's Report

The President expressed appreciation on behalf of the Council and Executive to the Organizing Committee of the XIII IGES and the II BGC for all their efforts. He went on to list some of the more important Association events that had occurred since the last AGM:

(1) In August of 1990, the Association published the new Association of Exploration Geochemists Directory. This publication lists all current members of the Association, names and addresses of companies providing geochemical, geological, and chemical services throughout the world, the By-Laws of the Association, and historical data relating to the Association.

(2) The Association moved the editorship of the newsletter *EXPLORE* to Denver, Colorado. *EXPLORE* is the only means of communication with the membership and this move will establish a quarterly publication schedule. A special note of appreciation was given to Chet Nichols for establishing the stature of *EXPLORE* as a world class newsletter. *EXPLORE* has been used as a model newsletter for other organizations.

(3) Dr. Stan Hoffman was appointed by Council and Executive to be the Business Manager of the Association. He will coordinate the business aspects of the organization.

(4) We are looking at ways to streamline the communications and processing of applications within the organization by combining these functions into one group.

(5) Two new Regional Councillors were elected this year; Dr. Gunter Matheis representing Europe and Dr. John M.A. Forman representing Brazil.

(6) Council and Executive established a position of Coordinator for Regional Councillors to insure maximum communication between the Association and the Regional Councillors. Dr. Kay Fletcher was appointed to fill the position.

(7) Council and Executive meet every two months via conference telephone call and this year it was decided to have one Regional Councillor present for each meeting. This has greatly helped communications and allowed direct input from the Regional Councillors.

(8) Council and Executive established a Developing Country membership fund. Members are encouraged to donate funds to provide memberships in the AEG for geologically oriented groups in Developing Countries that otherwise wouldn't be able to join the Association. The only restriction on these memberships is that they be approved by our publisher, Elsevier.

(9) An ad-hoc committee on Awards and Medals was established, headed by Dr. Robert Garrett. The AEG currently only has an Honorary Membership Award and additional awards and medals are being considered.

(10) An ad-hoc committee chaired by D. Alan Coope was established to study the future directions the Association should take. Anyone having opinions concerning this should contact Dr. Coope.

(11) The AEG published two volumes of the *Journal of Geochemical Exploration* (JGE) this year entitled "Epithermal Gold Mineralization of the Circum-Pacific: Geology, Geochemistry, Origin, and Exploration". This 921 page excellent compilation of new information about gold deposits in the Circum-Pacific has been an international "best seller".

(12) The Soils Short Course, Design and Interpretation of Soil Surveys, was given at the Prospectors and Developers meeting in Toronto.

(13) The AEG co-sponsored the Goldschmidt Conference in Baltimore, MD.

(14) The AEG is planning for future symposia. In May, 1991 there will be an International Geochemical Exploration Symposium (IGES) in Reno, Nevada and in 1993 there will be an IGES in Beijing, China. Proposals have been received for co-sponsoring a symposium in Irkutsk, USSR in 1994, for co-sponsoring regional meetings in Nova Scotia, Canada with the Geological Association of Canada, in 1992, and for meetings in Spain in 1995.

4. Secretary's Report

In the absence of the Secretary M.A. Chaffee gave the Secretary's Report.

The 1990 AEG membership is 1060 to date and consists of Voting,

PRESIDENT'S MESSAGE *continued from Page 1*

constantly hangs over the land masses of the Earth (even eastern Canada, as I look out of the window of the airplane) is just one of the many constant and grim reminders that man can no longer exploit the resources of the Earth without concern for the environment. Fortunately, exploration geochemists are trained to understand and to predict the behavior and fluxes of chemical species in nature, and no group is in a better position to help understand and ameliorate the massive releases and movement of chemical species now being caused by man. Each of us has friends or colleagues who have moved from exploration geochemistry into environmental geochemistry, and a major challenge faces the AEG in determining how to best continue to serve our traditional membership while at the same time responding to the very real needs and opportunities in environmental geochemistry.

Our past-president, Art Soregaroli responded to this evolving situation by establishing a committee to work on future directions for the AEG, especially with respect to our role in environmental geochemistry. The committee is chaired by a Councillor and founder of the Association, Alan Coope. Please feel free to communicate with Alan or any other member of the Executive concerning your feelings about future directions for your Association.

On another matter, I wish to inform you that the editorship and printing of *Explore* have been moved from Reno to Denver. We anticipate that more regular and timely publication will result from this change. At the same time we can only hope to maintain the high quality, high standards, and outstanding appearance of *Explore* established by Chet Nichols, Clark Smith, Howard McCarthy and other members in Reno.

Enough for now. Enjoy this issue of your newsletter, and please let us hear from you if you have anything you want to get off your chest.

Donald D. Runnells
President

Advertise in *EXPLORE*
Support Your Newsletter

Annual General Meeting *continued.*

Affiliate, and Student Members. It is hoped that by the end of the membership year in June, 1991 the Association will have an increase over the 1155 members for 1989. The Association would like to extend an invitation to all interested participants in the Prague Symposium to consider membership in this premier international society.

Members continued to enjoy the Explore newsletter, now in its second year of publication. Its popularity will insure its continued publication; it is one of the major benefits of membership in the Association.

Since the last AGM in Rio de Janeiro, Brazil in October, 1989 the Council of the Association has met 4 times and many matters of concern to members have been discussed.

The association has had several elections, both general and in Council, to elect a new Vice President, 2 Regional Councillors, and 5 Ordinary Councillors.

The Association hopes to continue to grow in the coming year and plans to actively solicit members in developing countries in the southern hemisphere, eastern Europe, and Asia.

5. Treasurer's Report

In the absence of the Treasurer M.A. Chaffee gave the Treasurer's Report. He announced that a copy of the Treasurer's Report for 1989 was available to attending members.

6. Introduction of the 1989-90 Executive

The President announced that the incoming President for 1990 would be Donald D. Runnells, the First Vice President would be W. Kay Fletcher, the Second Vice President would be Jeffrey A. Jaacks, the Secretary would remain Sherman Marsh, and the Treasurer would remain David M. Jenkins.

7. Announcement of the 1989-91 Ordinary Councillors

The M.A. Chaffee announced that, as a result of a general election, Ray E. Lett, Peter J. Rogers, and Paul Taufen had been elected as new Ordinary Councillors. Harold F. Bonham and S. Clark Smith were re-elected to a second term and Arthur E. Soregaroli would serve as a Ordinary Councillor in his ex-officio status. There were three outgoing members of Council, Stan Hoffman, Paul Matysek, and Fred Siegel. These Council members were thanked for their efforts in helping to run the affairs of the Association and were invited to remain active participants.

8. Announcement of Election of Regional Councillors

The President announced that Gunter Matheis had been elected as Regional Councillor for Europe and the appointment of John M.A. Forman as Regional Councillor for Brazil.

It was moved (Dr. Darnley) and seconded (K. Fletcher) that John M.A. Forman be elected as Regional Councillor for Brazil. The President asked for a vote on the motion. Passed with one vote against.

9. Motion to destroy ballots

It was moved (I. Elliot) and seconded (R. Garrett) that the accountants, Nemeth Thody and Associates, be instructed to destroy the ballots for Ordinary Councillor. The President asked for a vote on the motion. Passed unanimously.

10. Appointment of auditors

It was moved (G. Taylor) and seconded (G. Hall) that the Treasurer be given permission to reappoint the existing accounting firm of Nemeth Thody and Associates as auditors for the Association of Exploration Geochemistry for the year 1990. The President asked for a vote on the motion. Passed unanimously.

12. Transfer of meeting

The President transferred the meeting to Donald D. Runnells. On behalf of the Association D. Runnells thanked the out-going President, Secretary, and Councillors and welcomed the in-coming Councillors. He thanked A. Soregaroli for an outstanding year of

Continued on Page 21

MEETING REPORTS

PRAGUE-90

The 14th IGES symposium held in Prague, Czechoslovakia, August 29 to 31, 1990 is now history. The convention attracted 350 delegates, including 200 from western countries. The large attendance from the west can be attributed to proximity of Prague to western Europe and the recent dramatic changes in the political climate of this part of Europe. A large number of attendees from the Soviet Union and other eastern European countries contributed to the over 40 countries represented at the symposium. Excellent weather, marvellous sightseeing opportunities, and low cost greeted visitors and I am sure made a very favourable impression.

The symposium was accompanied by pre and post-symposium field trips to historically famous mining districts, and a series of preconvention workshops. Technical sessions of the symposium were accompanied by a large poster session. Many of the workshop contributions, posters and technical papers are summarized in a 262 page extended abstracts volume which is being made available for sale to AEG members, at a cost of US \$25.00 (US \$50.00 for non-members). The volume can be ordered from the AEG office in Rexdale, Ontario by requesting PRAGUE-90 ABSTRACTS. Please add US \$5.00 if airmail is required, as volumes will be mailed by the organizing committee of the 14th IGES from Prague.

1990 DIRECTORY

The 1990 AEG membership listing and DIRECTORY of geochemical exploration and environmental services has been published, and distribution was completed August 22, 1990. Unfortunately, the high cost of postage to localities outside North America mandated that the volumes be posted surface mail. Except for the most remote locations, all members in good standing should now have their volume. A total printing of 1300 covers the membership for 1990 and leaves some copies available for sale (see publication list of the AEG).

Review the letter that was included with the DIRECTORY, particularly those aspects which suggest you make corrections or additions and send them to my attention. Review your own membership information, and please make corrections or updates (i.e., telefax numbers). It would be appreciated if members would ensure they have a company affiliation (even though they may have all correspondence addressed to their home address) and their first name listed.

The AEG is making the service portion of the DIRECTORY available to its members on a floppy disk, at a cost of U.S. \$60.00. The disk can be prepared on low or high density 5¼" or 3½" diskettes compatible with DBase III or ASCII format (i.e., standard data format or delimited format). Updated disks will become available periodically, with notices published. Please send corrections and additions to the DIRECTORY file to help make the service section of greater value to you and others (i.e., check the alphabetic listings to see if your favourite suppliers, companies, etc., are listed, and if not send names, addresses, telephone/ telefax and contact individuals to my attention. Help them, other AEG members and the AEG!).

Stan Hoffman

Editor, DIRECTORY

c/o 630 - 1199 West Pender Street

Vancouver, B.C. V6E 2R1

Telephone: (604) 684-0069, Fax: (604) 682-7354

TECHNICAL NOTES

Exploration Geochemistry An Integrative Science

Geochemical exploration combines aspects of physical and biological science that deal with the petrology of mineral systems. Together with an understanding of statistics, qualities of the successful explorationist often include common sense, intuition, pluck, and a modicum of luck.

Few exploration programs are so purely reconnaissance in nature that genetic models play no role in the design of the program, or in the interpretation of data. Through continuing refinement, models of ore genesis achieve greater and greater clarity, and new types of mineralization challenge our abilities to assimilate information and to transcend tradition. Intelligent interpretations reflect the training, experience, and indeed the personal bias of the explorationist.

The more that is known of the genesis and character of mineral occurrences, the more meaningful the picture becomes. Mineralization often is found where we expect it to be, produced by processes that in part are understood, within lithotectonic settings that can be recognized.

Even within recognizable geologic settings, however, data offer considerable opportunity for misinterpretation. The distributions of anomalous samples must be accurately determined to ensure success and the best return for dollars spent on exploration. The determination of *threshold* concentrations remains a worthy but elusive goal in geochemical exploration.

Multiple element data packages now can be rapidly manipulated and integrated with data on structure, rock and mineral compositions, alteration, fluid characteristics, etc. The accompanying figure presents one example in which several data planes have been overlain to provide clues to concealed mineralization.

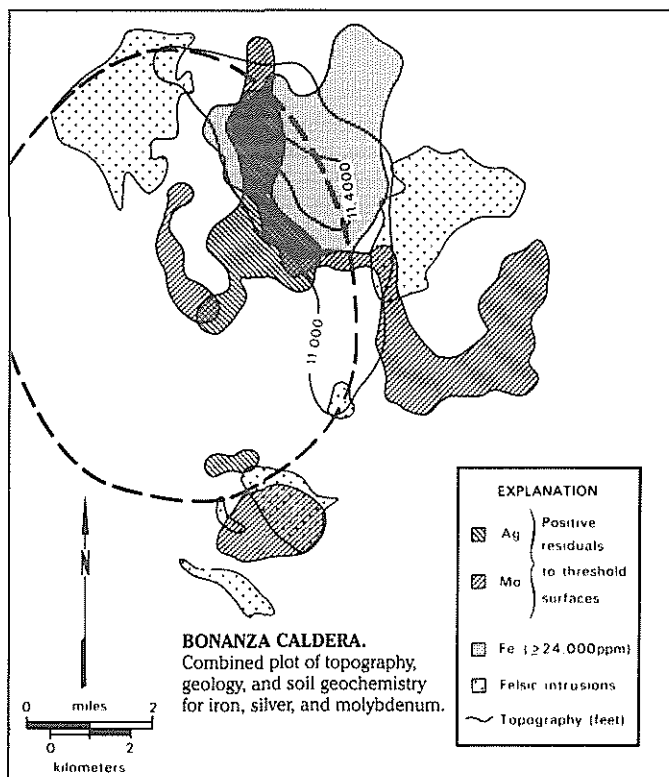
The target is the Bonanza caldera in the San Juan volcanic field, Colorado, U.S.A. Several million dollars in lead, zinc, copper, silver, and gold were produced from veins in the area during the period 1880-1930, and it is suspected that the mineralization may be the surface expression of one or more large igneous-hydrothermal systems concealed along the eastern margin of the caldera.

A regional study of fluid inclusions has shown that the exposed mineralization formed from fluids that were between 160° and 330°C, at salinities of less than five percent. In addition to several 1000's ppm combined lead - zinc - copper, seventy-five samples of mineralization average 207 ppm silver (max. 1870), 514 ppb gold (max. 8000 ppb), and 16 ppm molybdenum (max. 140 ppm). Tin was found in a small number of soil samples from the region.

The data base for the example includes geology, topography, and soil geochemistry for iron, silver, and molybdenum (16 samples per square mile). The occurrence of felsic (ring-type) intrusions is shown with respect to the margin of the caldera. Within caldera settings, these intrusions — and/or the heat associated with them — can make significant contributions to mineralization in the overlying rocks, and soil data for iron, silver, and molybdenum are examined with respect to the intrusions.

The topography of the region has been smoothed to facilitate comparisons between the chemical data and the geology. Interestingly, the topographic high for the entire Bonanza region marks a gap in the distribution of felsic intrusions along the eastern margin of the caldera, and as such may highlight the presence of concealed intrusive activity plus associated hydrothermal alteration.

Iron was included in the data base because anomalous concentrations in soils of the region may reflect the presence of epigenetic pyrite in the underlying rocks. The highest concentrations coincide with the regional topographic high. The regional plots for silver and molybdenum represent the distributions of positive residuals that lie above the threshold surfaces for those elements - i.e., samples for which silver and molybdenum are above the trends in element concentrations for the region as a whole. The residuals for both elements appear to be related spatially to felsic intrusions, particularly if the



gap conceals intrusive activity.

Always the goal in geochemical exploration, the isolation of authentic metal anomalies is accomplished most efficiently when various forms of data can be integrated. In the example, the most fertile area for follow-up study lies along the northeast margin, and the area east of the caldera margin also should be evaluated.

Douglas E. Pride
Ohio State University
Department of Geology & Mineralogy
Columbus, Ohio 43210-1110
Phone: (614) 292-7221

The difference between Eco-Tech
and other laboratories:

We Deliver What We Promise

Fast turnaround, quality service, competitive prices



Eco-Tech LABORATORIES LTD.

REGISTERED ASSAYERS, GEOCHEMISTS, ANALYTICAL CHEMISTS

**FIRE ASSAYING
ATOMIC ABSORPTION
MULTI ELEMENT ICP ANALYSES
CLASSICAL AND INSTRUMENTAL ANALYSES
BIO-GEOCHEMISTRY**

KAMLOOPS

LABORATORY
10041 E. Trans Canada Hwy
Kamloops, B.C.
V2C 2J3

Tel: (604) 573-5200
Fax: (604) 573-4557

FLIN FLON

LABORATORY
502 Coronation Drive
P.O. Box 767
Creighton, Sask
S0P 0A0

Tel: (306) 688-7164
Fax: (306) 688-2940

LA RONGE

PREP LAB
612 Farnham Street
P.O. Box 1135
La Ronge, Sask
S0J 1L0

Tel: (306) 425-2779
Fax: (306) 425-3879

YELLOWKNIFE

LABORATORY
Old Airport Rd
Industrial Park
Bag 3334
Yellowknife, N.W.T.
X1A 2P3

Tel: (403) 673-4979
Fax: (403) 673-4910

RENO

PREP LAB
c/o Shua Clark Smith
2235 Lakeshore Drive
Carson City
Nevada 89701

Tel: (702) 849-2235

Alkaline Cu-Au porphyries

The Model

The gold content of copper mineralized alkaline intrusive porphyry deposits can be appreciable. In British Columbia during the 1960's and 1970's, many were discovered and developed for Cu content and Mo (by-product). Evaluation of the Mount Milligan property in 1988-89 for Au potential has led to major exploration activity.

Mineralization is contained in altered andesites and basalts adjacent to an alkaline plug. The batholith and associated plugs, one of which is related to the Mount Milligan deposit, are readily apparent on aeromagnetic maps. Ore is hosted within rocks exhibiting potassic alteration, accompanied by secondary magnetite. Propylitic alteration extends up to 3 km beyond the margins of the alkaline stock.

Mount Milligan

Mount Milligan (Fig. 1) is an alkaline Cu-Au porphyry deposit owned by Continental Gold Corporation (70%) and BP Resources (30%) in central British Columbia. The deposit exceeds 300 million tons of mineral reserves, containing over 5 million oz. of gold and 2 billion lbs. of Cu (0.3% Cu and 0.02 opt Au). The Mount Milligan deposit is flat lying and measures 1500 m (4500 ft.) long by 1030 m (3100 ft.) wide and up to 300 m (880 ft.) thick. Seven high grade veins averaging 10ppm (0.3 opt) Au radiate outwards beyond the Mount Milligan deposit. A second zone, known as the Southern Star deposit, as yet not fully delineated, is 900 m (2700 ft.) long and 670 m (2000 ft.) wide.

Claims were acquired in 1984, over a Cu prospect first examined in the early 1970's, on the basis of strong soil geochemical responses (Fig. 2). A portion of this data was published (by the author, then



Figure 1. Location of Mount Milligan and Cat Mountain Properties

with BP Resources Canada Limited) in Reviews in Economic Geology, Volume 3, on pages 62 and 63. A reconnaissance stream sediment survey, conducted by the British Columbia government and completed in 1983, also indicated an exceptionally strong Cu anomaly.

PRIME GEOCHEMICAL METHODS LTD.

Dramatic changes in the methodology of exploration geochemistry have occurred in recent years. A strong competitive advantage is available to those exploration and mine development companies which make a strategic investment in geochemical expertise. Advantages to your program include:

- reduced overall costs.
- enhanced data presentation and interpretation.
- higher confidence in exploration target selection.
- effective "audits" of your sampling and analytical methods.
- efficient follow-up recommendations.

To maximize returns on your investment in geochemical surveys (or on chemical analysis), funds must be well spent. This does not just happen! **Prime Geochemical Methods Ltd.** is in business to service your needs in an efficient and cost-effective manner. For your multi-element plotting requirements contact **Cambria Data Services Ltd.** (see the accompanying advertisement).

Stan Hoffman, Ph.D.
Consulting Geochemist

Prime Geochemical Methods Ltd.
630 - 1199 West Pender St.
Vancouver, B.C., Canada V6E 2R1
Telephone (604) 684-0069
Message (604) 731-8892
FAX (604) 682-7354

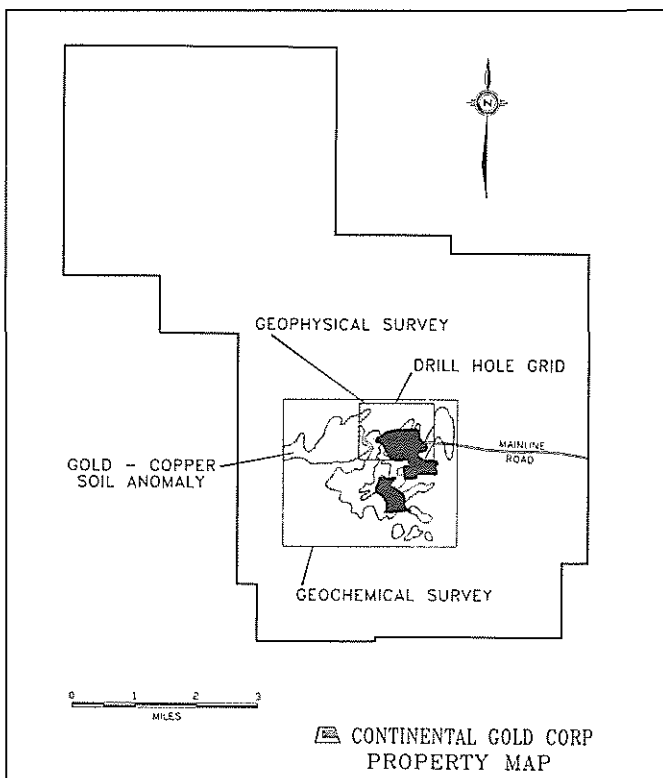


Figure 2. Soil geochemical anomalies averaging 50 ppb Au and 200 ppm Cu at Mount Milligan. The Mount Milligan deposit is the dark area to the north; the Southern Star deposit is the dark area to the south.

Three geochemical lessons were learned at Mount Milligan: (1) soil sampling had to be done carefully, otherwise organic-rich material would be collected and strong, false anomalies would result; (2) detailed sampling at an early stage of exploration could be rewarded by discovery, (3) multi-element signatures were obtained which focussed later interest at Mount Milligan. These are described in general terms in the next section.

The Mount Milligan case history will undoubtedly be published at a later date. In the meantime, those interested in following the progress of the Mount Milligan project are encouraged to write to: **Douglas B. Forster, Vice President - Project Development, Continental Gold Corp., Suite 1020 - 800 West Pender St., Vancouver, B. C., Canada, V6C 2V6. Tel: 604-684-6365 FAX: 604-684-8092**

Cat Mountain

Lessons learned at Mount Milligan were tested at another BP property, Cat Mountain (Fig. 1), which has the same regional and detailed geological and geophysical signatures. The need to collect proper soil samples was appreciated, and consequently soil data from Cat Mountain exhibit homogeneous patterns. The positive effects of high sample density and multi-element analysis should be noted since the merits of the property were apparent from the geochemistry.

Figure 3a shows Cu concentrations in soils, as known in 1975, when only Cu, Zn and Mo data were obtained routinely (60 X 120 m grid). No significance was attached to the Mo or Zn distributions at that time. When multi-element analysis became an acceptable and prudent method, the Cat Mountain soil pulps were reanalysed in 1984 to assess precious metal potential. The resulting gold anomaly (Fig. 3b) was large and exhibited exceptional contrast.

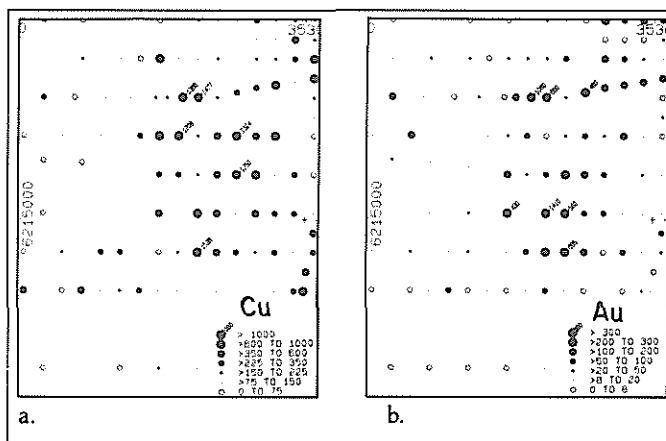


Figure 3. 1975 soil survey for Cu. Au was determined in 1984. (Cu - ppm, Au - ppb)

Unfortunately for Cat Mountain, 1984 was also the year BP discovered Mount Milligan. Both properties have comparable soil geochemical signatures, but Mount Milligan was closer to infrastructure. Now, road development makes the Cat Mountain area more accessible and developers like Lysander Gold Corporation have taken property positions (Fig. 8).

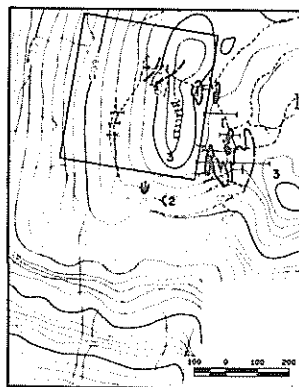


Figure 8. Property geology. Unit 1 - Monzoniorite, unit 2 - syenite, unit 3 - pyroclastic andesite/basalt. Roads and trenches are shown, as is Lysander Gold Corporation's claimblock.

Recent terrain analysis studies show a convincing relationship between the early geochemistry and the bedrock, despite a paucity of outcrop. Six different overburden types were identified and overburden control on the position of Cu-Au anomalies was recognized. The coarse fraction of the archive soils were reanalysed for Au and 30 aqua regia leachable elements, the data from which confirm a predominantly local source for Cu and Au (Fig. 4).

The soil survey was repeated in 1989 at a detailed scale. Multi-element signatures were striking! Figure 5 shows Cu, Au, Ag, As, Mo, W, Fe, and Co patterns. Figure 6 presents Mn, Ca, Sr, and Al data. Rather than showing

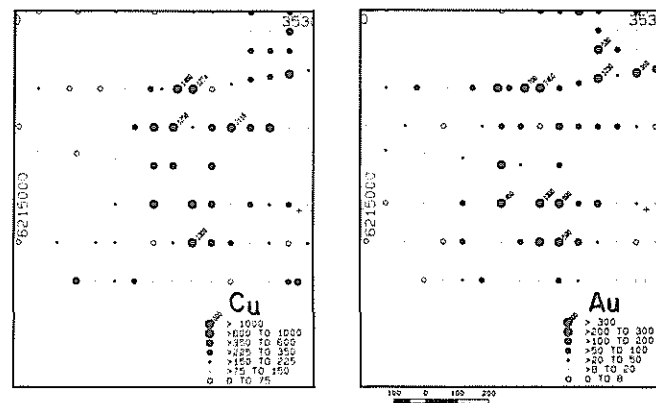


Figure 4. -10 + 80 mesh analysis of sample rejects collected in 1975. These confirm a local genesis of soil anomalies. (Cu - ppm, Au - ppb)

CAMBRIA DATA SERVICES LTD.

MULTI-ELEMENT GEOCHEMISTRY

Data Processing - Map Plotting

In conjunction with Prime Geochemical Methods Ltd., we offer services for the processing of your multi-element data. Our in-house computer systems are optimized for the rapid turnaround of large volumes of data. Enhanced data presentation allows all analytical results to be viewed in map form, ensuring a cost-effective and confident interpretation.

- Forward your sample location map upon completion of the sampling program. Your basemaps are ready for immediate plotting upon completion of the analysis.
- Interpretation and geochemical consulting are available from Dr. Stan Hoffman.
- If your processing requirements are large, talk to us about computer software sales and training.

Cambria Data Services Ltd. also markets and supports software for database, computer-aided map drafting and diamond drill logging applications.

Contact:

Paul J. McGuigan, Consulting Geologist
Michael Pond, Geologist-Programmer
Bob Sandu, Programmer

Cambria Data Services Ltd.
 630 - 1199 West Pender St.
 Vancouver, B.C., Canada V6E 2R1
 Telephone (604) 682-5313
 FAX (604) 682-7354

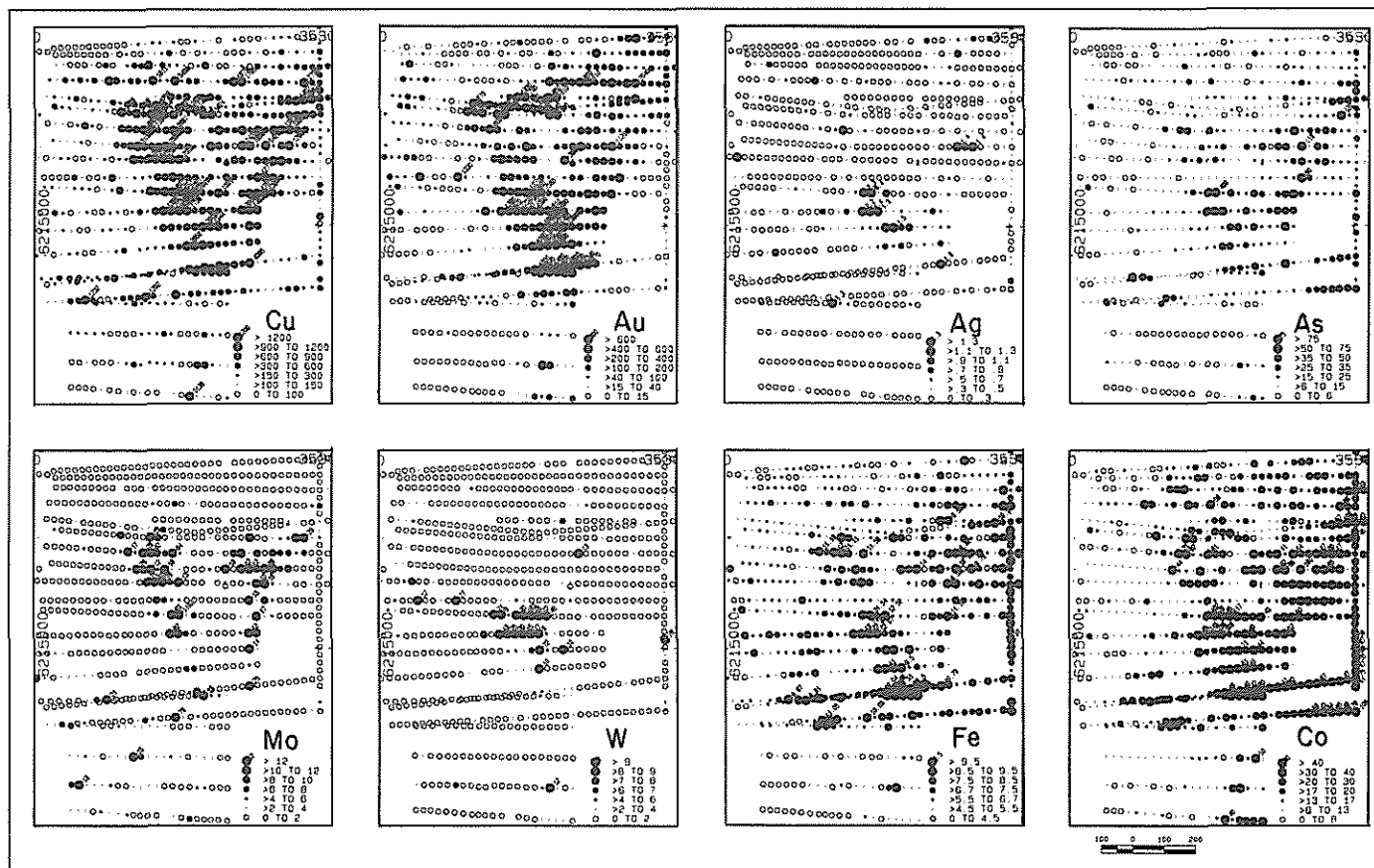


Figure 5. Ore and pathfinder element anomalies. (all elements ppm except Fe - % and Au -ppb)

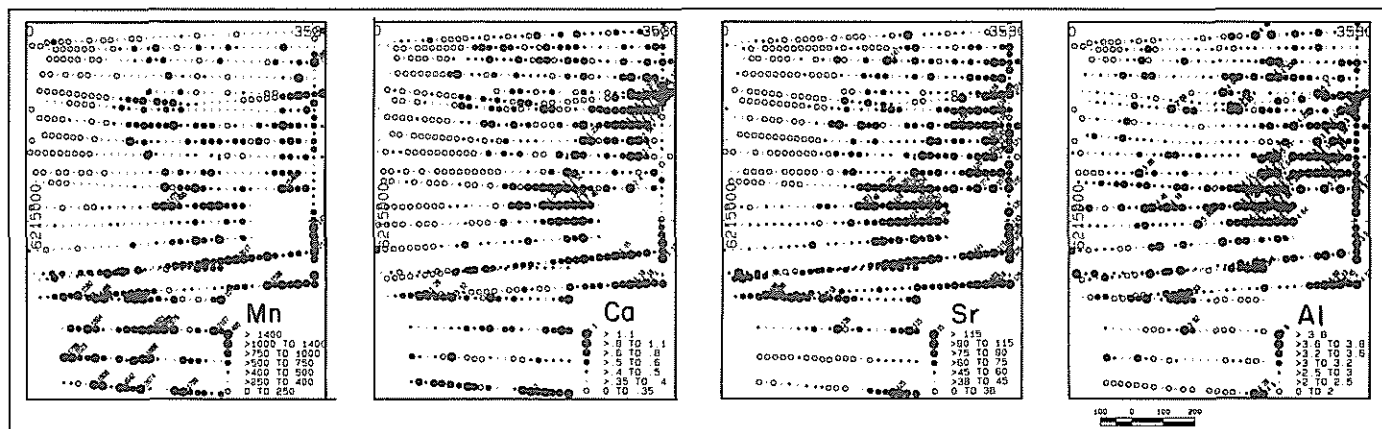


Figure 6. Elements commonly strongly influenced by soil sample quality. Note patterns are consistent. Distributions are being controlled by underlying geology. (Mn, Sr in ppm, Ca, Al in %)

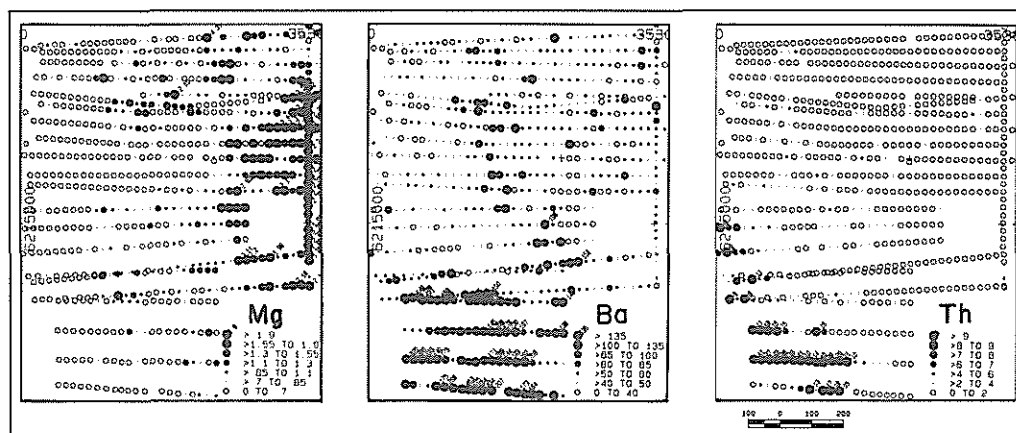
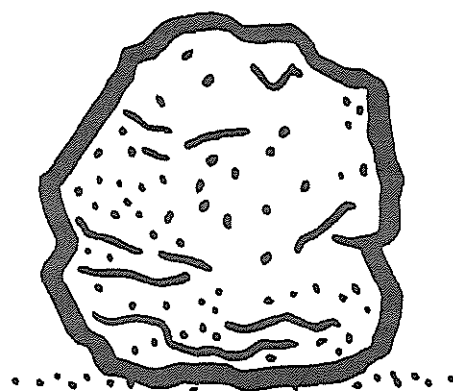
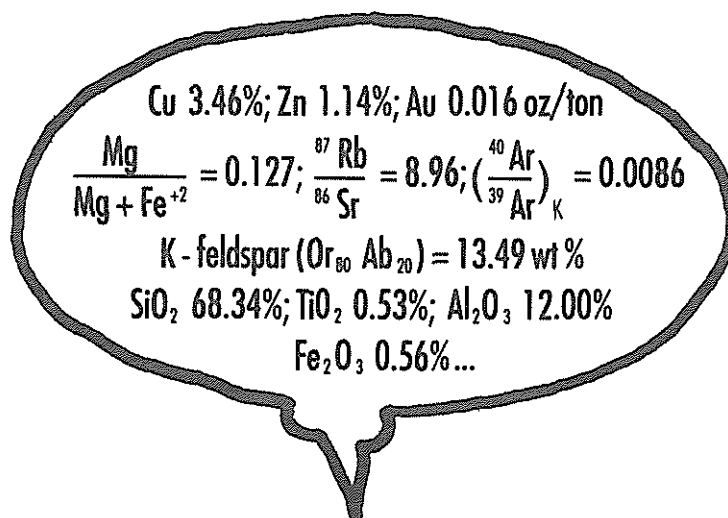


Figure 7. Mg, Ba, and Th distribution patterns undoubtedly relate to underlying geology. (Mg in %, Ba, Th in ppm)

We make rocks tell the truth.



Exploration geologists pick Bondar-Clegg
 for irrefutable assays and geochemical analyses.
 They have for over 25 years.



Bondar-Clegg, Inc.
 Sparks, Nevada
 (702) 359-9330
 Lakewood, Colorado
 (303) 989-1404

Bondar-Clegg & Company Ltd.
 Ottawa, Ontario
 (613) 749-2220
 N. Vancouver, B.C.
 (604) 985-0681

Chimitec Ltée
 Ste-Foy, Québec
 (418) 683-1777

strong biases toward accumulations in organic matter and iron oxides, these elements identify a zone of carbonate and clay alteration. Alternatively, elements such as Ba (Fig. 7), and Zn, Pb, V, Mg, Ni, K, and P (not shown) reflect underlying bedrock. Even aqua regia leachable Th (Fig. 7) displays a pattern correlating with a prominent magnetic low.

Re-sampling of 840 sites cost US \$20,000.00. Was the money well spent? The question can be answered by comparing Figure 3 with Figures 5 through 7 and noting that costs for the high density, multi-element survey were only 25% higher than the earlier work depicted in Figure 3.

Readers interested in following the development of this property can contact: **Mr. Lou Duarte, President, Lysander Gold Corporation, P.O. Box 49071, Three Bentall Centre, Suite 1283 - 595 Burrard St., Vancouver, B.C., Canada, V7X 1G4. Tel: 604-683-2346 FAX: 604-681-8069**

Stan Hoffman

Prime Geochemical Methods
630 - 1199 West Pender Street
Vancouver, B.C., Canada V6E 2R1
Telephone (604) 684-0069

Shea Clark Smith

MEG

**MINERALS EXPLORATION &
ENVIRONMENTAL GEOCHEMISTRY**

BIOGEOCHEMISTRY • VAPOR GEOCHEMISTRY

P.O. Box 18325, Reno, Nevada 89511 (702) 849-2235

VGC VANGEOCHEM LAB LIMITED

Serving the Mining Industries in
Canada & U.S. for 25 Years

Multi-Elements Analysis by ICP, AAS
Gold and Silver analysis by fire assay:
Conventional Assay, Geochemical
Analysis, Computer services
on site samples preparation services.

Various Locations to Serve Our Clients

(HEAD OFFICE & LABORATORIES) 1988 Triumph St. Vancouver, B.C. V5L 1K5
Phone (604) 251 5656 • Fax (604) 254 5717

* Mississauga, Ont. * Vancouver, B.C.
* Bathurst, N. B. * Pasadena, Nfld.
* Reno, Nevada, U. S. A.

Some Relationships Between Exploration Geochemistry and Environmental Geochemistry

Exploration geochemists work in an interdisciplinary field. They must have a good understanding of analytical chemistry and statistics, as well as familiarity with such disciplines as geophysics, pedology, and botany. Increasingly, exploration geochemists also need a working knowledge of the tools and techniques of remote sensing. The interdisciplinary nature of the work is at least one of the factors that tends to set exploration geochemists apart from specialists in one of the "pure sciences," such as mathematics or physics. Similarly, geochemists who work in the environmental arena are also strongly interdisciplinary, with an emphasis on analytical chemistry, hydrology, statistics, pedology, and computer modeling. Unfortunately, environmental geochemists sometimes must also learn a great deal about the law.

Despite the highly interdisciplinary nature of their work, there seems to be a surprising lack of communication between the community of exploration geochemists and the community of their first-cousins, the environmental geochemists. To demonstrate this, I wish to propose a "pop-quiz" for the reader. First question — can you name the professional organization which is the counterpart of the Association of Exploration Geochemists, but in the field of environmental geochemistry and health? (*Hint: In existence since about 1968, the society is based in Missouri, publishes a journal and a newsletter, and sponsors a large annual conference with published proceedings. Give up? Answer: The Society for Environmental Geochemistry and Health, Environmental Trace Substances Research Center, University of Missouri.*)

Second question — suppose you wanted to go to a single book to look

Gold & Precious Metal Exploration

Effective until March 31, 1991, ACME is offering two analytical packages for gold and precious metal exploration.

Package 1 - US \$6.70

Wet geochemical gold & 30
element ICP analysis
Detection limit: Au 1 ppb

Package 2 - US \$9.30

Fire Geochem Gold, Platinum,
Palladium & 30 element ICP
analysis
Detection limits: Au 1 ppb; Pt,
Pd 3 ppb; and Rh 3 ppb

Pricing Policy: Sample preparation is an extra cost; minimum 10 samples per shipment or add \$5.00 per shipment.

Note: ACME has serviced the mining and exploration industries for 20 years. During that time, the company has served its many clients in a professional fashion, offering high quality analysis at low cost with rapid turnaround of results. For example, during peak periods, over 2 tons of sample material arrives daily, and results are typically returned within 5 days. Please ask for our complete price brochure.

Shipping Address:

By Greyhound Bus

ACME Labs.
C/o Greyhound Bus Depot
Blaine, WA 98230

By UPS

ACME Labs.
264 H Street
Blaine, WA 98230



Acme Analytical Laboratories, Ltd.
852 E. Hastings St.
Vancouver, B.C. V6A 1R6
(604) 253-3158
FAX 604-253-1716

**Prices subject to change without notice.*

up information on the following topics: geochemistry of lake and stream sediments in southern Ontario, water and soil chemistry in Indiana, soil compositions in Missouri, geochemistry of molybdenum, cadmium-zinc interactions, and sampling designs for the geochemistry of soils and stream sediments — which book might it be? You might answer that it would be one of the fine volumes in the *Handbook of Exploration Geochemistry*, written by members of the Association of Exploration Geochemists and published by Elsevier, but you would be wrong. The answer is in the literature of environmental geochemistry: Special Paper 155 of the Geological Society of America (1975, 118 pp.) *Trace Element Geochemistry in Health and Disease*, edited by Jacob Freedman. Well, enough of these games. The point is that if the answers to the two questions above are news to you, you might find it useful to look a bit further into the field of environmental geochemistry.

Most exploration geochemists have some nodding acquaintance with environmental geochemistry, if only because mining companies usually face some type of environmental assessment and management in trying to bring economic mineral deposits into production. Also, with the decline in the fortunes of some mining companies over the last decade or so, many exploration geochemists have moved into the field of environmental geochemistry, either by choice or necessity. But I suspect that the wealth of data and information which hides in the field of environmental geochemistry is largely unknown to many explorationists, and that many environmental geochemists are equally lacking in their knowledge of the literature and techniques of exploration geochemistry.

There have been some significant publications over the years that have brought the two fields closer together by illustrating the many principles that they have in common. Notable examples include *Environmental Geochemistry* by J.A.C. Fortescue (1980, Springer-Verlag, 347 pp.), *The Natural Geochemistry of Our Environment* by D.H. Speidel and A.F. Agnew (1982, Westview Press, 214 pp.), and *Applied Environmental Geochemistry*, edited by I. Thornton (1984, Academic Press, 500 pp.). Fred Siegel's book *Applied Geochemistry* (1974, Wiley-Interscience, 353 pp.) also includes a chapter on environmental geochemistry. In general, however, geochemists who work in mineral exploration seem to not utilize the information and data that are available in environmental geochemistry. Such fundamental problems as the determination of geochemical background, distributions of populations, seasonal variation, and statistical validity of data are all of great importance in both fields, but very few papers in environmental geochemistry have ever been published in the literature of exploration geochemistry, and vice-versa.

To illustrate a few of the scientific ties that underlie environmental and exploration geochemistry, I will give two examples of data developed as part of environmental geochemical studies. Hopefully it will be clear that the results also have meaning for exploration. The first example concerns concentrations of metals in the sediment of a small, perennial stream in Arizona. The study was initiated by state and federal regulatory agencies concerned about possible contamination of the water by wastes from past and present mining operations. Table 1 shows the concentrations of the acid-soluble ($\text{HNO}_3/\text{HClO}_4$) fraction of

metals in the (-)250 fm fraction of the stream sediment at a single sampling site during high-water and low-water stages. The high concentrations result from the neutralization and precipitation of metals from acidic leachates escaping from mining and milling wastes upstream from the sampling site. Severe storms in this arid region cause sudden and dramatic increases in streamflow. The resulting decreases in concentrations of the metals shown in Table 1 are caused by the movement of non-contaminated sediments into the creek from the adjacent watershed, covering and mixing with the metal-rich precipitates deposited in the stream during low-water stages.

Table 1. Concentrations of acid-soluble metals (mg/kg) in the (-)250 fm fraction of stream sediment, during high-water and low-water stages at one sampling site.

Metal	low-water	high-water
As	3195	<150
Cd	4	<1
Cu	420	48
Pb	1840	<25
Zn	880	150

The concentrations of metals given in Table 1 vary by orders of magnitude from season to season. The two main points to made here are: (1) geochemical exploration using stream sediments in this region would have to take into account the profound changes in concentrations caused by the seasonal fluctuations in water level and sediment transport and (2) acidic leachates from mining and milling wastes may produce a significant overprint on any natural variation in the chemistry of metals in sediments downstream.

Multi-element Analysis for Routine Exploration Programs

Effective until March 31, 1991, ACME is reducing the price of its 30 element ICP analysis (aqua regia digestion) to US \$2.80.

Element Suite and Detection Limits

Element	Detection
Ag	0.1 ppm
Cd, Co, Cr, Cu, Mo, Mn, Ni, Sr, Zn	1 ppm
As, Au, B, Ba, Bi, La, Pb, Sb, Th, V, W	2 ppm
U	5 ppm
Al, Ca, Fe, K, Mg, Na, Ti	0.01 %
P	0.001 %

Digestion Procedure: 0.5 gm sample is digested with 3 ml 3-1-2 HCL- HNO_3 - H_2O at 95 degrees for one hour and diluted to 10 ml with water. This leach is near total for base metals, partial for rock forming elements and very slight for refractory elements. Solubility limits Ag, Pb, Sb, Bi, W dissolution for high grade samples.

Pricing Policy: Analytical cost is US \$2.80; sample preparation is an extra cost; minimum 10 samples per shipment or add \$5.00 per shipment.

Note: ACME has serviced the mining and exploration industries for 20 years. During that time, the company has served its many clients in a professional fashion, offering high quality analysis at low cost with rapid turnaround of results. For example, during peak periods, over 2 tons of sample material arrives daily, and results are typically returned within 5 days. Please write for our complete price brochure.



Acme Analytical Laboratories, Ltd.
852 E. Hastings St.
Vancouver, B.C. V6A 1R6
(604) 253-3158
FAX 604-253-1716

*Prices subject to change without notice.



Becquerel Laboratories Inc.
6790 Kitimat Rd., Unit 4
Mississauga, Ontario
Canada, L5N 5L9
Telephone (416) 826-3080
Fax (416) 826-4151

USE NEUTRON ACTIVATION TO
CONFIRM YOUR ANALYSES

NO CHEMICALS AND FEW STEPS
PRODUCES ACCURATE AND
PRECISE RESULTS

A third point that could be made is that the size fraction of sediment ($<250\ \mu\text{m}$) used for the chemical analyses in Table 1 was not the same as that which is commonly used ($<177\ \mu\text{m}$) in geochemical exploration; we find many such incompatibilities in the methods of sampling, extraction, and analysis between exploration and environmental geochemistry. Although the literature and resources are vast in both fields, the lack of standardization of even the most basic techniques makes it difficult to compare and transfer data.

A second example of an environmental study with possible applications to geochemical exploration concerns the reconstruction of historical background concentrations of dissolved metals in shallow ground waters in a highly-mineralized region of carbonate rocks in the Rocky Mountains. The deposits are replacement ore bodies in a host rock of dolomitic limestone. The presently contaminated site includes many abandoned lead-zinc mines and associated wastes. Seepage of ground water through the underground workings and leaching of mine wastes by surface water have caused contamination by dissolved metals, chiefly Zn, Mn, and Cd. Because of a lack of any historical data to the contrary, the regulatory agencies involved had initially suggested a criterion for clean-up based on the unreasonable assumption that prior to mining the native waters would not have had any detectable concentrations of dissolved metals, that is, the water would have been the equivalent of laboratory deionized water! Geochemical computer modeling was undertaken for the purpose of determining what concentrations of metals might have been present in the water in contact with the ore deposit prior to mining. Realistic suites of ore and gangue minerals were chosen and by calculation, the minerals were theoretically equilibrated with pure water at realistic values of temperature, redox potential, and partial pressure of carbon dioxide gas. The redox potential was chosen to represent mildly reducing conditions ($E_h = -0.12$ volts at pH 7), appropriate for a shallow ground water. The model mineral assemblages and the predicted concentrations of dissolved metals are summarized in Table 2.

Table 2. Model mineral assemblages, predicted concentrations of dissolved metals (mg/L), and pH, under slightly oxidizing conditions and elevated CO_2 gas pressure.

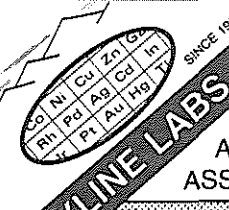
Model mineral assemblages	Predicted dissolved	(mg/L) metals
barite	Cd	0.01
greenockite (CdS)	Mn	12
sphalerite	Pb	0.45
galena	Zn	104
cerussite	pH	7.0
rhodochrosite		
calcite		
$\text{CO}_2 = 0.01\ \text{atm}$		

One could certainly argue about the accuracy of the predicted concentrations of the dissolved species in Table 2, but the single most important conclusion to be drawn is that the stream water and shallow ground water in contact with the oxidizing ore deposit should have contained significant concentrations of metals, even prior to the first disturbance by man. This result certainly gives a more realistic and meaningful estimate of the pre-mining background concentrations than to simply assume deionized water. In turn, more realistic goals for cleanup and restoration can then be established by the regulatory agencies. With respect to geochemical exploration, the modeling exercise suggests that similar ore deposits should be easily detectable by hydrogeochemical methods, using dissolved Zn and Mn.

The enormous emphasis on environmental protection underway in North America, and beginning to be felt in most other parts of the world, offers opportunities for exploration geochemists to

acquire data and techniques that may be helpful in prospecting. Conversely, the large amount of geochemical data collected by explorationists over the past fifty or so years, both in areas that have and have not been disturbed by mining, could be of enormous value to environmental geochemists in the task of setting realistic goals for clean-up and restoration of contaminated areas. It is unfortunate that so little interaction seems to have taken place between the two disciplines. Both groups could benefit from a greater awareness of the resources available in the other camp. I wonder if a joint exploration-environmental symposium might be useful, perhaps sponsored by the Association of Exploration Geochemists and the Society for Environmental Geochemistry and Health, with the goal of allowing these two scientific communities to learn from each other? (Please feel free to send your comments and ideas on this subject to the editors of *Explore* or to the author.)

Donald D. Runnells
Department of Geological Sciences
University of Colorado
Boulder, CO 80309-0250



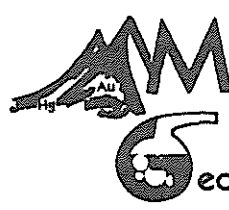
SKYLINE LABS, INC.

ASSAYING AND GEOCHEMICAL
ANALYSIS FOR GOLD AND
ASSOCIATED ELEMENTS

RARE EARTH ELEMENTS BY ICP

EXTRACTIVE METALLURGICAL TESTING

Denver	Reno	Tucson
(303) 424-7718	(702) 355-8826	(602) 622-4836
TLX (ITT) 499-0224		TLX (ITT) 499-0880



Geochemical Laboratory, Inc.

(702) 738-3236

-Specializing In Fire Assay-

-Trace Analysis

-Atomic Absorption

-1 ppb Au Capability

-Custom Sample Preparation

-Sample Pick-up

JOE KOCH, GENERAL MANAGER
Serving Nevada's Mining Industry With Pride & Expert Dependable Service

106 W. Front St. Elko, Nevada 89801

EXPLORE THE ELEMENTS

with this free periodic table color coded to Chemex analytical methods for geological materials.

ANALYTICAL METHODS

- Atomic Absorption Spectroscopy
- Plasma Atomic Emission Spectroscopy
- Fire Assay Procedures - Various Finishes
- Nuclear Analytical Methods (NAA, XRF)
- Colorimetric Procedures
- Electrochemical Procedures
- Fusion Gravimetric or AA Procedures
- Ion Chromatography

Secondary Analysis Method

- Atomic Number
- Atomic Weight
- Element Symbol
- Lowest Concentration Routinely Reported for Rock Samples
- Element Name

Primary Analysis Method

The periodic table includes elements from Hydrogen (H) to Oganesson (Og), with color-coding corresponding to the analytical methods listed.

Your field notebook sized copy of the chart with useful conversion factors is available from any of our ten operating locations.

994 Glendale Avenue, Unit 7
Sparks, Nevada 89431
Phone 702-356-5395
Fax 702-355-0179

651 River Street
Elko, Nevada 89801
Phone 702-738-2054
Fax 702-738-1728

2723 South Cole Road
Boise, Idaho 83709
Phone 208-362-3435
Fax 208-362-3358

5640 B Street
Anchorage, Alaska 99518
Phone 907-562-5601
Fax 907-562-6502

103 North Parkmont
Industrial Park
Butte, Montana 59701
Phone 406-494-3633
Fax 406-494-3721

212 Brooksbank Avenue
North Vancouver
British Columbia V7J 2C1
Phone 604-984-0221
Fax 604-984-0218

920 Commerce Street, Unit 5
Thunder Bay, Ontario
P7E 6E9
Phone 807-475-3329
Fax 807-475-9196

5175 Timberlea Blvd.
Mississauga, Ontario
L4W 2S3
Phone 416-624-2806
Fax 416-624-6163

Westend Industrial Park
Pasadena, Newfoundland
A0L 1K0
Phone 709-686-2084
Fax 709-686-2774

175 Industriel, CP 284
Rouyn, Quebec
J9X 5C3
Phone 819-797-1922
Fax 819-797-0106

 **Chemex Labs Ltd.**

- Analytical Chemists
- Registered Assayers
- Geochemists

PEARL HARBOR FILE

Gold Analysis of Soils

In EXPLORE issue No. 68, concluding remarks were issued on a Cu-Au alkaline porphyry example. Correspondence from readers suggests additional comments are warranted on the objectives and limitations of using aqua regia leachable determinations as a panacea method of analysis for all elements. The Pearl Harbor file requests readers comments on some of the points made below for publication in the next EXPLORE.

Managers of exploration projects always want to obtain maximum information at minimum cost. The aqua regia leach has been the routine digestion method to extract base metals or Ag from soil or rocks on exploration programs since the early 1980's (note that the previously routine digestion using nitric/perchloric acids was displaced as a consequence of the possibility of precipitating Ag and Pb from solution prior to analysis). Viability of the same aqua regia digestion to deliver As, Sb and Bi concentrations at levels which are suitable for many exploration programs has extended its application to gold exploration. Final determination is conducted by inductively coupled plasma spectroscopy (ICP).

The ICP can deliver suites of 30 or more elements simultaneously, including Cu, Pb, Zn, Ag, As, Sb, and Bi. Extraction of the latter elements, particularly when they are present in sulphide form (or weathering products thereof) is almost total. Determination of concentrations of elements such as Th, W, Ca, Ti, K, Al, etc. is partial, and this fact is commonly annotated as such by the laboratory on their data listing. Are values reported for these elements, albeit partial, of interest to exploration when the sample material is bedrock of some sort?

Geochemical lectures given ten to twenty years ago always stressed the application of partial extractions to differentiate mechanical from hydromorphic anomalies in soils and sediments. Use of reagents for selective dissolution of sulphide minerals from bedrock was also described. Unfortunately, little is published concerning the usefulness, limitations, or applications of the aqua regia partial extraction of bedrock or soil samples in exploration. The millions of such results being given by commercial laboratories to their clients suggest that if they have any value, empirical guidelines are needed to demonstrate their application(s). In theory, those individuals or companies who define how this information can be used and what limitations must be placed on such data would develop a competitive advantage in assessing "in-house" data or evaluating property submittals. Use of aqua regia leachable Fe, Mn,

Ca, Sr, and Al results of soil surveys described previously in this column was shown to be of fundamental importance in gauging soil survey quality.

Few have investigated the distribution and/or meaning of aqua regia-leachable metal contents in bedrock samples. The objectives of such work have to be clearly understood by the investigator; for example if barite concentrations are sought, will the aqua regia-leachable Ba determination suffice? How about aqua regia leachable K to determine potash alteration?

How many readers have seriously considered what is meant by rock analysis? I would appreciate hearing what factors you consider important in analyzing bedrock and if you think knowing the details of the analytical procedure is important. What details do you regularly investigate prior to sample submittals (hint, in your appraisal, consider what effect sample collection, preparation, and analysis procedures might have on the concentrations which are returned from the laboratory?).

EXPLORE 68 began an example on Fig. 12 of that issue describing Au analysis of soil samples. What, if anything, was peculiar with these data?

The histogram plotted on Fig. 12 was based on detection limit intervals, here 5 ppb. A population was defined to have a range of 30 to 65 ppb. The distribution of this population centers on lines within a 500 m wide portion of the grid, trending in a non-geologic or non-glacial direction. This line-controlled character suggested an analytical artifact and reanalysis was in order.

Figure 13 displays the same grid but shows Au levels (determined by the same procedure at the same laboratory) following reanalysis, and the new histogram. The 30 to 65 ppb Au population has disappeared and the geochemical distribution pattern has been significantly altered from Fig. 12. The laboratory was requested to comment on results, but no satisfactory explanation was forthcoming (comments concerning nugget effect were made - an all too common explanation for non-reproducible Au determination). It is not critical to know exactly why the initial results were high, but rather explorationists conducting Au exploration programs must be able to recognize analytical artifacts such as this and undertake remedial action. Failure to recognize analytical error can lead to expending followup funds in a fruitless fashion. I would be interested in hearing what procedures you use to recognize the nugget effect and how you initiate remedial action to mitigate it having a negative effect on assessing results of a survey.

Stan Hoffman
Prime Geochemical Methods Ltd.
 630 - 1199 West Pender Street
 Vancouver, BC V6E 2R1
 Canada
 Tel: (604) 684-0069, Fax: (604) 682-7253

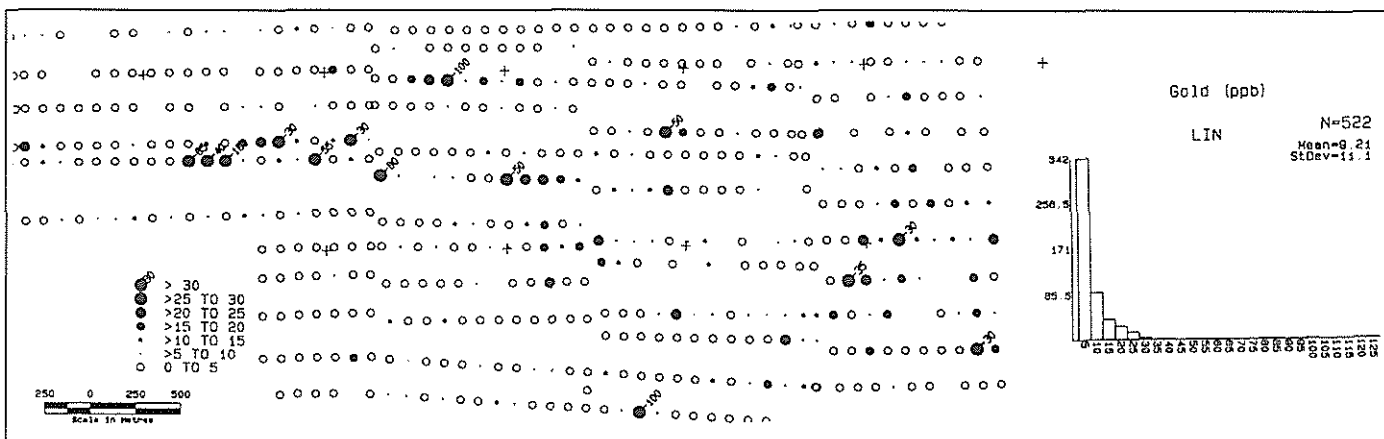


Figure 13. Au content (ppb) of soils after reanalysis. Histogram plots number of samples (vertical) versus Au-ppb (horizontal).

SPECIAL NOTES

Selection of a Geochemical Sampling Contractor

Case histories from the Pearl Harbor File, presented in *EXPLORE* over the past two years have focused on the consequences and ramifications of using improper sampling techniques. In summary, the studies show that geochemical anomalies can come and go, or move, depending on how the survey is conducted, with grave implications for effective exploration. Are the presented examples merely curiosities, or are we seeing the tip of an iceberg? Are soil survey geochemical anomalies fleeting features, or are they relatively permanent?

Surveying difficulties are introduced whenever soil trace element distributions vary with depth in the soil profile. The literature suggests such variations are normal, and can exceed an order of magnitude at a single location. It isn't difficult to imagine how anomalies can be created, or lost, depending on which soil horizon is sampled. Inexperience and improper geochemical training undoubtedly lead to defective surveys. What can we do to ensure our surveys are effective and money is well spent?

The best advice I can give is to be fully aware of the credentials of those you employ to do the work.

The selection of a soil sampling contractor is heavily influenced by cost. Along with some comments about qualifications, my report will continue with job costing for various survey tasks. Perhaps you will find your criteria are not too different from mine.

I may be a maverick, but I expect my soil sampling contractor to know something about soil sampling. Educational background and professional affiliations are good reference points. For example, I would not want to live in a house constructed by a contractor having no background or training in construction. Why would I want the success of my exploration program to depend on a contractor who may not know what needs to be done? A contracting firm in the business for the long term is probably a member of the AEG and has benefitted from the various symposia, short courses, and technical articles as they have appeared in the Journal and *EXPLORE*. Membership and involvement in the AEG would certainly be an important qualification for a soil sampling contract.

Work experience is another important criterion, but it could be a detriment. Imagine a contractor who has had no formal training and has no professional affiliation, but who has collected tens of thousands of soils samples by winning contracts. As a consequence, many bad habits may have been incorporated as routine, for example, taking small-sized samples to reduce sample weight in order to improve production.

Contract rates vary with country and logistics. A contract price can be estimated after the contractor answers the following questions:

1. What is your daily charge-out rate per sampler (not per sample), including accommodations, meals and transportation? (Cdn. \$250 - \$300/day)
2. What is your mobilization/demobilization cost? (Depending on location, could be two days salary plus airfare, plus extras).
3. Will you use stakes and aluminum tags to permanently mark sample numbers at soil sample stations? (Yes)
4. Will you record computer coded field site notes (in the field) following comparable procedures to those in Chapter 3 in Reviews in Economic Geology, Vol. 3? (Yes)
5. Will you plot sample locations on a topographic base map at an appropriate field scale as part of the contract price? (Yes)

6. What sampling rate, per day, do you estimate (after being provided with landscape, vegetation, overburden conditions, logistical, climatic and other factors that may be needed in making the estimate)? (Table 3.7 on page 68 of Review in Economic Geology, Vol. 3, gives my estimates).

In planning a geochemical survey, start with a known dollar value available for expenditure, and define survey parameters after the above questions are answered. Contingencies are known in advance for work proceeding faster (i.e., additional sampling is targeted) or slower (i.e., lines are eliminated in a predetermined order). The contractor is made aware of the contingency plans. Recognize costs can be quoted substantially lower on a per sample basis than would be invoiced using the above formula, but at what risk? Buyer beware — you get what you pay for, and money saved by using an unqualified bidder introduces two serious risks to your exploration:

1. False anomalies will dominate distribution patterns, and
2. Bona fide anomalies may be absent or so weak they appear insignificant by comparison.

The consequences: money and time are wasted following up false anomalies while important targets are missed. Follow-up represents a serious investment, typically much larger than the initial soil program, and deserves not to be compromised by initial penny-pinching.

I hope these observations will assist the planning of future surveys.

Stan Hoffman
Prime Geochemical Methods Ltd.
 630-1199 W. Pender St.
 Vancouver, B.C. Canada V6E 2R1

"THE TECHNOLOGY LEADER THAT GIVES YOU CONSISTENTLY OUTSTANDING RESULTS"

GEOCHEMICAL SERVICES INC.



The One Laboratory for Base and Precious Metal Exploration Programs

- Full Analytical Capabilities including: Inductively Coupled Plasma; Atomic Absorption; Graphite Furnace Atomic Absorption; Fire Assay; X-Ray Fluorescence; and Neutron Activation
- Complete Sample Prep Service: Soils, Stream Sediments, Rocks, Drill Cuttings and Plant Tissue
- Computer Managed Turn-Around
- Sample Pick-up
- FAX Reports at No Charge
- Reports and Job Status Available Daily Via Computer Modern (BBS)
- Full Geostatistical Support
- Field Support
- Domestic/International Service
- Excellent Quality Control
- Industry Leader in Pricing
- Pediments and Drill Vectoring Program

1-800-827-4GSI

3805 Alherton Road
 Rocklin, CA 95677
 (916) 624-6000
 FAX: (916) 624-8986

1498 Kleppe Lane
 Sparks, NV 89431
 (702) 359-6600
 FAX: (702) 359-6605

1077 South East 2nd St.
 Ontario, OR 97914
 (503) 889-2788
 FAX: (503) 889-2787

RECENT PAPERS

Exploration Geochemistry

This list comprises titles that have appeared in major publications since the compilation in Newsletter No. 68. 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 (GCS Paper) and Open File Report (GCS 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, Colorado 80401, Chairman AEG Bibliography Committee. Please send new references to Dr. Closs, not to EXPLORE.

- Ahmedali, S.T. (Ed.) 1989 *X-Ray Fluorescence Analysis in the Geological Sciences. Advances in Methodology Short Course V*. 7 Geol. Assoc. Can. 297 p.
- Aitchison, J. 1990 *Relative variation diagrams for describing patterns of compositional variability* Math. Geol. 22(4): 487-511
- Ajmal, M. 1990 *Trace-element study of manganese ores of the Barbil area, Keonjhar district Orissa, India* Min. Deposita 25(2): 160-162
- Appleton, J.D. et al. 1989 *Lithogeochemical exploration for silver mineralization in Bolivia, Mexico and Peru*. Trans. IMM 98: B201-211
- Anon. 1988 *Silver - exploration, mining and treatment* IMM 344 p.
- Anon. 1989 *Weathering: Its Products and Deposits: Volume I. Processes and Volume II. Products - Deposits - Geotechnics* Theophrastus Pub. (Athens). Vol. I: 462 p. and Vol. II: 671 p.
- Barnes, J.W. 1988 *Ores and Minerals: Introducing Economic Geology* Open Univ. Press. 181 p.
- Bernier, L.R. and MacLean, W.H. 1989 *Auriferous chert, banded iron formation, and related volcanogenic hydrothermal alteration, Atik Lake, Manitoba* Can. J. Earth Sci. 26(12): 2676-2690
- Bonnemaison, M. and Marcoux, E. 1990 *Auriferous mineralization in some shear-zones: A three-stage model of metallogenesis* Min. Deposita 25(2): 96-104
- Brimblecombe, P. and Lein, A.Y. (Eds.) 1989 *Evolution of the Global Biogeochemical Sulphur Cycle* Wiley. 241 p.
- Carr, D.D. and Herz, N. (Eds.) 1989 *The Concise Encyclopedia of Mineral Resources* Pergamon/MIT Press. 426 p.
- Chadwick, J. and Walker, S. 1990 *Assessing world exploration* Intern. Min. (Feb.): 22-29
- Clarke, D.B. et al. 1989 *Tourmaline composition as a guide to mineral exploration: A reconnaissance study from Nova Scotia using discriminant function analysis* EG 84(7): 1921-1935
- Closs, L.G. 1990 *Geochemistry - Annual Review* Min. Eng. 42(5): 432-434
- Davies, B.E. 1989 *Data handling and pattern recognition for metal contaminated soils* Environ. Geochem. and Health 11(3/4): 137-143
- de Groot, J.J. and ter Braak, C.J.F. 1990 *Model-free estimation from spatial samples: A reappraisal of classical sampling theory* Math. Geol. 22(4): 407-415
- Degens, E.T. 1989 *Perspectives on Biogeochemistry* Springer-Verlag. 427 p.
- Dennen, W.H. 1989 *Mineral Resources, Geology, Exploration and Development* Taylor and Francis. 255 p.
- Dunn, C.E. 1989 *Reconnaissance-level biogeochemical surveys for gold in Canada* Trans. IMM 98: B153-161

- England, E.J. 1990 *A variance of geostatisticians* Math. Geol. 22(4): 417-455
- Feely, M., McCabe, E. and Williams, C.T. 1989 *U-, Th- and REE-bearing accessory minerals in a high heat production leucogranite within the Galway Granite, western Ireland* Trans. IMM 98: B27-32
- Field, L.D. and Sternhell, S. (Eds.) 1989 *Analytical NMR* Wiley. 250 p.
- Fletcher, T.A. and Rice, C.M. 1989 *Geology, mineralization (Ni-Cu) and precious-metal geochemistry of Caledonian mafic and ultramafic intrusions near Huntly, northeast Scotland* Trans. IMM 98: B185-200
- Fletcher, W.K. and Day, S.J. 1989 *Behavior of gold and other heavy minerals in drainage sediments: some implications for exploration geochemistry surveys* Trans. Imm 98: B130-136
- Fytas, K., Chaouai, N-E, and Lavigne, M. 1990 *Gold deposits estimation using indicator kriging* CIM Bull 83(936): 77-83
- Harff, J. and Davis, J.C. 1990 *Regionalization in geology by multivariate classification* Math. Geol. 22(5): 573-588
- Hawthorne, F.C. (Ed.) 1988 *Spectroscopic Methods in Mineralogy and Geology. Rev. Mineralogy. V. 18* Min. Soc. Am. 698 p.
- Heling, D., Rothe, D., Forstner, U. and Stoffers, P. (Eds.) 1990 *Sediments and Environmental Geochemistry. Selected Aspects and Case Histories* Springer-Verlag. 350 p.
- Hess, P.C. *Origins of Igneous Rocks* Harvard Univ. Press. 336 p.
- Holland, P.T., Beaty, D.W. and Snow, G.G. 1989 *Comparative elemental and oxygen isotope geochemistry of jasperoid in the northern Great Basin: Evidence for distinctive fluid evolution in gold-producing hydrothermal systems. - A Reply* EG 84(6): 1707-1712
- Ittekkot, V. et al. (Eds.) 1989 *Facets of Modern Biogeochemistry* Springer-Verlag. 450 p.
- Jones, B.K. and Leveille, R.A. 1989 *Comparative elemental and oxygen isotope geochemistry of jasperoid in the northern Great Basin: Evidence for distinctive fluid evolution in gold-producing hydrothermal systems. - A Discussion* EG 84(6): 1705-1707
- Kaminskiy, V.G. 1989 *A geologic exploration model for porphyry-copper deposits of the Bainka zone* Intern. Geol. Rev. 31(12): 1240-1250
- Kerrick, R. 1990 *Carbon-isotope systematics of Archean Au-Ag vein deposits in the Superior Province* Can. J. Earth Sci. 27(1): 40-56
- Kettler, R.M. et al 1990 *Sulfidation of organic matter associated with gold mineralization, Pueblo Viejo, Dominican Republic* Applied Geochem. 5(1/2): 237-248
- Kovalevskii, A.L. and Kovalevskaya, O.M. 1989 *Biogeochemical gold halos on the different plant species and their parts* Izvestiia Akademii Nauk SSSR, Seriya Geologicheskaya 11:119-
- Krajca, J.M. (Ed.) 1989 *Water Sampling* Wiley. 212 p.
- Kral, S. 1990 *Advances in exploration technology are crucial for gold companies in the 1990s* Min. Eng. 42(3): 255-263
- Krivovichev, V.G. 1989 *Geochemical model of the formation of rare-metal granite pegmatites* Intern. Geol. Rev. 31(11): 1123-1133
- Kushnir, S.V. 1989 *Geochemical applications of sulfur thermodynamic diagrams* Geochem. Intern. 26(9): 105-118
- Leaman, L.M., Bowins, R. and Crocket, J. 1990 *The chemical composition of igneous zircon suites: Implications for geochemical tracer studies* GCA 54(6): 1597-1607
- Malmquist, L., Isaksson, M. and Kristiansson, K. 1989 *Radon migration through soil and bedrock* Geoexploration 26(2): 135-144
- Malyshev, B.I. and Korzhanovskaya, V.S. 1989 *Behavior of tin in calcareous-skarn and greisen processes* Geochem. Intern. 26(9): 45-54
- Miles, J.A. 1989 *Illustrated Glossary of Petroleum Geochemistry* Oxford. 137 p.
- Miller, R.M. 1989 *The keys to successful corporate mineral exploration* South Afr. J. Geol. 92(2): 146-166
- Myers, G.L. 1990 *Alteration zonation at the Fortitude gold skarn deposit, Lander County, NV* Min. Eng. 42(4): 360-368

- Naldrett, A.J. 1989 *Magmatic Sulfide Deposits* Oxford Univ. Press. 186 p.
- Neiva, A.M.R., Neiva, J.M.C. and Silva, M.M.V.G. 1990 *Geochemistry of gold quartz vein walls from Jales, northern Portugal* Chem. Geol. 82(3/4): 217-251
- Newall, P.S. and Newell, G.C. 1989 *Use of lithogeochemistry as an exploration tool at Redmoor sheeted-vein complex, east Cornwall, southwest England* Trans. IMM 98: B162-174
- Oostindier, J. et al. 1990 *Weathered, Ni-sulfide ore-hosting and barren serpentinites in the Fortaleza de Minas greenstone belt, Minas Gerais, Brazil: A rock geochemical study* Chem. Geol. 81(3): 209-22.
- Orem, W.H., Spiker, E.C. and Kotra, R.K. 1990 *Organic matter in hydrothermal metal ores and hydrothermal fluids* Applied Geochem. 5(1/2): 125-134
- Plant, J.A. and Jones, D.G. (Eds.) 1989 *Metallogenic models and exploration criteria for buried carbonate-hosted ore deposits - a multidisciplinary study in eastern England* IMM/Brit. Geol. Surv. 161 p.
- Petrov, O.M. and Khairatdinov, I.A. 1989 *Distribution pattern of massive sulfide mineralization at the Buribai ore region* Geologiya Rudnykh Mestorozhdenii 31(3): 57-64
- Prendergast, M.D. and Jones, M.J. (Eds.) 1989 *Magmatic Sulphides - The Zimbabwe Volume* IMM. 254 p.
- Puttman, W. and Gobel, W. 1990 *The Permian Kupferschiefer of southwest Poland: a geochemical trap for migrating, metal-bearing solutions* Applied Geochem. 5(1/2): 227-235
- Ramsden, A.B. and French, D.H. 1990 *Routine trace-element capabilities of electron-microprobe analysis in mineralogical investigations: an empirical evaluation of performance using spectrochemical standard glasses* Can. Mineralogist 28(1): 171-180
- Rao, K.S.P., Sastry, R.S.N. and Raju, S.V. 1989 *Results of geochemical soil survey in Ramagiri goldfield, Andhra Pradesh, India* Trans. IMM 98: B24-27
- Reimann, C. 1989 *Reliability of geochemical analyses: recent experiences* Trans. IMM 98: B123-129
- Robinson, G.D. 1990 *Metal-tolerant bacteria in geochemical exploration* Chem. Geol. 82(1/2): 145-158
- Rogers, J.J.W. and Greenberg, J.K. 1990 *Late-orogenic, post-orogenic and anorogenic granites: distinction by major-element and trace-element chemistry and possible origins* J. Geol. 98(3): 291-309
- Saunders, J.A. and Allard, G.O. 1990 *The Scott Lake deposits: a contact-metamorphosed volcanogenic massive sulfide deposit, Chibougamau area, Quebec* Can. J. Earth Sci. 27(2): 180-186
- Sawkins, F.J. 1990 *Metal Deposits in Relation to Plate Tectonics*. 2nd Ed. Springer-Verlag. 461 p.
- Skinner, B.J. 1990 *Resources in the 21st Century: Can supply meet needs?* Episodes 12(4): 267-275
- Sondag, F. et al. 1988 *Utilisation des methodes d'extractions chimiques selectives pour la prospection geochemique en milieu Lateritique* Sciences Geologiques 41(1): 37-46
- Spiridonov, E.M. and Prokof'ev, V.Y. 1990 *Geochemical characteristics and conditions of formation of the plutogenic gold-telluride deposits in the Caledonides of northern Kazakhstan* Intern. Geol. Rev. 32(2): 188-200
- Stumpfl, E.F. and Papunen, H. (Eds.) 1990 *Proceedings of the Fifth International Platinum Symposium-Helsinki 1989* Min. and Petrol. 42(1-4): 1-336
- Tan, L.P. and Ni, J.M. and Cheng, J.C. 1987 *A geochemical prospecting for gold mineralization in the Chinkuashih district, Taiwan* Acta Geologica Taiwanica 24: 151-
- Usenko, S.F. 1990 *Tin potential of Sikhote-Alin and the problem of geological prediction* Intern. Geol. Rev. 32(1): 100-107
- Vlassopoulos, D. and Wood, S.A. 1990 *Gold speciation in natural waters: I. Solubility and hydrolysis of gold in aqueous solution* GCA 54(1): 3-12. (Errata GCA 54(6): 1849)
- Vlassopoulos, D., Wood, S.A. and Mucci, A. 1990 *Gold speciation in natural waters: II. The importance of organic complexing - Experiments with some simple model ligands* GCA 54(6): 1575-1595
- White, L. 1990 *Treating refractory gold ores* Min. Eng. 42(2): 168-174
- Williams, D.F., Lerche, I. and Full, W.E. 1988 *Isotope Chronostratigraphy: Theory and Methods* Academic. 345 p.
- Wood, S.A. 1990 *The aqueous geochemistry of the rare-earth elements and yttrium, 1. Review of available low-temperature data for inorganic complexes and the inorganic REE speciation of natural waters* Chem. Geol. 82(1/2): 159-186
- Wright, D.F., Bonham-Carter, G.F. and Rogers, P.J. 1989 *Spatial data integration of lake-sediment geochemistry, geology and gold occurrences, eastern Nova Scotia, Canada* Trans. IMM 98: B175-184

Lackey

MINERALS EXPLORATION

Claim Staking · Geological Services
Surveying

NEVADA
702-348-0092

2032 CEDAR FLAT RD.
WILLIAMS, OR 97544

OREGON
503-846-6996

XRAL

Analytical Services for Exploration & Research Geoscientists

- Pb & NiS Fire Assay - Au & PGE's
- Multielement Analysis AA, DCP, ICP, ICP-MS, XRF
- Neutron Activation Analysis - Soils, Veg., Rock
- High quality whole rock analysis by XRF
- Rare-earth by ICP/MS or NA, chondrite plots
- Exploration and Research grade analysis

X-Ray Assay Laboratories
Toronto, Ontario
(416) 445-5755

XRAL Activation Services Inc.
Ann Arbor, Michigan
(313) 662-8528

Les Laboratoires XRAL
Rouyn-Noranda, Quebec
(819) 764-9108

Sample Preparation Laboratories;
c/o SGS Thunder Bay, Ontario/Arviat, N.W.T.
c/o SGS (GTL) Vancouver, B.C.
c/o MEG Reno, NV, Clark Smith (702) 849-2235
c/o SGS St. John, N.B.



A Member of the SGS Group
(Société Générale de Surveillance)

NEW MEMBERS

To All Voting Members:

Pursuant to Article Two of the Association's By-Law No.1, names of the following candidates, who have been recommended for membership by the Admissions Committee, are submitted for your consideration. If you have any comments, favorable or unfavorable, on any candidate, you should send them in writing to the Secretary within 60 days of this notice. If no objections are received by that date, these candidates will be declared elected to membership. Please address comments to Sherman P. Marsh, Secretary AEG, U.S. Geological Survey, Mail Stop 973, Box 25046, Federal Center, Denver, Colorado 80225, U.S.A.

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

VOTING MEMBERS

Holbek, Peter M.
Exploration Geologist
Homestake Min. Dev. Co.
Vancouver, B.C., Canada

Koval, Pavel, V.
Chief Appl. Geochem. Dept.
Siberian Branch Acad. Sci.
Irkutsk, U.S.S.R.

Knutsen, Galen C.
Manager of Mine Geology
Newmont Exploration Ltd.
Elko, Nevada, U.S.A.

McGuigan, Paul J.
Consulting Geologist
Cambria Geological Ltd.
Vancouver, B.C., Canada

Stanley, Clifford R.
Research Associate
Queen's University
Kingston, Ont., Canada

AFFILIATE MEMBERS

Adams, Sandra M.
Manager, Tech. Services
Chemex Labs Inc.
Sparks, NV, U.S.A.

Bellefeuille, Gilles
Engineer
Groupe B.S.A.
St. Eustache, P.Q., Canada

Bookstrom, Arthur A.
Tech. Advisor/Geologist
U.S. Geol. Survey
Spokane, WA, U.S.A.

Cannon, Bart
Cannon Microprobe/S.E.M.
Seattle, WA, U.S.A.

Cookro, Theresa M.
Geologist
U.S. Geol. Survey
Lakewood, CO, U.S.A.

Cooke, David L.
D.L. Cooke & Assoc.
Vancouver, B.C., Canada

Dwyer, John L.
Sr. Scientist
TGS Technology
Sioux Falls, SD, U.S.A.

Edwards, Glen W.
Phelps Dodge Mining
Pietersburg, R.S.A.

Enns, Steve G.
Project Geologist
Falconbridge Ltd.
N. Vancouver, B.C., Canada

Evans, Luke
Project Geologist
Westminer Canada Ltd.
Chibougamau, P.Q., Canada

Flores, Ramon A.L.
Exploration Geologist
Gladioli Services
Kuching, Sarawak Malaysia

Gatten, O. Jay
President
North American Explor.
Kaysville, UT, U.S.A.

Gauthier, Michel
Outrement, P.Q., Canada

Gibbins, Walter
District Geologist
DIAND-NWT Geol. Div.
Yellowknife, NWT, Canada

Grove, Ginny R.
Geologist
San Bernardino N.F.
San Bernardino, CA, U.S.A.

Halliwell, Douglas
Geologist
N. Vancouver, B.C., Canada

Hatton, Richard S.
The Robertson Group
Llandudno, U.K.

Hayes, John P.
Geologist
Dept. Mines & Energy
St. John's, Nfld., Canada

Horbach, Ruben
Geologist
Salvador, Brasil

Jeffress, Graham M.
Geologist
CRA Exploration
Madang, Papua New Guinea

Kirby, L.D.
Information Geologist
Dominion Mining
W. Perth, W. Australia

Lamoreux, Barbara
Canon City, Colorado, U.S.A.

Larouche, Claude
President
Ovalbay Geol. Services
Thunder Bay, Ont., Canada

Lehmann, Jon H.
Sr. Geologist
Inland Gold & Silver
Spokane, WA, U.S.A.

Leong, Clarence
Assayer
Acme Analytical Labs
Vancouver, B.C., Canada

Lutjen, Larry D.
Field Supervisor
Barnes Creek Minerals
Chase, B.C., Canada

Min, Kyoung Won
Asst. Prof.
Kangweon National Univ.
Chuncheon, Korea

Morant, Katie
Librarian
Australian Consol. Min.
Perth, W. Australia

Morishita, Yuicha
Geologist
Brown University
Providence, RI, U.S.A.

Norman, David I.
Assoc. Prof.
New Mexico Tech.
Socorro, NM, U.S.A.

Parker, Richard T.G.
Exploration Consultant
Crianlarich, U.K.

Pece, Raimondo
Professor
University of Naples
Naples, Italy

Ramshaw, R. Spencer
Ramshaw's Computer Solutions
Hamilton Ont., Canada

Ririe, G. Todd
Research Geologist
Unocal Science & Tech.
Brea, CA, U.S.A.

Simpson, Thomas
Geologist
ASARCO
Spokane, WA, U.S.A.

Stewart, Craig A.
Geologist
Geopeko
Brisbane, Qld., Australia

Stewart, Robert
Sr. Proj. Geologist
Falconbridge Ltd.
Duncan, B.C., Canada

Sullivan, Stephen
Mine Geologist
Colonel Light Gdns., Australia

Yam, Patrick
Marketing Manager
Acme Analytical Labs.
Vancouver, B.C., Canada

Vidojko, Jovic
Dept. of Geochemistry
Belgrade, Yugoslavia

Zanko, Lawrence M.
Asst. Scientist
Nat. Resources Res. Inst.
Duluth, MN, U.S.A.

STUDENT MEMBERS

Boamah, Daniel
ITC
Delft, The Netherlands

Campbell, Keith B.
Colorado State Univ.
Fort Collins, CO, U.S.A.

Cline, Jean S.
VPI & SU
Blacksburg, VA, U.S.A.

Hudak, George J.
Univ. of Minnesota
Duluth, MN, U.S.A.

Lavoie, Mirabelle
Univ. of Sherbrooke
St. Eustache, P.Q., Canada

MacInnis, Kandy A.
Univ. of Waterloo
Waterloo, Ont., Canada

Osterberg, Steven, A.
Univ. of Minnesota
Duluth, MN, U.S.A.

Williams, Cindy L.
Glenwood Springs, CO, U.S.A.

1991 DUES NOTICE

ASSOCIATION OF EXPLORATION GEOCHEMISTS

P.O. Box 523 (Metropolitan Toronto), Rexdale, Ontario, CANADA M9W 5L4

Your Name and Address:

(Current membership status is indicated on your address label.)

Please check ☐ Renewal ☐ New address
☐ New Member

NAME _____

TITLE _____

AFFILIATION _____

MAILING ADDRESS _____

TELEPHONE () _____

TELEX _____

FAX () _____

Date _____

Specialty or topic of interest selection 1 ☐ 2 ☐ 3 ☐ 4 ☐

(Insert number in box)

- | | | |
|------------------------|-------------------------|--------------------|
| 1. Mineral Exploration | 4. Computer | 7. Petroleum |
| 2. Analytical | 5. Agricultural | 8. Ground Water |
| 3. Environmental | 6. Terrain (Quaternary) | 9. Other (specify) |

Field of interest selection 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐

(Insert number in box)

- | | |
|--------------------------------|-------------------------------|
| 1. Drainage (streams & lakes) | 7. Statistical methods |
| 2. Soils | 8. Analytical instrumentation |
| 3. Lithogeochemistry | 9. Analytical procedures |
| 4. Biogeochemistry (geobotany) | 10. Pollution |
| 5. Gas geochemistry | 11. Theoretical |
| 6. Heavy minerals | 12. Other (specify) |

☐ Check here if you do not want your name and address made available for sale as part of the AEG mailing list on address labels.

☐ Annual dues for Voting or Affiliate Member, current year and next year

US \$ 85.00 _____

☐ Annual dues for current year, Voting or Affiliate Member

US \$ 50.00 _____

☐ Not a Voting Member? Check box to receive appropriate forms.

☐ Student Member
 (Note that students must have this form signed by a member of the academic staff verifying their full-time student status)
 I certify that the applicant is a full-time student at this institution.

US \$ 20.00 _____

 (Signature and Title)

 (Printed Name)

 (Institution)

☐ Corporate Member

US \$100.00 _____

☐ Corporate Member
 (without Journal of Geochemical Exploration)

US \$ 30.00 _____

☐ Third World Membership Fund donation
 (Your contribution in any amount will be put into a separate fund to support memberships in Third World countries.)

US \$ _____

TOTAL B (THIS PAGE)

US \$ _____

TOTAL A (FLIP PAGE)

US \$ _____

TOTAL ENCLOSED

US \$ _____

Please note that Cheques, International Money Order, UNESCO Coupons, International Postal Orders, VISA and Master Card are acceptable. All payments are in **U.S. FUNDS**. For users of VISA or Master Card, minor variations in your billing may reflect currency exchange rate fluctuations at time of bank posting. **Please note that cheques not drawn on U.S.A. or Canadian banks require an additional \$15.00 U.S. to be submitted to reimburse the AEG on bank charges.**

Charge: Master Card ☐ VISA ☐

Credit Card Account

Number Here

Expiration date _____

Signature _____

Print your name _____

Is your credit card number completed (if appropriate)?

CALENDAR OF EVENTS

International, National and Regional Meetings of Interest to Colleagues Working in Exploration and Other Areas of Applied Geochemistry

■ Sept. 9-17, '90 Geochemistry of Clay-Pore Fluid Interactions, Burlington House, Piccadilly, London, United Kingdom (Dr. D. Savage, British Geological Survey, Keyworth, Notts, United Kingdom, Tel: 06077, 6111)

■ Sept. 10-12, '90 Goldtech 4, mtg., Reno, Nev. Meetings Department, Society for Mining, Metallurgy and Exploration, Box 625002, Littleton, Colo., 80162-5002, Tel: 303-973-9550; Fax: 303-973-3845)

■ Sept. 10-13, '90 15th Colloquium on African Geology, Nancy, France (Prof. G. Rocci, Lab oratoire de Petrologie, Universite de Nancy 1, BP239, 50506 Vandoeuvre-les-Nancy Cedex, France)

■ Sept. 17-20, '90 Computers and minerals research, intl. symposium, Berlin, West Germany (F.L. Wilke, Technische Universitat Berlin, Institut fur Bergbauwissenschaften, Sekr. EB 11, Strasse des 17. Juni 136, 1000 Berlin 12, West Germany)

■ Sept. 21-23, '90 The Irish minerals industry, a review of the decade conf., Galway, Ireland (The organizing Secretary, I.A.E.G. 1990, c/o Ennex International plc., Piggott Street, Loughrea, Co. Galway, Ireland, Fax: 091-42356)

■ Sept. 28/29, '90 Earth resources mtg, St. John's, Newfoundland (Jeremy Hall, Centre for Earth Resources Research, Memorial University of Newfoundland, St. John's, A1B 3X5, Tel: 709-737-4519; Fax: 709-737-2589)

■ Sept. 29 - Oct. 7, '90 European Geological Societies, mtg., Lisbon, Portugal, by Geological Society of Portugal (Sociedade Geologica de Portugal, Apartado 2361, P 1109 Lisboa Codex)

■ Oct. 6-7, '90 Soils and landscape evolution, Binghamton Symposium, Binghamton, N.Y. (Peter L. K. Kneupfer, Department of Geological Sciences, State University of New York, 13901; Tel: 607-777-2389)

■ Oct. 8-10, '90 Remote Sensing: technology for mining and petroleum industries, intl conference and exhibit, London (The Institute of Mining & Metallurgy, 44 Portland Place, London, England W1N 4BR, Tel: 01-580-3802, Telex: 261410 IMM G, Fax: 1-436-538 8)

■ Oct. 9-14, '90 Epithermal exploration short course, Socorro, N.M. and Arizona (Society of Economic Geologists, Box 15570, Amarillo, 79105)

■ Oct. 22, '90 Modelling geological data consisting of multiple variable, short course, Houston (American Association of Petroleum Geologists, Box 979, Tulsa, Okla. 74101-0979, Tel: 918-584-2555; Fax: 918-584-0469)

■ Oct. 25-28, '90 Mineral-water interface geochemistry short course, Dallas (Mineralogical Society of America, Suite 414, 1625 I St. NW, Washington, D.C., 20006, Tel: 202-775-4344; Fax: 202-775-0018)

■ Oct. 27-28, '90 Metalliferous black shales and related ore deposits symposium, Dallas (Bartholomew Nagy, Laboratory of Organic Geochemistry, Department of Geosciences, University of Arizona, Tucson, 85721, Tel: 602-621-6973)

■ Oct. 29-31, '90 Remote sensing: an operational technology for the mining and petroleum industries, intl conf. and exhibition, London, England (The Conference Office, Institution of Mining and Metallurgy, 44 Portland Place, London W1N 4BR, England)

■ Oct. 29-Nov. 1, '90 Geological Society of America, ann. mtg., Dallas (Vanessa George, GSA, Box 9140, Boulder, Colorado 80301, Tel: 303-447-2020)

■ Nov. 5-9, '90 Soviet mineral resources mtg. and trade fair, Anchorage, Alaska (Alaska Miners Association, Suite 203, 501 West Northern Lights Blvd., Anchorage, 99503, Tel: 907-276-0347; Fee: \$275)

■ Nov. 12-17, '90 Intraplate volcanism, intl. mtg., Reunion Island, Indian Ocean (Institut de Physique du Globe de Paris, 4, Place Jussieu, 75252 Paris Cedex 05; Tel: 1 34549126, Fax: 33 1 43264029)

■ Nov. 15-17, '90 International Gold Expo, (Porta Hoffman, American Mining Congress, 1920 N Street N.W., Suite 300, Washington, D.C. 20036, Tel: (202) 861-2850, or (202) 861-7535)

■ Nov. 19-23, '90 Geological Congress of Central America, San Jose, Costa Rica (Escuela Centroamericana Geologia, U.C.R., Apartado 35 (2060) U.C.R.; Tel: 00506 25-7941, Fax: 00506 25-7941)

■ Dec. 11-12, '90 Mineral deposits study group mtg., Dublin, Ireland (Dave Johnston, Department of Geology, Trinity College, Dublin 2)

■ Jan 7-11, 1991 Short course entitled "Hydrothermal Alteration: Its Relationship to Mineralization," University of Nevada, Reno, Nevada (Mining, Division of Continuing Education, University of Nevada, Reno; Reno, Nevada 89557, phone (303) 784-4046).

■ Feb. 17-21, '90 Exploration in a changing environment, mtg., Sydney, Australia, by Australian Society of Exploration Geophysicists, and Geological Society of Australia (ASEG/GSA, Box 925, Crows Nest, N.S.W., 2065)

■ Feb. 25-28, '91 Society for Mining, Metallurgy, and Exploration ann. mtg., Denver, Colorado (Geochemistry: J. Stevens Zuker, Westmont Mining Inc., 4949 S. Syracuse St., Suite 4200, Denver, Colorado 80237, Tel: (303) 694-4936; Geochemistry & Geology: Kenneth A. Lovstrom, Lovstrom & Associates, 1628 S. Lee St., Lakewood, Colorado 80226, Tel: (303) 988-2854)

■ March, '91 International Conference on Economic Evaluation of Mineral Resources (Intergeoekonomika 1991 CSSR, GEOFOND Bratislava branch Kosice, Eng. St. Richter, Ph.D., Garbanova 1, 040 11 Kosice, Czechoslovakia. Tel: 437 649)

■ Mar. 11-14, 1991 Society of Engineering and Mineral Exploration Geophysicists 4th Annual Symposium on the Application of Geophysics to Engineering and Environmental Problems, University of Tennessee Conference Center, University of Tennessee, Knoxville, Tennessee (Richard A. Hopkins, Chairman, Marrich Inc., 6000 Kaywood Road, Knoxville, Tennessee 37920, phone (615) 573-4188).

■ Apr. 15-19, '91 Environmental pollution mtg., Lisbon, by European Centre for Pollution Research and others (Intl Conference on Environmental Pollution, 11-12 Pall Mall, London SW1Y 5LU, Tel: 01-930-6825; Fax: 01-976-1587)

■ Apr. 21-28, '91 2nd AusIMM-SME World Gold '91, Cairns, Australia (Meetings Dept., SME, Tel: (303) 973-9550, Fax: (303) 979-3461, Telex: 881988, or Mrs. J.M. Webber, CEO, AusIMM, P.O. Box 122, Parkville, Vic 3052, Australia, Tel: 613-347-3166, Fax: 613-347-8525, Telex: AA 33552)

■ Apr. 26-May 1, '91 Assoc. of Exploration Geochemists, intl. mtg., Reno, Nev. (Keryl Fleming and Mario Desilets, Nevada Bureau of Mines & Geology, Univ. of Nevada, Reno, 89557-0088, Tel: 702-784-6691)

■ Apr. 29-May 2, '90 Remote sensing and exploration geology, mtg., Denver, Colorado (Nancy Wallman, Environmental Research Institute of Michigan, Box 8618, Ann Arbor, Mich. 48 107-8618, Tel: 313-994-1200, x3234, Fax: 313-994-1575)

■ May 5-10, '91 Geology of industrial minerals mtg., Banff, Alberta (Wylie Hamilton, Alberta Research Council, Alberta Geological Survey Department, Box 8330, Station F, Edmonton, Alberta, T6H 5X2, Tel: 403-438-7676)

■ May 13-17, '91 Brazil Gold '91 (USA-Charles Thorman, USGS (Denver), Fax: (303) 236-5448; Canada-C. Jay Hodgson, Queens U., Fax: (613) 545-6592; UK-Robert Foster, U. Southampton, Fax: 59-3052; Australia-David Groves, U. Western Australia, Fax: 9386-6577)

■ May 27-29, '91 GAC-MAC (Annual mtg.), Toronto, Canada (J. Fawcett, Department of Geology, University of Toronto, Toronto, Canada M5S 1A1)

Continued on Page 24

Annual General Meeting *continued from Page 4*

accomplishments and emphasized improved communications as a critical achievement. He noted the addition of Regional Councillors to the Council Meetings as an example of this. He also noted A. Soregaroli's efforts to centralize the office functions of the Association, which will continue in the coming year. Sponsorship of people in developing countries was also a major achievement during A. Soregaroli's presidency.

D. Runnells outlined his thoughts for the coming year. He said that the Association was facing a crossroads. The AEG must decide if it can properly and appropriately participate in the environmental thrust in the world of geochemistry. Can the AEG strengthen the environmental activities being carried out throughout the world. He said that A. Coope was chairing a committee to investigate this issue. Should the AEG remain exclusively in the area of mineral exploration or should we broaden, in some appropriate way, into environmental geochemistry? He asked members to communicate their thoughts on this issue to either himself or A. Coope. He emphasized that the Council and Executive were open to all suggestions from membership and noted that little "feed back", if any, was ever received. He then introduced the out-going President, Arthur E. Soregaroli for his Presidential Address.

13. Presidential address

Arthur E. Soregaroli gave his Presidential Address, which will be published in an upcoming issue of the *Journal of Geochemical Exploration*.

14. Other business

No further business was brought before the Executive.

15. Adjournment

The President thanked Dr. Myrna and the people of the Czechoslovakian Geological Survey and all the support people for a superb meeting, for superb excursions, and for letting us see a beautiful and wonderful country.

It was moved (A. Coope) and seconded (R. Garrett) that the Annual General Meeting of the Association of Exploration Geochemists be adjourned. The President asked for a vote on the motion. Passed unanimously.

The Annual General Meeting of the Association of Exploration Geochemists was adjourned at 1:58 PM local time.

Sherman P. Marsh, Secretary
U.S. Geological Survey
MS 973, Federal Center
Denver, Colorado 80225 USA

MEETING REPORTS

Actions of April 18, 1990

1. The Secretary reported that a press release concerning the award to Robert Boyle of Honorary Member had been sent to 13 organizations and journals.

2. Two nominations were received for the Distinguished Lecture Series, both from Australia.

3. The Soils

Short Course was given to 37 people at the Prospectors and Developers meeting on March 9-11 in Toronto, Canada

4. D. Runnells reported that the By-Law Revision Committee had received all comments and were preparing a draft of the changes and modifications.

5. Council approved 3 Voting, 33 Affiliate, and 4 Student Members.

Actions of June 20, 1990

1. Stan Hoffman was appointed to the position of Acting Business Manager for the Association.

2. Council approved a motion to have the Annual General Meeting of the Association in the first quarter of the year in order to make the election process easier and to allow elected officers to serve a full one year term of office.

3. Council approved the nomination of Jeffrey A. Jaacks as Second Vice President of the Association of Exploration Geochemists.

4. Council approved a motion to make the term of the Distinguished Lecturer be one (1) year, extendable to two (2) years upon the agreement of the lecturer.

5. Council approved the move of Explore from Reno to Denver.

6. D. Jenkins agreed to chair a committee to decide how donated monies for giving subscriptions or memberships in AEG to institutions or individuals in developing countries would be dispersed.

7. Council approved 12 Affiliate members.

Sherman P. Marsh, Secretary
U.S. Geological Survey
MS 973, Federal Center
Denver, Colorado 80225 USA

ELECTION RESULTS

During the summer of 1990 the Association of Exploration Geochemists held its annual election of Ordinary Councillors. Also, during the year, two Regional Councillors were elected; one by popular ballot and one by Council appointment. Council also nominated a Second Vice President and the current Second Vice President moved to First Vice President. The existing First Vice President is the new President. The results of these elections are listed below.

President
Donald D. Runnells

First Vice President
W. Kay Fletcher

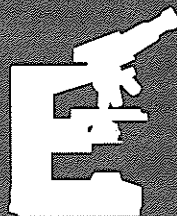
Second Vice President
Jeffrey A. Jaacks

Councillors 1990 - 1992
Harold F. Bonham
Ray E. Lett
Peter J. Rogers
S. Clark Smith
Arthur E. Soregaroli
Paul Taufen

Regional Councillors
Europe 1990 - 1992
Gunter Matheis

Brazil 1990 - 1992
John M.A. Forman

THEODORE P. PASTER, PH.D. Consulting Petrographer



- Thin and Polished Thin Sections
- Over 25 Years Experience
- Brochure Upon Request

11425 East Cimarron Drive
Englewood, Colorado 80111
Day or Night: (303) 771-8219

INTERNATIONAL SYMPOSIUM

15th International Geochemical Exploration Symposium

Plan to attend the 15th International Geochemical Exploration Symposium (IGES) to be held in Reno, Nevada, USA, from April 26 to May 4, 1991. An exciting array of talks will be presented during three days of plenary sessions, from Monday, April 29, to Wednesday, May 1, 1991. Poster sessions will be held concurrently. Field trips, short courses, and workshops will be split between pre- and post-meeting times. One hundred and fifty industry vendors, consultants, and professional organizations will be present in the spacious exhibit hall.

The Reno area has many special attractions to offer — top-notch entertainment, the thrill of casinos, and world class ski resorts, to name a few. The symposium will be held at Bally's Casino Resort, one of Reno's finest hotels. Bally's offers a variety of entertainment, from the Ziegfeld Theatre and the presentation of top-name entertainers, to full recreation facilities, to the largest hotel shopping and services mall in Reno. Seven restaurants, including the award winning Cafe Gigi serving French cuisine, are available for your dining pleasure. Symposium lunches will be held in the Ziegfeld Theatre. Deli lunches will also be available in the exhibit hall, with a centrally located no-host bar.

The social program includes such exciting events as a dinner cruise aboard a paddle wheel boat on scenic Lake Tahoe, a tour of the Virginia City-Lake Tahoe area, a presentation on "Secrets of a Showgirl" at Bally's, and a ski trip to the world famous Squaw Valley Ski Resort.

Technical Sessions:

1. Integrated geophysical and geochemical exploration.
2. New analytical techniques and improved methodologies.
3. Theoretical aspects of gold transport and deposition.
4. Regional geochemical mapping.
5. Primary element dispersion around gold deposits.
6. Remote sensing and biogeochemistry in exploration.
7. Concealed deposits
 - a: Case histories.
 - b: Exploration methods.
8. Geochemistry of gold and platinum deposits.
9. Current world-class deposits.
10. The "Triassic-Jurassic volcanic arc" mineral systems, eastern California and western Nevada, and their exploration.
11. General technical session.

Field Trips:

1. Hot springs and hot-spring-related ore deposits. (4/26 - 4/28)
2. Gold/silver deposits of Chile. (4/13 - 4/24)
3. Mother lode gold deposits/Foothill belt copper deposits of California. (4/26 - 4/28)
4. Geology and geochemistry of the Carlin Trend. (4/26 - 4/28)
5. Ore deposits of eastern Nevada. (5/2 - 5/5)
6. Geochemical relationships and ore deposits of the Osgood Mountains, Nevada. (5/1 - 5/3)
7. Geology and geochemistry of gold deposits of the central Battle Mountain-Eureka mineral belt. (4/26 - 4/28)
8. Geochemical signatures of several Nevada precious metal deposits concealed by alluvium or barren rock. (5/2 - 5/3)
9. Mineral deposits of Montana. (5/2 - 5/3)
10. Diverse epithermal gold-silver deposits in Tertiary extensional settings of the southern Great Basin. (5/2 - 5/3)
11. Massive sulfide and gold deposits of the Klamath Mountains. (4/25 - 4/28)
12. Ore deposits of the Republic and Wenatchee areas, Washington. (5/2 - 5/5)
13. Western Nevada mineral deposits. (4/26 - 4/28)
14. Volcanic-hosted precious metal deposits of western Nevada. (4/26 - 4/28)

Workshops:

1. The use of soil gases in geochemical exploration
Leader: Howard McCarthy, U.S. Geological Survey
Sunday afternoon, April 28
2. Practical applications of multielement data in exploration for gold deposits, with emphasis on disseminated deposits in the Basin and Range.
Leader: Charles G. Clifton, consulting geologist and geochemist
Sunday, April 28

Short Courses:

1. Statistical treatment of exploration and drill assay data.
Leader: Robin Young, James Askew Associates
Thursday, May 2
2. A case study and comparison of varying ore estimation techniques.
Leader: Robin Young, James Askew Associates
Friday, May 3
3. Biogeochemistry and geomicrobiology in mineral exploration.
Leader: S. Clark Smith, Minerals Exploration Geochemistry
Nancy L. Parduhn, Cereus Exploration Technology, Inc.
Saturday and Sunday, April 27 and 28 - short course and field trip

Social Programs:

- Virginia City-Lake Tahoe tour (Monday, April 29)
Squaw Valley ski trip (Monday, April 29 and Wednesday, May 1)
Secrets of a Showgirl (Tuesday morning, April 30)
Tahoe Queen dinner paddle wheel cruise (Tuesday evening, April 30)

CALL FOR PAPERS

The Symposium Committee invites you to submit papers for presentation at the plenary sessions or general posted session. Abstract deadline is December 15, 1990. Papers or extended abstracts as much as 500 words, in English, will be accepted. To receive information on submitting papers please mail or FAX your request to the Symposium Committee.

EXHIBITORS

The 15th IGES will attract over 1500 participants in the geological and geochemical sciences. This will be an excellent opportunity to meet individuals and representatives of companies from around the world. Exposition schedules will be designed to maximize contact time with attendees. Space in the exhibit hall is limited and is being allocated on a first-come, first-served basis. For further information, please contact the exhibit chairman, J.L. Christman, at the symposium address.

Air Travel Discounts

Rhodes Travel has been selected as the travel agent for the 15th IGES. Please make all travel arrangements with this company. Rhodes has established special discount rates with Delta and American Airlines. Please contact Rhodes directly for information at: Rhodes Travel phone: (608) 231-3431
702 N. Midvale Blvd.
Madison, WI 53705

in US: (800) 877-9494
FAX: (608) 231-1812

CONE
GEOCHEMICAL INC.

**FIRE ASSAY
GEOCHEMICAL ANALYSIS**

810 Quail St., Suite 1 • Lakewood, CO 80215 • Phone (303) 232-8371
4788 Longley Lane • Reno, NV 89502 • Phone (702) 827-3600

15TH IGES ADVANCE REGISTRATION FORM

Name to appear on badge

first name	middle initial	last name
affiliation		
address		
city	state or province	zip or postal code
country		

REGISTRATION FEES

Conference Registration:	AEG member	\$175.00	\$
	after 2/1/91	\$200.00	\$
	non-member	\$225.00	\$
	after 2/1/91	\$250.00	\$
	spouse	\$25.00	\$
	name for badge exhibit only	\$10.00	\$

Workshops:

1. Soil gases in geochemical exploration	\$75.00	\$
2. Applications of multielement data	\$150.00	\$

Short Courses:

1. Statistical treatment of exploration and drill assay data	\$230.00	\$
2. Case study of varying ore estimation techniques	\$200.00	\$
3. Biogeochemistry and geomicrobiology in exploration	\$450.00	\$

Field Trips:

1. Hot springs deposits	\$250.00	\$
2. Gold/silver deposits of Chile	\$2400.00	\$
3. Mother lode gold/Foothill belt	\$250.00	\$
4. Carlin Trend	\$300.00	\$
5. Ore deposits of eastern Nevada	\$350.00	\$
6. Osgood Mountains	\$275.00	\$
7. Central Battle Mountain-Eureka belt	\$250.00	\$
8. Geochemical signatures of several concealed precious metal deposits	\$200.00	\$
9. Mineral deposits of Montana	\$400.00	\$
10. Southern Great Basin	\$150.00	\$
11. Klamath Mountains	\$350.00	\$
12. Republic and Wenatchee areas, Washington	\$350.00	\$
13. Western Nevada mineral deposits	\$300.00	\$
14. Volcanic-hosted precious metal deposits, western Nevada	\$275.00	\$

Social Activities:

Virginia city tour	\$40.00	\$
Squaw Valley ski trip	\$20.00	\$
Secrets of a Showgirl	\$25.00	\$
Paddle wheel dinner cruise	\$60.00	\$

AEG Presidential address luncheon included

Tuesday luncheon	\$20.00	\$
Wednesday luncheon	\$20.00	\$

TOTAL: \$

Fees will only be accepted in U.S. dollars on a U.S. bank. Visas are required from a number of countries. Please check with a U.S. Consulate or Embassy before attempting to enter the United States.

Please mail this registration form to the Symposium Committee:
 15th International Geochemical Exploration Symposium
 P.O. Box 9126, Reno, Nevada 89507
 FAX: (702) 784-6691

Calendar of Events *continued from Page 20*

■ Aug. 30 - Sept. 3, '91 Source, transport and deposition of metals mtg., Nancy, France (25 Years SGA Meeting, CREGU BP 23, 54501 Vandoeuvre-les-Nancy Cedex, France, Fax: 33-83-44-00-29)

■ Aug. 11-24, '91 XX General Assembly IUGG, Vienna, Austria (IUGG Organizing Committee, c/o ZAMG Hohe Warte 38, A-1190 Vienna, Austria, EUROPE, Tel: 43-222-36 4453 ext. 2001)

■ Sept. 16-19, '91 Environmental Geochemistry Uppsala, Sweden (Prof. Dr. Mats Olsson, Department of Forest Soils, Swedish University of Agricultural Sciences, Box 7001, S-750 07 Uppsala, Sweden, Tel: 46 18 672212, Fax: 46 18 300831)

■ Oct. 21-24, '91 Geological Society of America, ann. mtg., San Diego, California (Vanessa George, GSA, Box 9140, Boulder, CO 80301, USA, Tel: 303-447-2020)

■ Aug. 24-Sept. 3, '92 29th International Geological Congress, Kyoto, Japan (Secretary General, IGC-92 Office, P.O. Box 65, Tsukuba, Ibaraki 305, Japan, Tel: 81-298-54-3627; Fax: 81-298-54-3629)

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

Fred Siegel

*The George Washington University
Department of Geology
Washington, D.C. 20052*

LIST OF ADVERTISERS

Acme Analytical Laboratories, Ltd.	10,11
Becquerel Laboratories, Inc.	11
Bondar-Clegg	9
Cambria Data Services, Ltd.	7
Chemex Labs	13
Cone Geochemical, Inc.	22
Eco-Tech Laboratories, Inc.	5
Graphic Harmony	2
GSI Geochemical Services, Inc.	15
Lackey Minerals Exploration	17
MEG, Shea Clark Smith	10
Monitor Geochemical Lab	12
Theodore P. Paster	21
Prime Geochemical Methods, Ltd.	6
Skyline Labs, Inc.	12
Van Geochem Lab, Ltd.	10
XRAL Analytical Services	17

President:
Donald D. Rinnells
Department of Geological Sciences
University of Colorado at Boulder
Campus Box 250
Boulder, Colorado 80309-8323
USA Phone (303) 492-8323

Vice Presidents:
W. Kay Fletcher
Department of Geological Sciences
University of British Columbia
Vancouver, British Columbia V6T 2B4
Canada Phone (604) 228-2392

Jeffrey A. Jaacks
Westmont Mining Inc.
4949 S. Syracuse, Suite 4200
Denver, Colorado 80237
USA Phone (303) 694-4936

Secretary:
Sherman P. Marsh
U.S. Geological Survey
Federal Center, MS 973
Denver, Colorado 80225
USA Phone (303) 236-5521

Treasurer:
David M. Jenkins
Suite 525 890 West Pender Street
Vancouver, British Columbia V6A 1J9
Canada Phone (604) 684-6463

Councillors:
1989-1991
Maurice A. Chaffee (ex officio)
J. Alan Coope
Peter H. Davenport
Colin E. Dunn
Gwendy M. Hall
Erick F. Weiland

1990-1992
Harold F. Bonham
Ray E. Lett
Peter J. Rogers
S. Clark Smith
Arthur E. Soregaroli (ex officio)
Paul Taufen

Regional Councillors:
Australia: 1989-1991
Eric C. Grunsky
Graham F. Taylor

Europe: 1990-1992
Gunter Matheis

Southern Africa: 1989-1991
Cecil C. Begley

Brazil: 1990-1992
John M.A. Forman

Northern Countries: 1989-1991
Alf J. Björklund

The Association of Exploration Geochemists Newsletter

U.S. Geological Survey, Federal Center MS 973, Denver, CO 80225

Please send changes of address to the
Association Office at P.O. Box 523 (Metropolitan Toronto)
Rexdale, Ontario, M9W 5L4, Canada.
EXPLORE does not maintain its own mailing list.



416 VOTING PAID-90
WILLIAM B. COKER
GEOLOGICAL SURVEY OF CANADA
601 BOOTH STREET
OTTAWA, ON K1A 0E8
CANADA