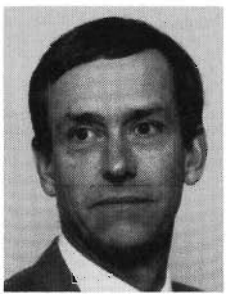
EXPLORE

The Association of Exploration Geochemists Newsletter

NUMBER 67 JANUARY 1990

PRESIDENT'S MESSAGE



This is my last communication to you as your President. It has been my pleasure to work with the Council and members of AEG during this past year. I have particularly appreciated receiving the communications (not all positive!) from those of you who took the trouble to write or telephone me about AEG issues. Thank you for your participation in AEG.

During my tenure as President, one of the issues I have focussed on is how AEG can better serve our non-North American members and how both AEG as an organization and you as individual members might help to spread information about the Association to nonmembers worldwide.

A study of our membership database indicates that our members are located in about 60 countries; however, about three-fourths of the members are concentrated in only three countries—the U.S., Canada, and Australia. Our membership is under-represented in a number of resource-rich countries including, but not limited to, Czechoslovakia, the People's Republic of China, India, Indonesia, Italy, Mexico, Nigeria, and Papua New Guinea. We currently have no members at all in countries such as Argentina, Chile, Poland, Turkey, and the Soviet Union.

Information from Elsevier indicates that there are currently less than five institutional subscribers to our Journal of Geochemical Exploration in countries such as Argentina, Austria, Czechoslovakia, Chile, the People's Republic of China, Colombia, German Democratic Republic, Greece, Indonesia, Mexico, New Zealand, Nigeria, Pakistan, Poland, Turkey, Venezuela and Zambia.

Those of you who travel to any of the above-mentioned countries, as well as to other countries where scientific literature is difficult to obtain, can perform a real service by identifying potential members and institutions that could benefit from receiving AEG publications and other literature.

Your Executive and Council have been encouraging our Regional Councillors to become more involved in the affairs of AEG in their respective regions. If you live or work in an area represented by a Regional Councillor, please let that Councillor know of potential new members and also where our publications are needed. If you live in or visit areas not presently represented by a Regional Councillor, please contact one of the members of the Executive or Council with any information. I feel that there are opportunities for the AEG to grow, particularly in countries other than the "Big Three". The help of every member is solicited.

Maurice A. Chaffee
U.S. Geological Survey
Denver, Colorado

TECHNICAL NOTES

Use of seismic geophysics in the detection of epithermal precious metal deposits in the western U.S.

Introduction: Seismic geophysical methods can be very useful in the discovery and delineation of the extent of hydrothermal systems which contain precious metals. Some applications of this technique have been in Carlin-type deposits, volcanic environments, and vein type deposits emplaced in sedimentary and volcanic rocks of Tertiary age. This paper presents observations made near the Carlin mine and at Round Mountain, Nevada.

Other current uses which have not been completely evaluated are exploring decollements in southern California and western Arizona, defining Chainman Shale vs. Joanna Limestone and other shale vs. massive limestone type environments in eastern Nevada, and hot spring deposits of Holocene, Pleistocene, and Pliocene age.

The physical principal involved is that hydrothermal alteration changes the velocity at which the altered host rock transmits seismic waves. During the mineralizing process, the rocks in and adjacent to the ore body have been altered significantly. Furthermore this alteration is commonly superimposed over an area of structural deformation. Carlin is an example of the alteration extending along fractures associated with apparent thrust faulting. One example of discovery and investigation of a Carlin-type deposit is presented in this paper.

Carlin-Type Deposits: The typical Carlin-type deposit is generally defined as gold mineralization present locally in a quartz-dominated, epithermal phase of a hydrothermal system emplaced in sedimentary host rocks of early to middle Paleozoic age. Significant volumes of disseminated pyrite, some of which contains gold, were deposited locally within the hydrothermal system. Host

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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 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-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

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NOTES FROM THE EDITOR

Journal of Geochemical Exploration Volumes 32, 33, and 34 (three numbers each) have been issued since the last newletter. 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. 283.00 or US$138.00. AEG members can save over $350 a year for the 1987 through 1989 volumes by ordering through the Rexdale office.

The proceedings of the 12th International Geochemical Exploration Symposium (IGES), held in Orleans, France during April 1987 are published as Volume 32 edited by **Stuart E. Jenness.** At 512 pages, it is the largest of the new issues, featuring 53 articles on gold including lateritic environments, exploration in tropical terrains, biogeochemistry, exploration using transported overburden, analytical methods, exploration with isotopes, data processing and interpretation, and rock geochemistry.

Volume 33, edited by **Xie Xuejing** and **S.E. Jenness**, contains 21 papers mostly from the Third Chinese Exploration Geochemistry Symposium held in Guilin, Guangsu during September 1986.

Volume 34 includes 6 papers from the proceedings of the Symposium on Exploration Geochemistry held in Pretoria, South Africa in 1987 which were edited by **G.L. Coetzee, Nok Frick,** and **Cecil Begley.**

Nominations for Councillor of the Association are requested on p. 21. People in related disciplines like environmental geochemistry, geophysics, geostatistics, and hydrocarbon geochemistry should also be considered.

EXPLORE Number 66 was distributed to **4000** professionals including members of AEG, Alaska Geological Society, Geological Society of the Oregon Country, the Utah Geological Association, and the Association for Women Geoscientists. Bulk shipments were made to **Graham Taylor** for Australia, **Paul Taufen** for Brazil and **Stan Hoffman** for Canada and Mexico. The remainder were handed out by me at the meeting in Reno on Structural Styles in the Northern Basin and Range and by **Erik Rorem** at the Northwest Mining Association meeting in Spokane. 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.

Chet Nichols

TECHNICAL NOTES

Continued from page 1

rock lithologies vary from carbonates to chert, siliceous shale and siltstone. Thrust faults and/or detachments have been identified at many of the mines in the district and they are believed to be related to the formation of the ore deposits. The age of mineralization is thought to be Oligocene (Radtke, 1985).

The ore bodies are contained within a larger mass of hydrothermally altered rock. Commonly, this mass of altered rock is in the form of a stratum or lense which attains a thickness of about 120 feet at the Carlin mine. In discussing the physical properties of the altered zones, it appears that decalcification and other forms of chemical degradation effect the rock more than the more obvious silicification that seems to pervade in these deposits. These lenses, commonly discordant with the attitudes of the host rock strata, were probably, at least in part, developed along fractures and breccias resulting from detachment or thrust faulting. Seismic reflections of anomalously large amplitude are generated at the contacts of the altered rock masses.

The elastic moduli and densities of the rock within the altered lenses have been significantly changed. The greater the difference in elastic moduli and density between the rock units, the larger the reflection originating at their contact. Consequently, anomalously large seismic reflections emanate from the upper and lower contacts of the hydrothermally altered rock with their unaltered equivalents. Radtke(1985) depicts the oxide ore zone at the Carlin mine as being 120 feet thick. In this paper the oxide zone of Radtke's is being equated with the altered lense. Figure 1 shows a portion of one of Radtke's sections. Figure 2 is a seismic time section located about 1.5 miles to the northwest, and roughly parallel to Radtke's section. Figure 3 is an interpreted version of Figure 2. Given a thickness of the lense equal to 120 feet, and a 30 millisecond interval from the top to the base of the lense on the seismic section, the velocity within the lense is 2 x 120 feet/30 milliseconds or 8.0 fpms(feet per millisecond). This compares with velocities ranging from 14.0 fpms to 20.0 fpms measured in unaltered rock of Paleozoic age in this region. From these observations it may be concluded that one can expect anomalously high amplitude reflections emanating from the surfaces of the altered lense.

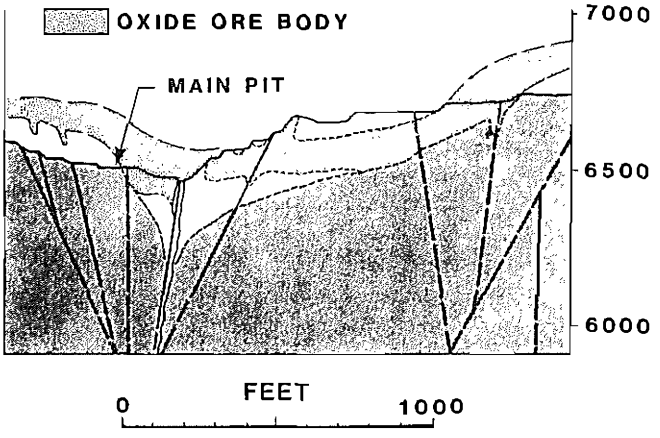

Figure 1. Geologic section at the Carlin mine (after Radtke, 1985).

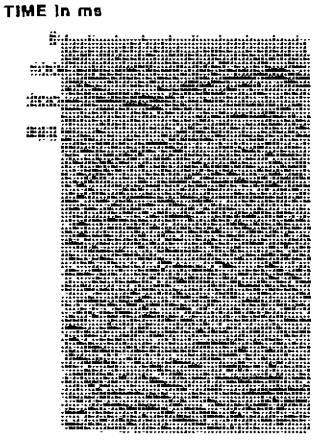

Figure 2. Seismic time section located about 1.5 miles northwest of Fig. 1 and roughly parallel to it.

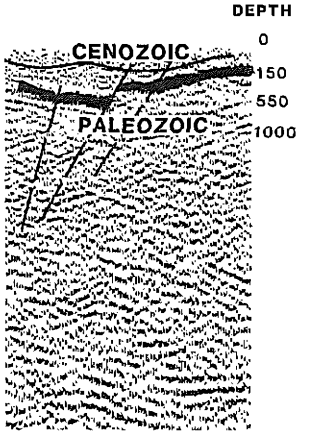

Figure 3. Interpretation of Fig. 2, dark areas interpreted as altered lenses.

The seismic section also depicts high angle faults and several sections of stratified events. One of the high angle faults offsets the altered lense and appears to have normal movement. The altered lense is much less affected by the other two faults. Also shown is the contact between the Carlin Formation (?) of Pliocene age and the Paleozoic formations.

Figure 4 shows a typical sequence of four traces on a reflection seismic section. The contact of the more competent siliceous units over the hydrothermally altered lense is represented by the negatively polarized wavelets. The contact of the less competent altered lense over the very competent carbonate assemblage is represented by a large amplitude, normally polarized wave, the onset of which lies within the large amplitude event about 32 milliseconds below the onset of the negatively polarized wavelet.

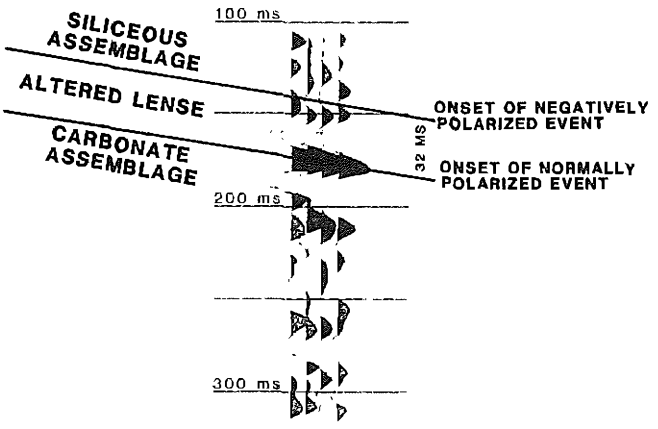

Figure 4. A typical sequence of four traces on a reflection seismic section. The seismic signature which denotes a Carlin-type deposit is shown.

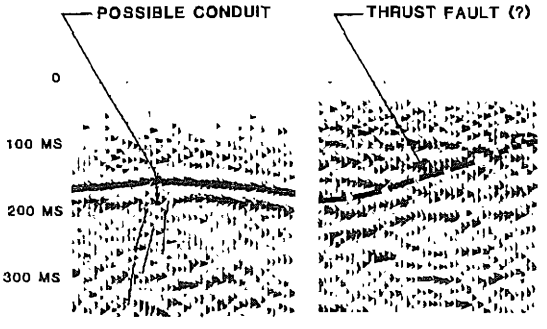

Figure 5. Comparison of seismic section depicting a Carlin-type deposit and a section in which only the thrust fault zone is defined. The sections are about one-half mile apart.

The validity of equating the large amplitude anomalies with the perimeters of the hydrothermally altered rock of Carlin-type deposits is partly substantiated by comparing the seismic sections, approximately one-half mile apart, shown in Figure 5. The left section depicts the obvious, strong amplitude waves generated at the top and base of the lenticular mass of hydrothermally altered rock. This section also depicts a possible conduit entering the al-

tered lense from below in the form of diminished amplitude and a downward bending of the lower event. This downward bending suggests lower velocity which equates with less competent rock suggesting more intense alteration. The area of low amplitude signal immediately below the large amplitude events is a function of the AGC (automatic gain control) and is not directly related to the geology. For interpretation purposes, it is useful in comparing this anomaly to others such as the section to the right.

In the left section, the AGC exerted a great deal of suppression to the signals originating from the altered zone, thus the area of low amplitude immediately below the amplitude anomaly. The right section depicts events of much lesser amplitude and coherence in the same region, but without the suppressed signal below the events. These lesser events originate along strata in proximity to an unmineralized portion of the thrust fault. No drilling data have been released at the time this paper was written, however strong circumstantial evidence indicates the above observations to be valid.

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Phone 913-241-3167

References

Barnes, H. L., 1979, Geochemistry of hydrothermal ore deposits, second edition: John Wiley & Sons

Bonham, H. F., Jr., Tingley, J. V., eds. 1986, Sediment-hosted precious-metal deposits of northern Nevada: Nevada Bureau of Mines and Geology, Report 40, 11 authors, 103 pp.

Radtke, A. S., 1985, Geology of the Carlin gold deposit: U. S. Geologic Survey Professional Paper 1267, 124 pp.

A Check for Error in Drill Hole Sampling Using Paired Assays

Introduction

In advanced stages of exploration, check assays are commonly run on analytical samples, but the many steps which ready a sample for assay are not often checked. This situation invites unpleasant problems with data quality. Inappropriate sample processing can fatally flaw resource investigations and mine planning.

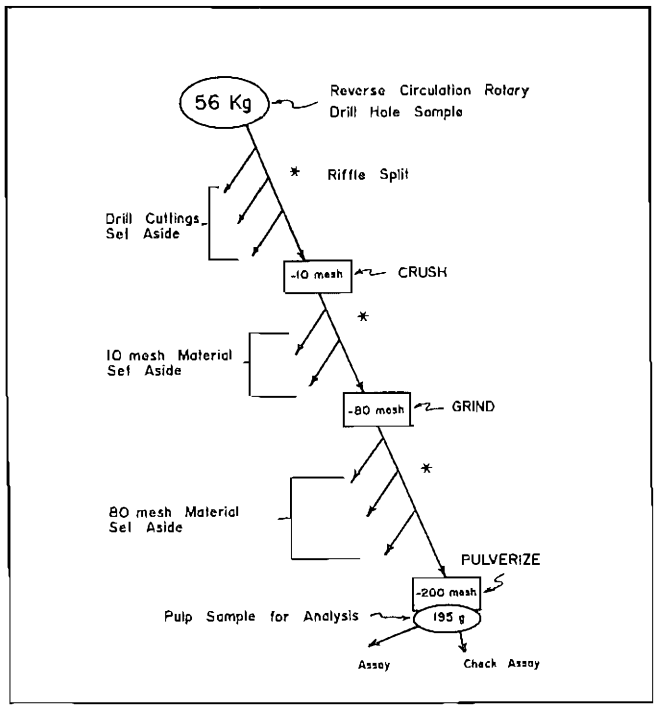

Figure 1. An expedient sampling procedure for drill cuttings in gold exploration.

Error in Assay Values

Every splitting, comminution, and analytical procedure in sampling introduces an increment of error into assay values. Splitting steps, including selection of the assay charge, typically impose the worst sampling errors, but the worst *splitting* errors often involve drill cuttings. As only minor errors accrue from careful comminution, digestion, dilution, instrumental analysis, etc., only sample splitting will be considered here.

Subsample inhomogeneity caused by inappropriate splitting procedures creates a subsample distribution which no longer represents the true sample distribution. What in effect is created is an inseparable combination of true and artificial distributions which can not be adaquately characterized by either statistics or geostatistics. Since most assay values in distributions of this sort typically report lower than true, and a few much higher than true, and since high "erratic" assays are often cut, ore grades above cutoff can be underestimated. Consequently, grade boundaries tend not to be realistic.

Thus, an expedient sampling procedure -- used for the first few holes in a continuing project -- must be checked. Sampling steps which generate non-representative assays and excessive error must be redesigned so that subsequent drilling and sample processing can provide reliable assays for resource estimation and mine planning. A relative variance of $(11.5\%)^2$ to $(16\%)^2$ (Schwarz, 1989) measures the maximum tolerable limit for error from a single sampling step.

Estimating Error

Error generated at any volume-reduction step is investigated by use of paired assays. Replicate samples from several ore-grade intercepts are isolated at the splitting step in question and processed in the same way as the original samples. Resulting assay values are transformed as follows:

$$\%\ \text{difference} = 100 \times (\mathbf{O}-\mathbf{R}) \div (\mathbf{O}+\mathbf{R}) \qquad (1)$$

for original **O** and replicate **R** assays. Relative variance of "% difference", calculated by the usual formulation, estimates error in units of percentage^2 for a given splitting step. If the sigma key of a pocket calculator is used to tabulate values from (1) above, tedious mathematical manipulations are avoided, and the relative variance is easily calculated.

Material selected from a narrow range of assay values will avoid problems with sample value distribution. If the project geologist

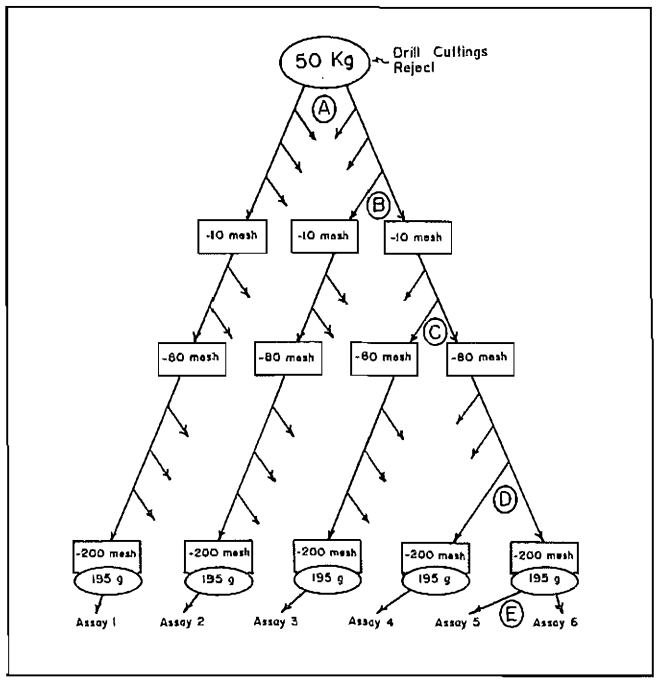

Figure 2. Paired samples isolated from several splitting steps of an expedient procedure for a check of sampling error using paired assays. Resulting paired assays can check sampling error.

checks samples which report ore grades near cutoff, the critical ore/waste boundry is also examined. If several intercepts in a narrow range of assay values are not available, a broader range may be used after logarithmic conversion. These can substitute for original and replicate values in (1) above.

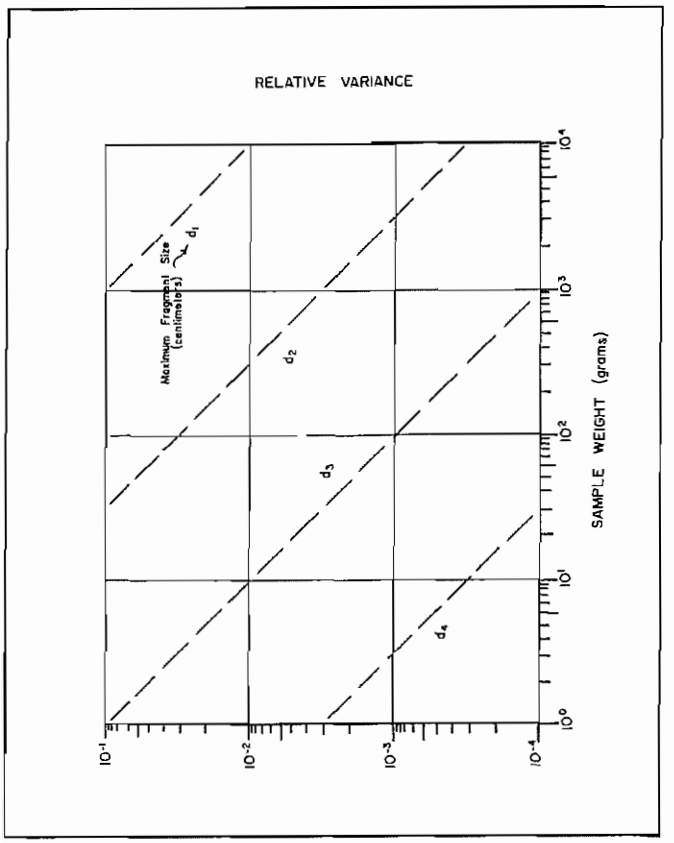

Figure 3 An example sampling nomograph (modified from Gy and Pitard, 1989)

Example Procedure

Figure 1 shows an expedient sampling procedure used at start-up of a rotary reverse circulation drilling program. The initial sample, 56 kg of material, comes from a 5-ft drill intercept. This material is riffle-split to convenient subsamples which are crushed, ground, and pulverized to provide the analytical sample. Since the worst errors typically come from splits of coarse materials, uncrushed cuttings and laboratory rejects must be temporarily stored to later provide replicate samples for procedural checking.

Figure 2 shows several splitting steps isolated for checking. The splitting step at **A** provides replicate Assay #1 paired with original Assay #5. Assay #1 can also be paired with #2, #3, and #4. These assays generate an estimate of variance at **A**. Similarly, splits at **B**, **C**, **D**, and at the analytical check **E**, provide replicate/original assay pairs which generate a variance for each splitting step.

Checking can conveniently begin with splitting steps immediately preceeding comminution -- **B** and then **C** in Figure 2, and so forth. (If **B** does not generate excessive error, splitting steps above **B** are O.K. Similarly, at **C**, etc.) Either reprocessed or stored material can be used.

Redesign

Modification of potentially devastating sample splitting steps is easily justified for an ongoing project. Considering that redesign depends on logistics, budgets, and project objectives, the project geologist can minimize error by replacing problem steps with procedures which reduce grain size at a larger sample volume.

The project geologist can simply replace a troublesome step and test the modified procedure. Since such iterative work is tedious and expensive, it is preferrable to work the problem on paper.

When relative variance at several sampling steps is determined, these data characterize not only the sampling procedure, but also the material itself. Thus, any similar method for processing this material can also be characterized.

Several variances calculated at different sample volumes and various particle sizes are used to construct a "sampling nomograph" (Gy et al, 1989). The nomograph uses the general relationship:

log variance is proportional to 3 log **d** − log **m** (2)

where variance is the decimal % relative variance, **d** is the centimeter screen size passing 95% of material, and **m** is sample weight in grams.

A calculated variance at known **m**, a variance/m point, is plotted on the nomograph (Figure 3). The known **d** at each variance/m point also defines a nomograph line with a slope of negative one (see (2) above). This line shows the range of possible variance/m points for the given **d**. Alternate **d**'s can be extrapolated from plotted lines representing known **d**'s.

At a comminution step, **m** holds constant while **d** and variance decrease; at a sample splitting step, **d** holds constant while variance and **m** decrease. Graphical manipulation of **m** and **d** can consider and weigh: logistics and budgets; the limit of an acceptable variance $(15\%)^2$, for example, plotted as .0225 decimal % difference); and the advisability of spreading increments of error more-or-less evenly among the splitting steps. Thus, the nomograph can predict variance, **D**, and **m** and suggest design modifications without the need to iterate sampling procedures.

After redesign, the modified procedure should be checked for excessive error. As the project continues, sampling should be continually and routinely monitored. Even in the best programs, carelessness, changed ore characteristics, equipment problems, etc. can flaw assay data unexpectedly and increase data variance.

A project geologist should avoid the consequences of discovering, at the end of an advanced drilling program, that assay data for which he is responsible does not reasonably reflect samples taken. It may then be too late to resolve this very unpleasant situation.

Thanks to Freeport McMoRan Gold Company for permission to share these thoughts.

Frederick P. Schwarz, Jr.
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Mountain City Star Route
Elko, Nevada 89801

References Cited

Gy, Pierre, and Pitard, Francis, 1989. Sampling of gold, theory and practice: Colorado School of Mines short course, October 1988.

Schwarz, F. P., 1989. Minimizing errors in drill sampling for gold: Proceedings, SME/AusIMM Gold '89 symposium. pp 33-37.

NEWS & COMMENT

Soils Short Course March 9-11, 1990

The AEG will be presenting a **soils short course** prior to the 1990 Prospectors and Developers Association (PDA) annual convention (March 11 - 14, 1990). Readers of EXPLORE will be aware that a similar course was given prior to the NWMA convention in 1988 where the overwhelming consensus from participants was positive — the many ideas and case histories provided to them were likely to have an impact on their future exploration. The short course at PDA is probably the last time this course will be offered.

For those considering whether or not to reserve one of the 100 places available, a brief summary of the topics and instructors is provided. The short course is led by five instructors headed by Dr. Kay Fletcher of U.B.C. and represents state-of-the-art exploration geochemistry. It is designed to help the explorationist make reliable and cost-effective decisions on projects.

The course commences with Dr. Ian Thomson of Pan Orvana Resources reviewing basic geochemical principles. Theory and practical problems are addressed. Geochemical models for element dispersion in glaciated terrain are highlighted. Topics, such as geochemical gradients and barriers, are explained with reference to case histories for vein type Mo and volcanogenic massive sulphide (VMS) deposits. A checklist describing the many components of a geochemical survey is presented to ensure that individual explorationists can conduct their own programs with the highest level of reliability.

Dr. Stan Hoffman of Prime Geochemical Methods Ltd. continues with a review of the reasoning process involved in designing an exploration program. A discussion of factors revolves around the unconformity-type U deposit as a model, with frequent references made on how lessons learned from this model could be applied to other deposit types, particularly epithermal gold. The project manager is warned that over-reliance on "off-the-shelf" technology — without giving proper thought to the project at hand — could be disastrous.

Dr. Hoffman then examines the factors that need to be considered during the physical process of soil sampling. In this he is assisted by Mr. W. A. (Bill) Price, a soil scientist, who describes the many competing processes involved in soil formation. The discussion is supported by case histories for a wide range of physical environments, soil types, trace elements and deposit types. The reasons why care and attention are essential during the sampling program are amply documented, and ways to avoid the pitfalls common in many of today's surveys are described.

Dr. Fletcher follows with a review of procedures for sample preparation and analysis. Case histories document what can go wrong, and how to avoid problems, maintain quality control, and optimize procedures for individual geochemical surveys. Peculiarities associated with analysis of gold and platinum are addressed and the influence of the nugget effect on results is discussed.

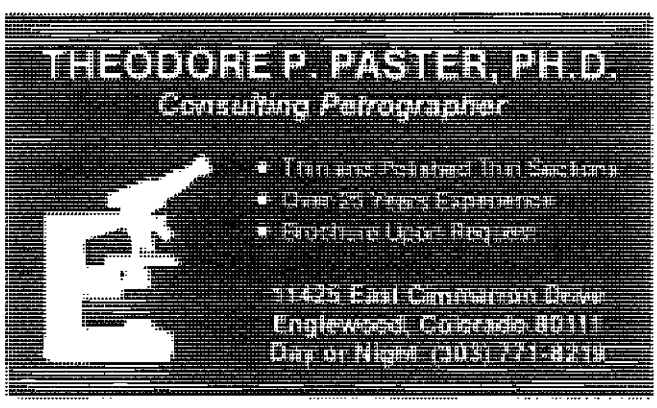
Once data are confirmed as accurate and precise, they must be interpreted to determine significant anomalies. Mean plus two standard deviations is not the way to go; Dr. Al Sinclair of U.B.C. reviews methods of data analysis. Has widespread availability of inexpensive multi-element analysis changed methods of data analysis? Dr. Sinclair will bring you up to date.

How are soil survey data interpreted? The most common approach is to contour the highest numbers. The reliability of this approach is considered by Drs. Thomson and Hoffman who provide an alternate approach based on geochemical and geological reasoning. How significant are the different approaches? Course participants can judge with reference to several case histories.

Over 50 case histories are referenced during the course. Most are brief, however detail is provided in examples from VMS deposits in the Bathurst and Buchans camps. Dramatic contrast is seen between conventional and unconventional soil surveys, and course participants will learn how they can compete from the position of advantage in the Appalachians. Case histories focus on the Canadian Shield describing deep overburden surveys and how these compare and contrast to humus surveys.

A case history of exploration at Mount Milligan, an alkaline Cu-Au porphyry in Western Canada, is also given. This significant new deposit contains 6 million oz. of Au and 4 billion lbs. of Cu, and the exploration is still in its initial stages! The case history of the QR gold deposit that helped focus on Mount Milligan and the CAT Mountain property of Lysander Gold Corp. which benefitted from orientation work at Mount Milligan is also described.

Themes running throughout the course include the use of computer applications to rapidly evaluate data and the impact multi-element data analysis is having on modern interpretation. With 30-element, high quality analysis as inexpensive as US $2.80, can an exploration program afford to make do with analysis of only three or four elements?



The instructors practice what they preach, and represent over 80 years of hands-on experience. Registrants are encouraged to participate and to submit questions or problems which could be addressed during the course. Only 100 positions are available for this course. Register early.

For registration materials write the Prospectors and Developers Association of Canada at Suite 1002, 74 Victoria Street, Toronto, Ontario M5C 2A5, Canada, You may also call 416-362-1969 or fax 416-362-0101. The Soils Short Course costs $CN 400; payments by American Express, Visa, and MasterCard are accepted.

Stan Hoffman

Vancouver MEG Directory

The 1990 edition of the Vancouver Mining Exploration Group (M.E.G.) Membership Directory is available. The 80-page Directory lists over 1000 geologists and engineers plus related industry and government services in B.C. and the Yukon Territory. First published in 1988, the Directory quickly established itself as the premier networking source for Canadian Cordilleran explorationists.

The M.E.G. Directory is sold for $4.00 Cdn. per copy at M.E.G. luncheons, and at the offices of the B.C.-Yukon Chamber of Mines and the B.C. Ministry of Mines in Vancouver. Copies mailed to addresses within Canada or the U.S. cost $6.00 Cdn. or $5.25 US. Those mailed to other countries cost $8.00 Cdn. or $7.00 US.

Money orders are made payable to Linda Thorstad, Treasurer of M.E.G. Please address orders and advertising inquiries to:

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1990 AEG Directory

The Association publishes a popular ***Membership Listing and Directory of Geochemical Services*** which many consider to be a valuable and unique reference volume. The Directory includes members' addresses, telephone numbers and FAX numbers (sorted alphabetically as well as geographically). Service companies worldwide are listed by speciality and location. As exploration companies extend their horizons and have a need to become familiar with local analytical and other services, the Directory will serve as a handy reference.

The 1990 Directory will list assay and geochemical laboratories alphabetically as well as by country (and region where countries have a well-developed exploration infrastructure). Laboratory specialities — such as sample preparation, water analysis, vegetation analysis, and isotope analysis — will also be listed separately. Topics in the 1988 Directory include: Environment, Metallurgy, Overburden Drilling, Soil Testing, Consulting, Exploration Program Design, Statistical Data Processing, Computer Plotting, Exploration Field Supplies, and Coal. New headings such as Contract Soil Sampling, Computer Programming, and Universities specializing in training geochemists and soil scientists, will be added to the 1990 volume. You are encouraged to review the 1988 volume and make suggestions. What would you like to see?

Laboratories Note: it costs nothing to have your company name and specialities described in the Directory. New this year, the corporation name will be highlighted by using bold print if the company or one or more of its employees are AEG members. *Cost of AEG membership for an individual is $US 50.00, or for a corporation, $US 100.00* . See p.25 of this issue.

The Directory is sponsored by advertising revenue. It is an excellent vehicle to reach an interested audience, and it supports a non-profit organization representing your interests. Advertising possibilities are summarized below, including the availability of labels. Please submit the requested information to Stan Hoffman at Prime Geochemical, Suite 630, 1199 West Pender Street, Vancouver, B.C. V6E 2R1. Camera-ready copy will be accepted until *March 15, 1990* for publication about April 1, 1990.

Please check:

_____ I am/The company is/ an AEG member.
_____ I am/The company is/ not an AEG member.
_____ Enclosed find $US 50 or $US 100 for 1990 individual or company membership (circle correct amount).

Please verify your company data on the address label and include your phone number, FAX number, and/or TELEX:

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CAME Symposium — Computer Applications in Mineral Exploration March 9 & 10, 1990

A commercial exhibit is scheduled and participants of the above **soil short course** will be permitted to attend without paying the $CN 125 cost of this symposium.

GEOPHYSICS

The use of EM Modelling in Exploration for Deep Sulphide Deposits: **J. Macnae,** *Lamontagne Geophysics Ltd.*

Compilation of Airborne Geophysical Data on a PC: **R. Whitton,** *Urquhart Dvorak Limited.*

Ground Compilation - Do's and Don'ts: **L. Bradish,** *Noranda Exploration Company, Limited.*

New Advances in Tomography: **J. Wong,** *JODEX*

GEOCHEMISTRY

The Application of Computers to the Display and Interpretation of Geochemical Data: **P. Davenport,** *Newfoundland Department of Mines and Energy.*

Geochemical Exploration Using Microcomputer-Based Systems with Reference to Nova Scotia: **P. Rogers,** *Nova Scotia Department of Mines and Energy.*

Application of CAD Systems to Geochemistry: **M. Pond,** *Cambria Data Services Ltd.*

Computer Treatment of Regional Geochemical Data: **P. Matysek,** *British Columbia Ministry of Energy and Mines and Petroleum Resources.*

GEOSCIENCE INFORMATION SYSTEMS

The Decision Making Process in the Selection of Computer-Based Technology for Geoscience Data: **L. Chauvin,** *Ministere de l'Energie et des Ressources du Quebec.*

Application of Geographic Information Systems in Quebec: **C. Roy,** *Ministere de l'Energie et des Ressources du Quebec.*

The Use of Geographic Information Systems for Exploration and Mining: **G. Bonham-Carter,** *Geological Survey of Canada.*

Database Management of Spatial Geoscience Data: **A. Currie,** *Ontario Geological Survey.*

DRILLHOLE HANDLING

Computer Treatment of Drillhole Data at Placer Dome: **W. R. Green,** *Placer Dome Inc.*

Drillhole Data at Les Mines Selbaie, Quebec: **R. Deptuk,** *BP Resources Canada Limited.*

The Exploration Value of Enhanced Drillhole Display with Autocad: **R. Grant,** *Inco Ltd.*

ORE RESOURCES

The Usefulness of the Computerization of Drillhole Information: **P. Holbek,** *Homestake Mineral Development Company.*

The Change from Manual to Computerized Reserve Estimation Approaches: **M. Cormier,** *Les Mines D'Or Kiena Limitee.*

3-D Solids Modelling: Its Application from Exploration to Feasibility: **H. Brown,** *Pamorex Minerals Inc.*

Computer-Based Ore Reserve Estimation: Practitioners Views: **N. Champigny,** *The Coopers & Lybrand Consulting Group.*

MINE PLANNING AND MINE DESIGN

Computer-Aided Mine Planning at Newmont Gold Company: **F. Seymour,** *Newmont Gold Company.*

For more information, contact:
Normand Champigny
The Coopers and Lybrand Consulting Group
145 King Street West, 24th Floor
Toronto, Ontario, Canada M5H 1V8
Tel: (416) 869-1130, FAX (416) 863-0926

CALENDAR OF EVENTS

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

■Mar. 12-15, '90 **SAGEEP 90** 3rd ann. symp. geophysics in engineering and environmental problems, Golden, Colorado (Scott Eberhard, Dorothy Weber, Colorado ARC Enterprises, Ltd., 133 S. Van Gordon, Suite 200, Lakewood, Colorado 80228, Tel: 303-980-1648)

■Apr. 1-5, '90 **Geology and ore deposits** of the Great Basin, Reno, Nev. (Geol. Soc. Nevada, Box 12021, Reno, 89510)

■Apr. 8-12, '90 International **High-level radioactive waste management** conference, Las Vegas, Nevada (American Nuclear Society, 555 N. Kensington Ave., La Grange Park, IL 60525, Tel. 312-352-6611)

■Apr. 30-May 3, '90 International Conference on **Metals in Soils, Plants and Animals**, Orlando, Florida (Dr. Domy C. Adriano, International Conference on Metals, Savannah River Ecology Laboratory, Drawer E, Aiken, SC 29802, USA)

■May 2-4, '90 V.M. **Goldschmidt Conference**, Baltimore, Maryland (Donna Ricketts, 409 Keller Conference Center, The Pennsylvania State University, University Park, PA 16802)

■May 6-12, '90 **Pacific rim** , 90 Congress, Gold Coast, Queensland, Australia, by Australasian Institute of Mining & Metallurgy (AusIMM-PACRIM 90, Box 731, Toowong, Queensland 4066, Australia. Tel: 617-371-7900)

■May 14-18, '90 **World Mining** (14th Congress), Beijing, P.R. China (14th World Mining Congress, 54 Sanlihe Road, Beijing, P.R.China)

■May 16-18, '90 **Geological Association of Canada**/Mineralogical Association of Canada, ann. mtg., Vancouver, B.C. (R.I. Thompson, 801-750 Jervis St., Vancouver, V6E 2A9. Tel: 604-681-5226)

■June 3-6, '90 **Geoanalysis 90** Huntsville, Ontario, Canada (Gwendy E.M. Hall, 601 Booth Street, Ottawa, Ontario,Canada K1A 0E8, See p. 20 of this issue).

■June 24-29 '90 GeoInfo IV, 4th International Conference on **Geoscience Information**, Ottawa, Canada (David Reade, GeoInfo IV Secretariat, 601 Booth Street, Ottawa, K1A 0E8, Canada)

■July 2-6, '90 Geology and **mineral resources** of continental margins: ancient and modern (23rd Earth Science Conference, Geological Society of South Africa), Cape Town, South Africa (Dr. P.G. Gresse, Geological Survey, P.O. Box 1739, Bellville, 7530, South Africa)

■July 29-Aug. 3, '90 Circum-Pacific **energy and minerals resources** (Conference), Honolulu, Hawaii (Mary Stewart, Circum-Pacific Council on Energy and Mineral Resources, 5100 Westheimer Road, Houston, TX 77056)

■Aug. 12-18, '90 8th Symp. of Intl. Assoc. on the **Genesis of Ore Deposits,** Ottawa, Canada (L.M. Cumming, Secretary, 8th IAGOD Symposium, Geological Survey of Canada, 601 Booth St., Ottawa, Ontario, Canada K1A 0E8)

■Aug. 12-18, '90 **Mineral deposit modelling** (International Conference), Ottawa, Canada. Held with 8th IAGOD Symposium. Sponsored by IUGS and UNESCO (R.V. Kirkham, Geological Survey of Canada, 601 Booth Street, Ottawa, Ontario, Canada K1A 0E8)

■Aug. 15-17, '90 **Arctic geology & petroleum potential,** mtg., Tromso, Norway (Norwegian Petroleum Society, Box 1897, Vika, 1024 Oslo 1)

■Aug. 29-31, '90 **14th International Geochemical Exploration** Symposium, Prague, Czechoslovakia (Frantisek Mrna, see p. 13 of this issue).

■Oct. 29-31, '90 **Remote Sensing**: technology for mining and petroleum industries, int'l conference and exhibit, London (The Instit. Mining & Metallurgy, 44 Portland Place, London, England WIN 4BR, Tel: 01-580-3802, Telex: 261410 IMM G, Fax: 01-436-5388)

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

■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

■Apr. 26-May 1, '91 **15th International Geochemical Exploration** Symposium, Reno, Nevada (Keryl Fleming and Mario Desilets), Nevada Bureau of Mines & Geology, Univ. of Nevada, Reno, 89557-0088. Tel: 702-784-6691

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

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

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

PEARL HARBOR FILE

Recognizing Sampling Problems

The irreproducibility of Au and As data from a follow-up survey at the Gladstone property in north central California was described in *EXPLORE* no. 66. The reader was posed with these questions: Was it possible that the nature of the mineralization was different near the Old American ore shoots compared to the area around the Gladstone? Could the difference be accounted for by an increase in average gold grain size, thus producing a severe nugget effect? How could the geochemist determine if the difference was real?

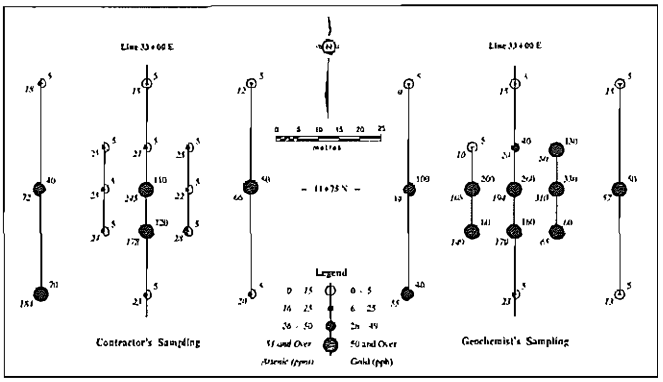
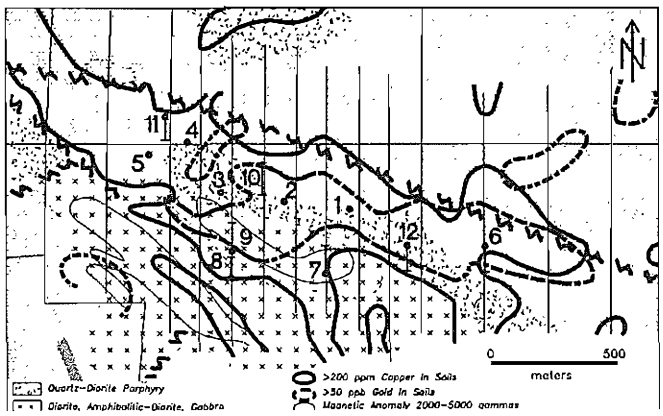


Figure 9. Comparison of same grid, two samplers.

One way to determine the quality of a sampling program is to perform F and t tests on the data. If the geochemist had started with these tests, comparing the contractor's data to his own, it would have been apparent that the contractor's samples might have been collected from a single site. However, gold and arsenic data would not have been particularly useful as they do not approximate the normal or lognormal distributions needed for the statistical tests. Fortunately, other ICP trace-metal data was available and could be used.

Standards and blind duplicates were not available for testing heirarchies of variation due to analysis, sub-sampling, and between-site influences. The only solution was to resample the local contractor's mini grid.

The geochemist's suspicions were confirmed when he returned to 33E, [11+75N] and found no station markers and ultimately compared his results to the contractor's (see Fig. 9 vs. Fig. 8c and 8d in *EXPLORE* no. 66. Indeed, sample bags had been filled from a single hole in both these mini-grids. Note that seven values around the center are the same. Values from the geochemist's samples (Fig. 9) show which location all the duplicates came from.



We are all familiar with examples of unmotivated samplers cutting corners because the company will never recognize the deficiencies in a survey introduced by, say, collecting a number of samples from one hole. This is certainly true if Au is the only element determined, but with ready availability of multi-element ICP data, it is easy to recognize cases such as this one.

The last five issues of *EXPLORE* have included examples in the Pearl Harbor File where improper sampling has foiled seemingly sound geochemical practice. Recent discussions with other consultants, contractors, and representatives of established exploration companies all lead to the same conclusion: the desire is to achieve absolute minimum costs regardless of how useful the data will be.

To emphasize how misguided this sentiment is, consider tbe Cr example reported in *EXPLORE* no. 63 (Fig. 3). That program used marginally trained samplers and cost about $6 per sample for collection plus line cutting. If trained samplers had been used, the job would have cost about $10 per sample. Savings of $4 per sample, or $4000 for the 1000 sample survey apparently provided strong incentive to use contract rather than professional services. Was this really a saving?

Half the samples were pulverized, at a cost of $1.50 per sample. Computer processing and plotting of the data cost about $2.00 per sample; the interpretation, which identified the problem, cost $2.00 per sample; and communications (long distance telephone charges, memos and time) cost $0.50 per sample. Time spent by the laboratory to deliver their opinion was not charged back to the company. Total cost, not including that subsidized by the laboratory, was $6 per sample for project cost $12,000. The project status: redo that portion of the survey where samples were pulverized, but this time taking adequately sized samples.

A thoughtful reader would suspect that there are more serious problems with the initial survey than have been reported here. Indeed this is the case. A portion of a resampling project is reported as Fig. 3 of my *Presidential Address* which is found in *JGE 34, 106-107.* The address actually shows bow significant mineralization can be missed entirely using "conventional" methods.

Briefly, the shortfalls were corrected at an additional cost of $14 per sample (or $7,000 for the 500 samples that had to be collected) for a total cost of $19,000. The job could have been done right the first time for $14,000. I encourage interested readers to consider participating in the soils short course scheduled March 9 - 11, 1990 prior to the PDA convention in Toronto, to discover other pitfalls that may spoil your next geochemical survey.

Now let's embark upon the next *Pearl Harbor* example and examine the illusion created by inappropriate chemical analysis. Fig. 10 presents the soil geochemical data for Cu (200 ppm) and Au (50 ppb) for a copper property in the mountains of central British Columbia. The geochemical data, in map form, have been in the public domain since the 1970's. These published results stimulated the exploration program described below. It was assumed that a significant Au content would be found to justify continued exploration on this copper property at a time of low copper prices.

The property lies above treeline and is associated with a regionally prominent gossan. Soils are poorly developed, comprising regosols (a thin organic-LH layer above relatively unaltered C horizon material) and brunisols (LH - BM - C horizon sequence (see *Reviews in Economic Geology*, v.3, p. 61, for soil nomenclature). Soil profiles have developed on locally derived material, essentially from underlying bedrock and moved downslope minimally (maybe 25 m) under the influence of gravity. Bedrock or rubble derived from bedrock is widespread, except

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Table 2: Au and Cu grades of core, assayed at 3m intervals down hole

Sample Number	Cu %	Au gm/T
1	.05	.05
2	.02	.10
3	.04	.25
4	.01	.15
5	.01	.05
6	.01	.05
7	.13	.20
8	.21	.25
9	.20	.25
10	.25	.20
11	.27	.20
12	.17	.20
13	.17	.15
D.L.	.01	.05

Figure 10 does not fully reveal the basis for the excitement generated by the property. Copper values of over 1% (to maxima of 2%) characterize both soils and stream sediments draining the area. The gossan is associated with a major fault zone cutting andesite, rhyolite and basalt, which is intruded by diorite, amphibolitic diorite, gabbro, and quartz diorite porphyry.

A soil grid was established in the 1980's to control geological mapping and geophysical surveys (the location of the original grid, positioned in the 1960's, was not wholly recoverable). An IP survey defined, not surprisingly, excellent chargeability anomalies and a ground magnetic survey outlined major anomalies characterizing the more mafic intrusions. Rock chip samples of outcrop or local rubble delineated only weak anomalies. In view of the fact Cu and Au soil data were already available, a soil survey was not undertaken.

Coincident soil and geophysical anomalies within the prominent gossan area were selected for drill testing. In your armchair appraisal of this property, are there any bits or pieces of information you would need before you would proceed to the drill stage? Make a list and send them to me.

Locations of diamond drill holes are indicated on Fig. 10. Core was split and assayed in 3 m sections for Cu and Au. Table 2 gives representative results. Grades are not suggestive of ore in sufficient volume to have economic significance, but are they enough to explain the soil anomalies? What would you do to advance this property, or would you allow the ground to lapse?

Stan Hoffman
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630-1199 West Pender Street
Vancouver, B.C., Canada V6E 1R2

MEETING REPORTS

1989 GSA Annual Meeting

Approximately 5000 geoscientists attended the 1989 annual meeting of the Geological Society of America held in St. Louis, Missouri, November 6-9. Various theme sessions and symposia addressed contemporary subjects, and a special presentation on the recent San Francisco earthquake of October 17th attracted a large audience Tuesday evening.

In keeping with the geographic location of the meeting, sessions of the Society of Economic Geologists included a two-part symposium on Mississippi Valley-type (MVT) deposits and a session on the potential for Olympic Dam-type Cu-Au-U-REE deposits in Proterozoic granite-rhyolite terranes of the Midcontinent. Other SEG sessions included sediment-hosted, metamorphic-hosted, epithermal, and other gold deposits, and sediment-hosted ores/Cu-Ni and platinum deposits.

In the MVT session F.C. Furman used stable isotopes and fluid inclusion data to establish the New Albany Shale and St. Louis Anhydrite as the source rocks from which the MVT mineralization of the Illinois-Kentucky region developed. N.R. Shaffer followed with a presentation of geochemical and stable isotope data indicating that the extreme syngenetic metal enrichment in the New Albany Shale in the Illinois Basin is mainly of terrigenous origin. This illustrates the complex nature of the geochemical cycles and reservoirs which are sometimes ultimately responsible for the genesis of mineral deposits.

The question of the genesis of MVT deposits is apparently not yet settled. Some authors prefer a fluid source from basement structures for some of the MVT deposits and others interpret stable isotope and fluid inclusion data as indicating that two fluids are required. Still others interpret their data as indicating that a single evolving fluid is responible for mineralization over hundreds of square miles.

The session on Olympic Dam-type deposits was dominated by descriptions of the unusual Fe-REE-U-Au-base metal deposits in Missouri and comparisons with the Australian Olympic Dam deposit. Many authors feel that the unusual deposits in Missouri are variants of the Olympic Dam system and that high potential exists for the discovery of a large deposit of the Olympic Dam-type in the Midcontinent of the United States.

Other items of general interest included a description by Samuel A. Bowring from Washington University of his discovery of 3.96 Ga rocks from the Slave Province, Northwest Territories. These are now the oldest known rocks on Earth, being older than the 3.8 Ga rocks in Greenland which previously held the record.

The GSA Presidential Address on mineral zoning patterns in vein systems was delivered by Ulrich Petersen. He indicated that a thorough examination and understanding of zoning patterns can aid substantially in guiding exploration for blind ore by predicting the presence or absence of particular mineral zones at depth.

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Nevada Bureau of Mines and Geology
University of Nevada
Reno, Nevada 89557 USA
Phone: 702-784-6691

13TH IGES — Rio '89

The tropical sun has set on the 13th International Geochemical Exploration Symposium here in Rio. Delegates have returned home, hopefully with a sense of satisfaction based on the new and renewed friendships and the new professional contacts from the event. Many of the non-Brazillian delegates will certainly return with a sense of what impact inflation can have in an economy such as Brazil's. The US dollar rose against the New Cruzado 9% in one day and then over 14% two days later!

The turnout was above expectations with 131 foreign

and 410 Brazilian geoscientists. Delegates were treated to 140 papers presented in the Brazilian Geochemical Congress, 93 papers presented in the IGES, and the cultural sensation of "mulatas" dancing the Samba during the evening. A proceedings volume for the Brazilian Congress and an abstracts volume for the overall event have been printed and soon will be available for sale with other AEG publications.

Workshops at the event were well attended and provided a learning experience through both presentation and discussion. The enthusiasm generated was demonstrated by the fact that extra discussion sessions were scheduled and held beyond the original finishing times. On behalf of the Rio '89 Organizing Committee, our thanks go out to the workshop coordinators for preparing the subject matter and stimulating the discussions, and to the other participants for making the workshops dynamic.

The most worthwhile accomplishments of our AEG International Symposia year after year are perhaps the building up of collective shared experiences in exploration geochemistry and the strengthening of associated professional contacts. The significant exploration geochemistry activity in Brazil historically has been relatively isolated from the rest of the world, and hopefully Rio '89 served to bring the international and Brazilian geochemical communities closer together.

We thank the authors and participants for coming to Rio and hope the experience of all delegates was professionally rewarding as well as enjoyable.

Paul Taufen
Rio '89 Committee

Basin and Range Structure Symposium

The Nevada Petroleum Society and the Geological Society of Nevada jointly sponsored a seminar entitled ***Compressional and Extensional Structural Styles in the Northern Basin and Range***. The seminar was held November 17-18 in Reno, Nevada and was attended by 268 participants. Eight speakers discussed various aspects of Basin and Range structure.

The seminar was particularly timely due to the current high level of interest in the Great Basin province with its many large gold deposits and notable petroleum wells. The slate of distinguished speakers ensured good attendance.

Mike Wilson of Newmont Exploration presented the keynote speech Friday evening and the first talk Saturday morning. He summarized the geologic and structural history of the Basin and Range province through Phanerozoic time. With this background established he described how geologic and structural models of the Basin and Range could be used to advantage in exploration for both metal and petroleum resources. The processes responsible for the accumulation of both resources require suitable source rocks, host or trap rocks, and the proper relationship between the two.

B.C. Burchfiel and L.H. Royden from MIT described the nature of the Antler orogeny in the Great Basin in light of investigations of the analogous Mediterranean orogenic belt of Italy. Cenozoic faulting has obscured much of the Paleozoic geologic relationships developed during the Antler orogenic event in the Great Basin. However, the Neogene Mediterranean thrust belt presents a relatively clear picture of the geological relationships in this type of setting. The authors related structural style, such as the development of back-arc extensional terrains, to subduction (crustal shortening) rates.

The present structural relationships in the Basin and Range are the result of combined compressional and extensional geologic events and associated folding and faulting. An example of this combined structural effect was elucidated by A.W. Snoke and others in the description of a metamorphic core complex in the Ruby Mountains and East Humboldt Range in eastern Nevada.

The paleogeography of the Cretaceous hinterland, controlled mainly by effects of the Sevier compressional event were expounded upon by James Schmitt and Dirk Vandervoort of

AEG ANNUAL GENERAL MEETING

14TH INTERNATIONAL GEOCHEMICAL EXPLORATION SYMPOSIUM
5TH SYMPOSIUM ON METHODS OF GEOCHEMICAL PROSPECTING
Prague, Czechoslovakia ● August 29-31, 1990

Sponsors:
Association of Exploration Geochemists
International Association of Geochemistry and Cosmochemistry
Prague Geological Survey *and*
other geological organizations of Czechoslovakia

Symposium Themes:
1. Geochemistry related to human activity
2. Geochemical mapping: regional, ecological, and ore districts
3. Mathematical processing of geochemical information
4. Geochemistry of ore systems (U, Au, Pt, W, Sn, Cu, Pb, Zn and others): new approaches to prospecting

Pre-symposium Workshops August 28 (US$20):
1. Panning in geochemical prospecting and its integration with other geochemical prospecting techniques
2. Biogeochemical research and prospecting
3. Geochemical modelling of ore districts
4. Teaching in geochemistry
5. Analytical techniques and reference samples
6. Geochemical data bases
7. Geothermal resources: geochemical prospecting and environmental impact
8. International geochemical mapping (starts on the 27th)

Excursions:
★ August 25-27 Deposits of gold, scheelite, tin-tungsten, and polymetallic ores in southern and western Bohemia.
★ August 28 Geological and ore-deposit localities in the vicinity of Prague.
★ September 1-4 Polymetallic deposits in eastern Bohemia and Moravia and deposits of gold and polymetallic ores in the neovolcanites of Slovakia.

Official Language: English with a possibility of translating Russian contributions into English.

Abstract Deadline: March 31, 1990

Visas: A visa is required for entry to Czechoslovakia. There is usually little problem in obtaining a visa by requesting an 'Application for Czechoslovak Visa' from Czech. embassies or consulates, several weeks before you plan to travel. In canada application forms can be obtained from Consulate General of Czechoslovakia, 1305 Pine Avenue West, Montreal, Quebec H3G 1B2, Tel. 514-849-4495, Fax. 514-849-4117. The visa costs C$13. In the United States the address is Czechoslovakian Embassy and Consulate, 3900 Lennean Avenue NW, Washington, D.C. 20008, Tel. 202-363-6315, Fax. 202-966-8540.

This should prove to be one of those rare and valuable occasions for a face-to-face interchange of ideas and information between geochemists from eastern and western countries. The cost of getting to Czechoslovakia in August from the eastern seaboard of North America is less than US$1000 for a round trip by APEX, and expenditures whilst there are likely to be very reasonable. Registration fees and accommodations are very modest, but you should register before 31st March to take advantage of discounted rates. Try to build this important meeting into your busy schedule!

The second circular concerning this International Symposium on Geochemical Prospecting has recently been dispatched to all who responded to the 1st circular. A fourth field trip is being added after the meeting, and there will be an exhibition. For more details contact: ***Dr. Frantisek Mrna***
General Chairman, Geological Survey of Prague, 118 21 Praha 1, Malostranske nam. 19, Czechoslovakia.

Montana State. Details of this lithologic and structural complexity, and implications for hydrocarbon exploration, were reviewed by Dietrich Roeder of Anschutz Corporation in a series of E-W cross sections through the eastern Basin and Range of Nevada and Utah.

Elizabeth Miller and Phillip Gans of Stanford provided an overview of the geochronology of Sevier thrusting, intrusion of Cretaceous muscovite granites and pegmatites, and peak metamorphism. Their data indicates that Sevier thrust faulting predated the 90-70 Ma granitic intrusion and concomitant crustal metamorphism event by 10-15 Ma.

Basin and Range Tertiary extensional tectonics was not restricted entirely to a largely E-W direction as evidenced by the presentation of John Bartley of the University of Utah. Bartley explained a possible dynamic model for changing Tertiary extension directions in southeastern Nevada. His interpretation combines classic E-W Basin and Range extension with a transient NNE-SSW component induced by a southward-moving Tertiary magmatic belt.

Brian Wernicke of Harvard closed the formal technical session with a description of regional scale dextral shearing in southern Nevada. He explained how crustal blocks and a crustal fluid layer might be involved in the development of the structural regime of portions of southern Nevada and adjacent California.

The symposium ended with a structured question and answer session during which participants were able to probe the speakers' knowledge for answers to geologic questions of personal interest.

Copies of the Seminar Proceedings are available. Interested individuals should contact: Donna Flanigan, Nevada Petroleum Society, P.O. Box 71408, Reno, NV 89570-1408 USA (phone: 702-786-0333).

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Phone: 702-784-6691

Gold in Europe

Gold 89 in Europe, an international symposium on gold metallogeny, exploration and beneficiation, was held 23-25 May 1989 in Toulouse, France on the campus of the Universite Paul Sabatier. Approximately 400 papers, about equally divided between oral and poster sessions, were presented. The papers covered the following general topics: gold provinces or districts, geochemistry, transport and precipitation of gold, mineralogy of gold deposits, and methods of extraction, beneficiation, and gold recovery. Selected papers from the symposium will appear in one of four journals, depending on subject: Mineralium Deposita, Revue de la Societe de l'Industrie minerale, La Chronique de la Recherche Miniere, or Terra Nova.

The attendees at the symposium were dominantly from western Europe. Eastern Europe and Africa were well represented and there were a few attendees from North and South America. Field trips were conducted to a number of gold districts in France and Spain, including Salsigne, France and Rodalquillar, Spain and to the gold deposits of the Bohemian massif in Czechoslovakia.

Anyone interested in the gold occurrences in Europe or in the current status of gold exploration and research in Europe, would be well advised to obtain a copy of the abstract volume for the symposium from either R.P. Foster, Department of Geology, University of Southampton, Southampton SO9 5NH, United Kingdom, or F. Tollon Laboratoire de Mineralogie, Universite Paul Sabatier, allees Jules Guesde, 31400 Toulouse, France, the secretaries of the symposium.

H.F. Bonham Jr.
Nevada Bureau of Mines and Geology

SPECIAL NOTES

Call for Analyses of Chromite Reference Samples for PGE Exploration

Two new chromitite reference samples have been prepared as part of a collaborative project between the CRPG, Nancy, France (K.Govindaraju) and The Open University, Milton Keynes, England (Phil Potts). These samples were collected from mineralised (CHR-Pt+) and barren (CHR-Bkg) areas of the Unst ophiolite complex, Isles of Shetland, Scotland. They have been prepared to fill a gap in availability of chromitite reference samples for which reliable composition data is available for gold, platinum-group elements and other trace elements of exploration interest as pathfinder elements.

These two chromitite samples are designed as a complemen-

tary pair with gold and PGE concentrations varying from the parts per billion range in CHR-Bkg to parts per million levels in CHR-Pt+. These materials are now available in 100g splits to laboratories that are willing to offer analyses to assist in their chemical characterisation. We should particularly like to hear from laboratories that have well-calibrated procedures suitable for chromitite matrices and are particularly interested in determinations of the major elements, gold, the platinum-group elements, Cu, Ni, Zn, V, S, As, Se, Te, and Hg. It is our intention to publish a statistical assessment and compilation of all submitted analytical results in Geostandards Newsletter (contributors may elect to remain anonymous). These samples will then be made available as new reference materials through the International Working Group of Geostandards Newsletter.

If you can help us with this project by analysing these chromitites, samples are available now, without charge, from K.Govindaraju, Geostandards, CRPG PO Box 20, 54501 Vandoeuvre-les-Nancy Cedex, France.

Phil Potts
Dept. Earth Sciences, Open University
Milton Keynes, MK7 6AA, England
Tel. (0908) 653609/653012

Dr. W.K. Fletcher Elected as Distinguished Lecturer

Dr. W.K. Fletcher was elected as the 1988-1989 Distinguished Lecturer by vote of Council. He received his Ph.D. in Applied Geochemistry at Imperial College of Science and Technology, University of London. Since 1968 he has been a member of the Department of Geological Sciences, University of British Columbia, where he is now a Professor.

During leaves of absence he has served as Chief Geochemist to MINDECO (Zambia) and Team Leader of The United Nations Project at the Southeast Asia Tin Research and Development Centre in Malaysia. He is the author of more than 50 papers covering many aspects of applied geochemistry and a textbook on *Analytical Methods in Geochemical Prospecting*. His principal interest at

present is the transport and behaviour of heavy minerals in streams.

Dr. Fletcher completed his first lecture tour in April of this year. He was warmly received at McGill University, Montreal, Quebec; Dalhousie University, Halifax, Nova Scotia; and Virginia Polytechnic Institute and State University, Blacksburg, Virginia. Two lecture or seminar subjects were chosen by each university for presentation. Lecture titles available for selection were ***Behaviour of Gold and Other Heavy Minerals in Drainage Sediments, Analysis in Exploration Geochemistry,*** and ***Interpretation of Exploration Geochemical Data: Background and Threshold.***

The second lecture tour of 1989 broke new ground for the Association as the first AEG Distinguished Lecturer tour outside of North America. Paul Taufen and Dr. Dorival Bruni organized lectures in Porto Alegre, Sao Paulo, Belo Horizonte, Brasilia, and Salvador in Brazil.

AEG Student Paper Competition

The Association of Exploration Geochemists is holding its fifth annual Student Paper Competition in the field of, or closely related to, exploration geochemistry. Papers eligible for the competition must have been published in a refereed scientific journal within the last five years *and* less than five years since the graduation of the student author. Mutliple authors are allowed, although the student must be the senior author. Please respond with nominations by March 15, 1990.

The award will be announced in April 1990 and the prize will consist of a two-year membership at the appropriate level in the Association of Exploration Geochemists and receipt of all publications. Please send nominations, including three copies of the paper and the current address of the nominee to:

Professor Ronald W. Klusman
Department of Chemistry/Geochemistry
Colorado School of Mines
Golden, Colorado 80401
303-273-3617/3610

1988 Treasurer's Report

This year was a time of change in the Treasurer's office. The books of the organization were converted to a computerized format, accounting was changed from a cash basis to an accrual basis, Nemeth Thody & Associates of Vancouver were appointed as the new auditors and there was a change in Treasurer. This writer was appointed to the office in early 1988. He replaced Lynda Bloom, who retired, after a period of exceptional service to the Association, in order to devote more time to her new consulting practice.

A review of the Balance Sheet and Statement of Revenue And Expenditure given below will indicate that even though revenue increased in 1988 by 71%, as compared with 1987, Association assets decreased by 6.3%. Dues revenue increased by 79% due to new memberships and several campaigns by Dr. Stan Hoffman to recover some of the Association's lost or strayed members from previous years. Revenue from publication sales was generally greater in 1988 than in 1987. Two significant sources of publication revenue for 1988 were Geo Expo '86 and Volume 3, Reviews in Economic Geology. The two volumes accounted for an increase of approximately $12,000 in 1988 publication revenue. It is anticipated that Association income from sales of these two publications will in later years be a small percentage of their 1988 contributions.

Publication expenditures as reported in the Association's Financial Statements also increased dramatically in 1988. This change is more apparent than real and due to timing of invoicing by Elsevier Publishing and payments made to them by the Association for 1987 Journal publishing costs. Cost to the Association for publication of EXPLORE [illegible] than $6,000 while increasing the 1987 and 1988 was in the number of special projects funded and the level of their funding during fiscal 1988. The Association provided seed money for two meetings, three special publications and the Distinguished Lecturer Series in 1988. This is in contrast with providing minimal seed money for one meeting and a very inexpensive Distinguished Lecturer Series in 1987.

In summary the Association of Exploration Geochemists is financially healthy. It ended fiscal 1988 with a larger membership than in recent years and potential for a broader revenue base. It paid off commitments contracted or otherwise incurred in previous years and as a consequence suffered a one time deficit.

Respectfully submitted,
David M. Jenkins, P.Geol.
Treasurer

Balance Sheet

	DECEMBER 31 1988	1987
ASSETS		
CURRENT ASSETS		
Cash	$ 38,127	$ 58,992
Investments	81,992	69,264
Advances	84	—
	120,203	128,256
LIABILITIES		
CURRENT LIABILITIES		
Accounts Payable	$ 14,282	—
MEMBERS EQUITY		
BALANCE, BEGINNING OF YEAR	$ 128,256	$ 119,169
Excess of Revenue over Expenditure	(29,957)	3,799
	98,299	122,968
Foreign Exchange Translation	7,622	5,288
BALANCE END OF YEAR	105,921	128,256
EQUITY PLUS LIABILITIES	120,203	128,256

Statement of Revenue and Expenditure

	DECEMBER 31 1988	1987
REVENUE		
Dues	$ 52,476	$ 29,306
Interest	9,631	8,669
Publications	9,394	4,907
Geo Expo '86	9,336	1,251
Vol. 3, Reviews in Econ. Geol.	4,444	—
Royalties	7,388	11,347
Advertising – Lab. Directory	4,012	—
Miscellaneous	917	1,557
	97,598	57,037
EXPENDITURE		
General and Administration	30,891	25,669
Publications and Newsletter	57,269	25,994
Special Projects	39,395	1,575
	127,555	53,238
EXCESS OF REVENUE OVER EXPENDITURES	$ (29,957)	$ 3,799

ANNUAL GENERAL MEETING

On October 5, 1989 the Association of Exploration Geochemists

1. Call to Order

The President called the meeting to order at 6:00 pm, local time, and established that a quorum of Voting Members was present.

2. Minutes of the 1988 Annual General Meeting

The President asked if there were any matters arising from the minutes of the 1988 AGM, as published in EXPLORE. There were no matters arising.

It was moved (R. Mazzucchelli) and seconded (F. Siegel) that 1988 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

On behalf of the Council and Executive, the President expressed appreciation to the Organizing Committee of the XIII IGES 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 December 1988, the Association co-sponsored a very successful trade show and meeting with the Northwest Mining Association in Spokane, Washington.

2 We sponsored the XIII International Geochemical Exploration Symposium in Rio de Janeiro. Upcoming symposia are the XIV IGES in Prague, Czechoslovakia in 1990, XV IGES in Reno, Nevada in 1991, and the XVI IGES in Beijing, China in 1992.

3 We will be co-sponsoring or participating in meetings with the Prospector's and Developer's Association Convention in 1990 and the 2nd Goldschmidt Conference in 1990.

4 We have reviewed ways of increasing our membership by strengthening our contacts with our Regional Councillors and looking for members outside our traditional exploration geochemistry base.

5 We have published the proceedings of AEG symposia in South Africa, China, and France in the Journal of Geochemical Exploration.

6 We are examining options for how we, a professional organization, can educate the political and legal professions as to what analytical methods are valid for professional reports.

7 We are examining our By-laws and, if necessary, will update them for current practices and terminology.

8 We have changed our methods of accounting to better reflect our income and expense timing.

9 We continue to improve communications with our publisher, Elsevier, so that our member records and finances are more current.

10 This year, for the first time, our Distinguished Lecture series has gone international.

11 We are in the process of improving our member data-base, and in the future your mailing labels will tell you more about your membership status.

12 We are currently reviewing bibliographic software to permanently archive our bibliographic data-base for future publication. G. Closs would like to have volunteers to send in geochemical references from all over the world.

13 Our special publication on probability plots is a "best seller" and the Association is currently going ahead with a reprint.

14 We have been granted a copyright for the name and logo of EXPLORE.

15 Our long time business manager, John Hansuld, resigned this year and the position will remain open until it is time to renegotiate our contract with Elsevier for the Journal of Geochemical Exploration.

16 Two Acting Regional Councillors were appointed this year and the Association is seeking a new Regional Councillor for the area of Central and Southern Europe.

The President said that he was confident that members could look forward to continuing improvement in benefits from their membership in the AEG and said that it had been a pleasure to serve as President for the last year.

4. Secretary's Report

The Secretary stated that the last year had been one of membership growth for the Association with 234 new members having been reviewed and accepted into the Association; 206 as Affiliate or Student and 10 Voting. He suggested that Affiliate Members consider becoming Voting Members and that Voting Members encourage Affiliate Members to apply for Voting Membership. The EXPLORE newsletter marked it's first anniversary of publication and membership response has been very positive. He reported that since the last AGM the Council had met 7 times, there had been an election of Ordinary Councillors for 1989-91, and a new Vice President and 2 Acting Regional Councillors had been elected.

5. Treasurer's Report

See page 16 of this issue.

6. Introduction of the 1989-90 Executive

The Secretary announced that the President for 1990 would be Arthur E. Soregaroli, The First Vice President would be Donald D. Runnells, The Second Vice President would be W. Kay Fletcher, the Secretary would be Richard Glanzman, and the Treasurer would be David M. Jenkins.

7. Announcement of the 1989-91 Ordinary Councillors

The Secretary announced that, as a result of a general election, J. Alan Coope, Peter H. Davenport, and Gwendy M. Hall had been elected as new Ordinary Councillors. Colin E. Dunn and Erick F. Weiland were re-elected to a second term and Maurice A. Chaffee would serve as ex officio Ordinary Councillor.

8. Announcement of Honorary Member

The President said that he had asked Alan Coope to head a committee to determine whether anyone should be nominated as an Honorary Member in the AEG. As a result of the committee's deliberations and recommendations, Council unanimously voted for Dr. Robert W. Boyle as an Honorary Member.

9. Motion to destroy ballots

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

10. Election of Regional Councillors

The president announced that Cecil C. Begley had been selected as Acting Regional Councillor for Southern Africa and Eric C. Grunsky as Acting Regional Councillor for Australia.

It was moved (R. Smith) and seconded (J.A. Versfeld) that Cecil C. Begley and Eric C. Grunsky be accepted as Regional Councillors. The President asked for a vote on the motion. Passed unanimously.

11. Appointment of auditors

It was moved (S. Hoffman) and seconded (I. Thomson) that the Treasurer be given permission to appoint the existing accounting firm of Nemeth Thody and Associates as auditors for the Association of Exploration Geochemistry for the year 1989. The President asked for a vote on the motion. Passed unanimously.

12. Transfer of meeting

The President transferred the meeting to S. Hoffman who was acting on the behalf of the new President, A.E. Soregaroli.
On behalf of the Association S. Hoffman thanked the out-going President, Secretary, and Councillors and welcomed the in-coming Councillors. He then introduced the out-going President, M.A. Chaffee, for his Address.

13. Presidential address

M.A. Chaffee gave his Address, which will be published in an upcoming issue of the Journal of Geochemical Exploration.

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

AEG COUNCIL MINUTES

Actions of February 16, 1989

1. Council approved Cecil C. Begley as Acting Regional Councillor for Southern Africa.

2. John Hansuld resigned as Business Manager for the Association and Council decided not to fill the position with an individual but by a committee, to be utilized only when negotiations were needed.

3. The Association finances were changed from a cash basis to an accrual basis.

4. Council expressed concern about "missing members" and discussed ways of finding them and encouraging them to rejoin the Association. Lists of "lost members" would be published in forthcoming issues of Explore.

5. Council agreed that a membership list and the By-Laws should be published every two years (next in 1990).

6. A. Soregaroli agreed to chair a committee addressing the issue of "credibility of analyses", focussing on the fact that it is less important what type of analysis is used than who does it. This was a response to the Vancouver Stock Exchange, which had asserted that only fire assay gold analyses from Canadian laboratories were acceptable.

7. Council approved 19 Affiliate Members.

Actions of April 13, 1989

1. Council approved ballots and candidates for Second Vice President and Ordinary Councillors.

2. Council discussed the publication of the Journal and the President said that the 1989 Volume issues would start in July. Elsevier hoped to be caught up with the publication schedule for the 1990

Actions of June 8, 1989

1. The Association applied for a Trademark "EXPLORE" and the newsletter banner.
2. A committee chaired by A. Coope was formed to recommend a candidate for Honorary Member of AEG.
3. The auditor's report for 1988 was approved.
4. E. Grunsky was nominated to be Acting Regional Councillor for Western Australia.
5. Arrangements were made for the Distinguished Lecturer (K. Fletcher) to give lectures at selected universities in Brazil in conjunction with the 13th IGES.
6. Council agreed to reprint Special Volume 14 (PROBPLOT).
7. Council approved 33 Affiliate and Student Members.

Actions of September 7, 1989

1. A review of the Association's By-Laws was initiated.
2. Council authorized the move of the Association's assets to an interest bearing insured account in Vancouver, Canada.
3. A telephone-telefax connection to the Rexdale, Ontario office was proposed to improve communications between members and the Association..
4. Publication of a hard-bound bibliography was proposed for the Association's 25th aniversary in 1995.
5. Council discussed means of providing subscriptions of the Journal to libraries in developing countries without jeopardizing the contractual agreement with Elsevier.
6. 58 Affiliate and Student Members and 8 Voting Members were approved.

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

INFORMATION REQUESTED

Nomination for Councillor, Association of Exploration Geochemists

We, the undersigned, wish to nominate _____, who by signature below has agreed to stand for election to Councillor for the Association of Exploration Geochemists. This nomination is made in accordance with Article 4.04 of By-Law 1 (1979), with the term starting after the Annual General Meeting in 1990.

PLEASE PRINT

1. Name _____ *Signature* _____
Address _____ *Date* _____
2. Name _____ *Signature* _____
Address _____ *Date* _____
3. Name _____ *Signature* _____
Address _____ *Date* _____
4. Name _____ *Signature* _____
Address _____ *Date* _____
5. Name _____ *Signature* _____
Address _____ *Date* _____
6. Name _____ *Signature* _____
Address _____ *Date* _____

I, _____, a Voting Member of the Association of Exploration Geochemists, agree to serve as an Ordinary Councillor and to attend Meetings of Council if elected.

Signature _____

Send nominations for councillor to the Secretary of the Association, ***Sherman P. Marsh,*** *U.S. Geological Survey, Federal Center, Building 25, M.S. 912, Denver, CO 80225, USA.*

★ ★ ★

AEG 1990 Distinguished Lecturer

Call for Nominations

The Association's Distinguished Lecturer will present lectures at six locations. Historically two lecture series have been presented, one in the Spring and the other in the Fall. This schedule could be modified at the convenience of the elected Distinguished Lecturer.

The Committee encourages nominations of distinguished geochemists irrespective of their country of residence. Given the low cost of airfares between Europe and North America, it is practical to send a lecturer in either direction across the Atlantic. Funding can probably be obtained from sponsors to support transportation to or from other locations.

The Committee would also like to correspond with persons on other continents who are willing to help with the local organization of a Distinguished Lecturer Series.

To nominate a person as 1990 Distinguished Lecturer, please respond with information in the format below and return as soon as possible to:

D.M. Jenkins
Ainsworth-Jenkins Consultants
Suite 525, 890 West Pender Street
Vancouver, B.C. V6C 1J9 Canada
Telephone (604)684-6463
Telefax (604)684-5392

I nominate: Name _____
Address

The nominee is worthy of this honor because:

_____
_____
_____
_____

Signature _____
Name (type or print) _____
Address _____
_____
Phone (_____) _____

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 [illegible] comments to Sherman P. Marsh, Secretary AEG, US Geological Survey, M.S. 973, Box 25046, Federal Center, Denver, CO 80225, USA.

Editors note: *Council has decided that all new applicants will receive the journal and newsletter upon application for membership. The process of application to the Toronto office, recommendation by the*

VOTING MEMBERS

Beers, Armond Henry
Chief Geologist
Simplot Exploration
Nampa, Idaho, U.S.A.

Coopersmith, Howard G.
Vice-President, Exploration
Australian Ores & Minerals Ltd.
Fort Collins, Colorado, U.S.A.

Hall, Gwendy E.M.
Analytical Chemist
GSC
Ottawa, Canada

Larson, Lawrence T.
Professor and Chair
Mackay School of Mines
Reno, Nevada, U.S.A.

Lintern, Melvyn J.
Experimental Scientist
CSIRO
Wembley, W. Australia

Marjono, Anton
Chief Geochemist
BHP-UTAH Pacific Inc.
Gorontalo, Indonesia

Schmitt, Harold R.
Contract Geochemist
GSC
Ottawa, Canada

Tole, Mwakio P.
Senior Lecturer
University of Nairobi
Nairobi, Kenya

Zimbelman, David R.
Research Geologist
US Geological Survey
Denver, Colorado, U.S.A.

AFFILIATE MEMBERS

Aario, Risto
Professor of Surficial Geology
University of Oulu
Oulu, Finland

Adler, James E.
President
On-Line Explor. Services Inc.
Anchorage, Alaska, U.S.A.

Agnew, Paul D.
CRA Exploration Pty. Ltd.
Madang, Papua New Guinea

Allen, Mike
Chem. Plant Operator
Molycorp Inc.
Boulder City, Nevada, U.S.A.

Alonso, Daniel
Senior Geologist
Amok Ltd.
Saskatoon, Sask., Canada

Al-Thekair, Mohamed
Jeddah, Saudi Arabia

Anthony, E. Grayme
Resource Geologist
Canhorn Mining Corp.
Toronto, Ontario, Canada

Arnold, Mark A.
Geologist/Project Manager
Micronesian Min. Res. Co.
Saipan

Bartos, Paul J.
Geologist
ASARCO
Lakewood, Colorado, U.S.A.

Basnett, Richard
Manager Expl. Yukon
Total Energold Corp.
Whitehorse, Yukon, Canada

Baxter, David A.
Staff Geologist
Boise Cascade Min. Resources
Hibbing, Minnesota, U.S.A.

Behi, Ahmed M.
Senior Geochemist
Surad Exploration Co.
Lakewood, Colorado, U.S.A.

Berar, Sodi
Calgary, Alberta, Canada

Boyer, Clyde I.
Exploration Geologist
Combined Metals
Reduction Co.
Hawthorne, Nevada, U.S.A.

Brand, Nigel W.
Exploration Geochemist
Western Mining Corp.
Kalgoorlie, W. Australia

Brown, George B.
District Geologist
Bureau of Land Management
Spokane, Washington, U.S.A.

Buis, Patricia F.
Geologist Trainee
Bur. of Topo. & Geol. Surv.
Pittsburgh, PA, U.S.A.

Byington, Craig B.
Sr. Exploration Geologist
Homestake Mining Co.
Reno, Nevada, U.S.A.

Cardosa, Jose C. de Pinho
Assistant
University of Aveiro
Aveiro, Portugal

Casaceli, Robert, J.
Partner
Annapurna Exploration
Reno, Nevada, U.S.A.

Caughlin, Brenda L.
Manager ICP Services
Chemex Labs Ltd.
North Vancouver, B.C., Canada

Chin, Geoffrey T.
Geologist
Senneville, Quebec, Canada

Clark, David N.
President
Uranium Exchange Co.
Danbury, Connecticut, U.S.A.

Clore, C. Wendell
Winslow, Washington, U.S.A.

Cocker, Mark D.
Sr. Geologist
Georgia Geological Survey
Atlanta, Georgia, U.S.A.

Coolen, J. Marc
Sr. Geologist
Billiton Minerals U.S.A. Inc.
Lancaster, California, U.S.A.

da Silva, Eduardo A. F.
Assistant
University of Aveiro
Aveiro, Portugal

Davidson, Gordon
Project Geologist
PNC Exploration (Can.) Ltd.
Vancouver, B.C., Canada

Doebrich, Jeff L.
Economic Geologist
US Geological Survey
Reno, Nevada, U.S.A.

Doyle, Peter J.
Sr. Geologist
Westfield Minerals Ltd.
Toronto, Ontario, Canada

Dynes, William
Field Manager
Stetson Res. Manag. Corp.
Vancouver, B.C., Canada

Edgell, Paul
Sales Manager
DFC Ceramics Inc.
Canon City, Colorado, U.S.A.

Egan, Judith
Technical Advisor
Molopo Australia Ltd.
Melbourne, Australia.

Elevatorski, Edward A.
Manager
Minobras Mining Services Inc.
Bonsall, California, U.S.A.

Ellingham, Elaine
Sr. Geologist
Duration Mines Ltd.
Toronto, Ontario, Canada

Eggleston, Ted J.

Evans, Judith A.
Research Geochemist
JCI Co. Ltd.
Randfontein, South Africa

Fields, Edward D.
Supervisor
Boise Cascade Corp.
Phoenix, Arizona, U.S.A.

Fitz Gerald, Patrick
Exploration Director
Barnagapal Ltd.
Dublin, Ireland

Fleming, Keryl L.
Geologic Computer Specialist
Nevada Bur. of Mines & Geol.
Reno, Nevada, U.S.A.

Frishman, David
Geologist
US Geological Survey
Denver, Colorado, U.S.A.

Gadzala, Roman E.
Field Geologist
Falconbridge Ltd.
Timmins, Ontario, Canada

Garside, Larry J.
Research Geologist
Nevada Bur. of Mines & Geol.
Reno, Nevada, U.S.A.

Gingrich, Mark
Geologist
First Miss Gold Inc.
Golconda, Nevada, U.S.A.

Goodwin, Terry A.
Project Geologist
Westminer Canada Ltd.
Sackville, N.S., Canada

Gosson, Greg
Sovereign Explorations
Reno, Nevada, U.S.A.

Gray, David J.
CSIRO
Wembley, W. Australia

Gray, John
Research Geologist
US Geological Survey
Denver, Colorado, U.S.A.

Groves, David A.
Project Geologist
Newmont Exploration Ltd.
Duluth, Minnesota, U.S.A.

Gutierrez, Carlos G.
Professor of Geology
Chihuahua, Mexico

Hayashi, Ikuhiro
Manager Nat. Res. Dept.
Mitsubishi Metal Co.
Ohmiya-shi, Japan

Hitzman, Daniel C.
Presidnet
Geo-Microbial Technol. Ltd
Ochelata, Oklahoma, U.S.A.

Jenkins, Robert E. II
Sr. Geologist
E.I. Dupont de Nemours & Co.
Newark, Delaware, U.S.A.

Kerin, Leo J.
Fairbanks, Alaska, U.S.A.

Kilmister, Greg F.
Manager Reg. Labs. & Devel.
Australian Laboratory Services
Stafford, Qld., Australia

Knox, Anthony J.
Chemex Labs Ltd.
Mississauga, Ontario, Canada

Koch, Bernhard C.
Geologist/Geochemist
Texasgulf Minerals & Metals
Golden, Colorado, U.S.A.

Laffoley, Nicholas
Sr. Geologist
Ashanti Goldfields Corp.
Accra, Ghana

Lee, Bu Kyung
Instructor
Sang Ji University
Seoul, Korea

Lehmuspelto, Pasi
Geochemist
Geological Survey of Finland
Rovaniemi, Finland

Lestinen, Pekka
Geochemist
Geological Survey of Finland
Kuopio, Finland

Lightle, Robert J.
Gold River, B.C., Canada

Logsdon, Mark J.
V.P./Senior Geochemist
Adrian Brown Consultants
Denver, Colorado, U.S.A.

Long, Scott D.
Geochemist
Newmont Exploration Ltd.
Elko, Nevada, U.S.A.

Lopez, G.P.
Toronto, Canada

Lopez-Rendon, Jorge E.
Head, Dept. of Geology
Universidad Eafit
Medellin, Columbia

Lyons, Edward M.
Consulting Geologist
Courtenay, B.C., Canada

MacDonald, David M.
CRA Exploration Pty. Ltd.
Madang, Papua New Guinea

Martin, Dennis
Research Scientist
Minnesota Dept. of Nat. Res.
Hibbing, Minnesota, U.S.A.

Martin, Glen T.
Salt Lake City, Utah, U.S.A.

Martin, H.E.O.
Professor
University of Louvain
Louvain-La-Neuve, Belgium.

McCarthy, Paul
Vancouver, B.C.. Canada

McConchie, David
Lecturer
University of New England
Lismore, N.S.W., Australia

McGoldrick, Peter
Geologist
Geol. Sur. of W. Australia
Kalgoorlie, W. Australia

McKibben, Michael A.
Asst. Professor
Univ. of Calif. Riverside
Riverside, California, U.S.A.

Megaw, Peter
President
IMDEX Inc.
Tucson, Arizona, U.S.A.

Morrison, Gregg
Director, Gold Res. Group
James Cook University
Townsville, Qld., Australia

Nicholson, Donald
VP Technical Operations
Pacific Engineered Materials
Vancouver, B.C., Canada

Nikkarinen, Maria
Geologist
Geol. Survey of Finland
Kuopio, Finland

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RECENT PAPERS

EXPLORATION GEOCHEMISTRY

This list comprises titles that have appeared in major publications since the compilation in EXPLORE No. 66. 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.

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Recent Papers on Analytical Geochemistry

This column highlights analytical papers of geochemical interest published in major international journals. These include: Analytical Chemistry(Anal. Chem.), Analyst, Journal of Analytical Atomic Spectrometry (J. Anal. At. Spectrom.), Analytica Chimica Acta (Anal. Chim. Acta), Talanta, Applied Spectroscopy (Appl. Spectrosc.), Spectrochimica Acta Part B (Spectrochim. Acta), Atomic Spectroscopy (At. Spectrosc.) and Analytical Proceedings (Anal. Proc.).

Pertinent papers from Geostandards Newsletter, published in April and October yearly,are too numerous to cite. This journal is a "must" for the geochemist. Where the number of authors on one paper is greater than four, "et al." is used. This list covers those issues received by the author since those listed in EXPLORE No. 66.

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