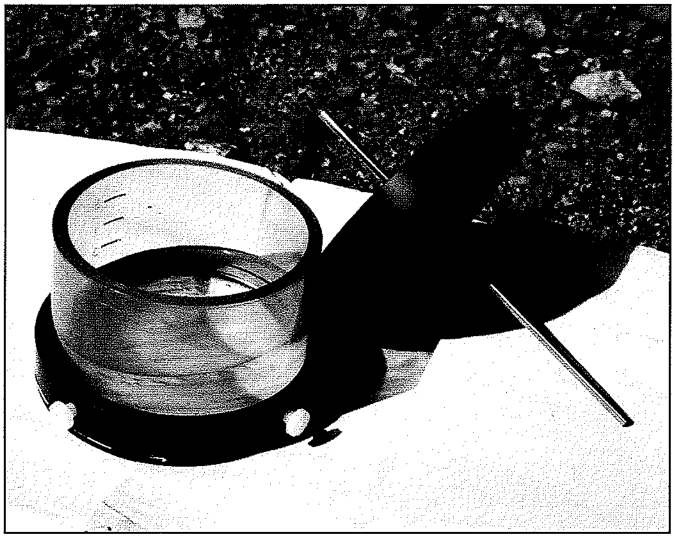
EXPLORE

Newsletter for the Association of Exploration Geochemists

NUMBER 79 APRIL 1993

TECHNICAL NOTES



The USGS-designed ion collector electrode for testing the electrogeochemical sampling method, CHIM, and a variation thereof, APLOCHIM.

The Russian CHIM Method — Electrically- or Diffusion-Driven Collection of Ions?

Introduction

The electrogeochemical exploration method, CHIM, developed over twenty years ago in the former Soviet Union, is claimed to be a means of collecting ions emanating from ore deposits concealed by thick cover (Gol'dberg et al., 1990). Available treatises on CHIM (the term is an acronym derived from the Russian phrase "*C*hastichnoe *I*zvlechennye *M*etallov," meaning partial extraction of metals) in the English language are limited. Summaries may be found in Shmakin (1985), Bloomstein (1990), and Antropova et al., (1992). The method is based on the premise that an applied electric field will drive ions in the soil into specially designed collector electrodes. Ions accumulate in an electrolyte within the electrode. The electrolyte, typically nitric acid of 2N to 4N concentration, also serves to conduct current from the power source to the soil through a low-permeability membrane of synthetic parchment located at the base of the electrode.

This communication summarizes recent studies of the CHIM technique by the U. S. Geological Survey (USGS) which indicate that the applied electric field may play only a secondary role in causing ions to move into the collector electrodes. Experiments show that diffusion is a major, if not the predominant, mechanism by which the ions are moved. The ions are formed by *in situ* leaching of soil by acid diffusing out of the electrodes. Resulting concentration gradients cause the reverse diffusion of the ions into the electrodes. Alekseyev et al., (1990) conducted laboratory experiments to determine the influence of diffusion effects on CHIM but appear to underplay its significance. A more detailed report on our investigation of the contribution of diffusion to collection of ions by the CHIM method will be submitted for journal publication in the near future. However, it is felt important to present this information as soon as possible to enable current investigators in the field to consider the implications and offer comments.

Experimental Results Demonstrating the Role of Diffusion

Evidence for the occurrence of diffusive processes in CHIM was obtained during tests conducted at the Kokomo Mine near Central City, Colorado, and at the Cross Mine near Nederland, Colorado (Figure 1). Previous USGS CHIM investigations at the Kokomo Mine are reported by Smith et al., (1993), Smith et al., (1991), and Hoover et al., (1992). Mineralization at both localities consists of gold-bearing base metal veins concealed by shallow overburden (3 meters of colluvial material at Kokomo, 10 to 12 meters at Cross). The tests involved using 12-volt batteries to induce electrical fields that are of lower strength than those typical of CHIM. The low-current, battery-operated version of CHIM has since been termed APLOCHIM, derived from *a*utonomous *p*ower, *l*ocal *o*peration CHIM. "Aplo-" is also the Greek combining form meaning "simple." The batteries generally provide current in the 1 to 10 milliampere (mA) range, depending on soil resistivity, whereas the generators generally used with CHIM may yield currents of 400 to 500 mA. We discovered that not only was the anomaly pattern repeated with the lower current, but similar quantities of ions were collected

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Information for Contributors to EXPLORE

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

Format Manuscripts should be double-spaced and include camera-ready illustrations where possible. Meeting reports may have photographs, for example. Text is preferred on paper *and* 5¼- or 3½-inch IBM-compatible computer diskettes with ASCII (DOS) format that can go directly to typesetting. Please use the metric system in technical material.

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

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

All contributions should be submitted to:

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EXPLORE

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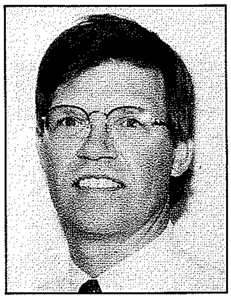
NOTES FROM THE EDITOR

This issue of **EXPLORE** is being distributed just as the Society of Economic Geologists, Association of Exploration Geochemists, and Society of Exploration Geophysicists (SEG^3) meeting on integrated exploration gets under-way in Denver, Colorado. With hundreds of delegates from all over the world, scores of interesting and relevant papers by world-renowned authors and world class field trips and mine tours, this promises to be the exploration event of the decade. We can expect exploration practices and understanding to make a perceptible advancement, starting this year. This Denver meeting will also be the location of the AEG annual general meeting at which, voting on the AEG's proposed new by-law will be announced, as well as results of the election of ordinary councilors. In addition, this meeting will see the installation of the AEG's first non-North American as President (Graham Taylor, CSIRO, Australia) and the awarding of the Association's prestigious *Past President's Medal*. We all have high expectations for this meeting as well as the AEG's year ahead. Because Denver is now the editorial "hub" of **EXPLORE**, we hope to see as many of you as possible at the meeting.

This issue of **EXPLORE** begins with an article describing research into the CHIM electrogeochemical method. The past few years have witnessed an increased interest in this Soviet-developed method, and a few of us have been involved with CHIM surveys. The findings of the USGS should be of interest to both practitioners and the curious. ✻

Owen P. Lavin
Editor

PAST PRESIDENT'S MESSAGE



This has been a year of transition within the AEG. Changes within the mining industry have affected the composition and priorities of our volunteer staff. A majority of the committees witnessed significant changes in personnel during the year, however, this has not interrupted the momentum of the Association.

The By-law revision was completed under the capable direction of Don Runnells and submitted to the Voting membership for approval. Under Stan Hoffman's direction the 1992 Membership Directory was published and forwarded to members. In addition, Stan supervised corrections and updates to the membership database and development of a new database interface. The Bibliography Committee has completed the initial conversion of the Geochemical Exploration Bibliography to electronic format in preparation for distribution of an updated all-inclusive bibliography to be published in 1995. The Environmental Committee, under Dick Glanzman's guidance, organized publication of mining-related geochemistry articles in EXPLORE (No. 78) and established ties with the Society of Environmental Geochemistry and Health. The Admissions Committee, chaired by Lloyd James, is simplifying the membership application procedure.

The AEG sponsored geochemical sessions at the Mining, Exploration and the Environment Meeting in Seattle, Washington and the Goldschmidt Conference in Reston, Virginia. The Association is also co-sponsoring the Integrated Methods in Exploration and Discovery Meeting being held in Denver, Colorado this April.

Our Distinguished Lecturer, Dr. Jane Plant, completed successful lecture tours in Southeast Asia and Australia.

The Past Presidents medal will be awarded to Dr. Eion M. Cameron at the upcoming AGM for distinguished service to the Association. In addition, the 1992 Student Paper Competition Prize will be awarded to Stephen J. Cook for his paper entitled "Distribution and behavior of platinum in soils, sediments and waters of the Tulameen Ultramafic Complex, southern British Columbia."

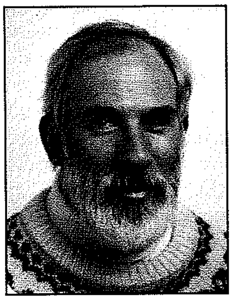
In anticipation of greater international participation, several changes are being implemented in the administration of the Association. These primarily include hiring a business manager and improving communications with members outside of North America.

It has been a busy year for the Association. All of this work has been conducted with volunteers and with assistance from Lorraine Kluber who manages our office in Vancouver. My thanks to all of these individuals for their contributions.

On another note, the Annual General Meeting will be conducted on Monday, April 19, 1993 at 4:30 pm in the Grand Ballroom of the Red Lion Hotel in Denver, Colorado in association with the Integrated Methods in Exploration and Discovery Meeting being co-sponsored by the AEG. I look forward to seeing you there.

J. Jaacks
Past President

PRESIDENT'S MESSAGE



I assume the Presidency of the Association at a time of change. We have already witnessed a greater emphasis on environmental geochemistry in both the Journal of Geochemical Exploration Geochemistry and **EXPLORE**. This reflects the growing concern within developed countries for the environment. As a consequence, there is greater emphasis on mineral exploration and exploitation in developing countries where environmental concerns are of less consequence than overseas debt, however, it does provide us with the opportunity to apply geochemical techniques in new environments and to provide "baseline" geochemistry for future environmental concerns.

The majority of our techniques relate to inorganic geochemistry and yet much of the material we use has an organic component. It seems to me that a closer relation with our colleagues in the Association of Petroleum Geochemical Explorationists (some of whom are members of AEG) will help in the application of organic geochemistry to mineral exploration particularly in the fields of basin analysis, migration and thermal history analysis.

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President's Message

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For some time now I have been of the belief that there is a need for a full time Business Manager, who would be responsible to Council for the day-to-day affairs of the AEG. We have been well served by Inez Filicetti, and Lorraine Kluber as Office Managers and by Stan Hoffman as part-time Business Manager. With Stan's resignation, Council has decided to hire a full-time Business Manager, and is presently preparing a detailed job description. I have already received a valuable suggestion that whoever is appointed should be charged with developing an "AEG Plan for 2000 and beyond - 25 years of Active Geochemical Exploration." We should be able to announce the name of the new Business Manager in the next issue of **EXPLORE.**

Another crusade has been to make the Association truly international. Recent Distinguished Lecturers have made extensive tours throughout the world, and raised the profile of AEG in countries other than the USA and Canada. Various committees of the Association have assumed a more international membership, and hopefully the Presidency will continue to be shared globally. One area of concern is the role and involvement of Regional Councillors. It is extremely difficult for one person to have a major influence in a region such as South America, South Africa or even parts of Europe. If we are to become truly international, we will need to reconsider the Regional Councillor's roles and possibly provide more assistance.

As President, I hope to continue some of this change which will lead to a broadly-based, international and professionally managed organization. Any suggestions will be welcomed.

G. Taylor
President

AEG COUNCIL ACTIONS

Once again it is time to bring members up to date on the activities of your Council. The last few issues of **EXPLORE** have been devoted to technical papers and the special issue on environmental geochemistry. With this issue I will bring you up to date on Council's actions.

Actions of August 20, 1992

1. Council approved the applications of 10 Affiliate Members.

2. Council approved funding to send the President to the 17th International Geochemical Exploration Symposia in Beijing, China in September 1993, if necessary.

3. XRAL Laboratories offered to a donate $500 cash prize to the Student Paper Prize.

4. The Association purchased a computer for the Bibliography Committee to enter and maintain the entire AEG bibliography into electronic form.

Actions of October 15, 1992

1. Council approved the applications of two Voting, nine Affiliate, and two Student Members.

2. J. Plant completed a very successful lecture tour in SE Asia and Australia as the AEG Distinguished Lecturer.

Actions of December 16, 1992

1. Council approved the printing of an extra 1000 copies of **EXPLORE** No. 78, the environmental issue, for distribution to appropriate environmental associations.

3. Council approved a distinguished lecture tour of Finland, Norway, Sweden, Denmark, and Germany by J. Plant, Distinguished Lecturer.

Sherman P. Marsh
Secretary of the AEG

Technical Notes

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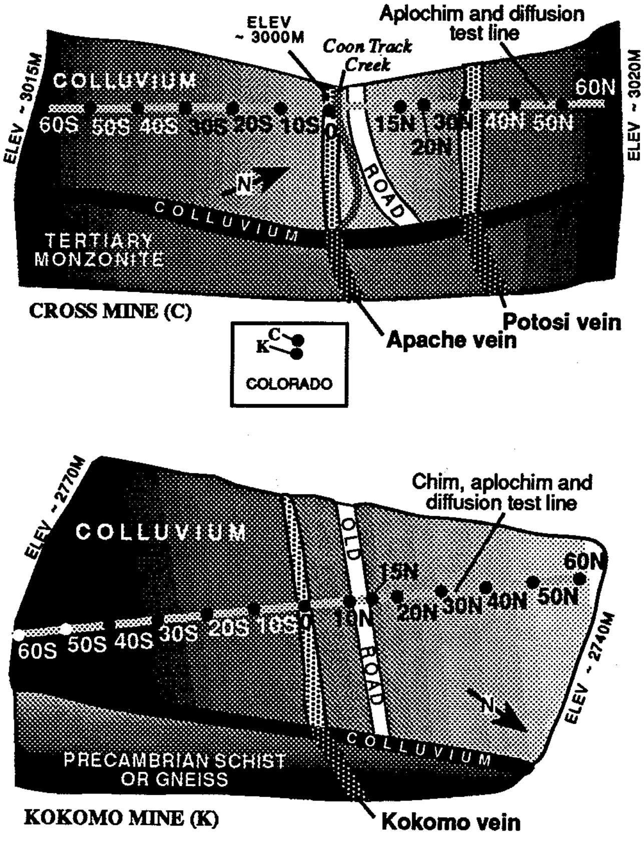

Figure 1. *Index map showing location of the Cross (C) and Kokomo (K) Mines, Colorado; sketch of the geology and position of test lines relative to location of the mineralized veins at each mine. Sample site spacing is in meters.*

(Figure 2). The data shown in Figure 2 are from a standard CHIM run of 8 hours duration at 500 mA and an APLOCHIM run of 23 hours at about 6 mA. The total ampere-hours (amperes x hours) for the CHIM run was about 30 times that for the APLOCHIM system, although similar quantities of copper and zinc were collected.

Developmental studies indicated that APLOCHIM was comparable to CHIM in defining anomaly patterns and it was more efficient (number of metal ions collected per ampere-hour) than CHIM. In testing APLOCHIM, it was also observed that similar quantities were accumulating in both positively charged collector electrodes (anion collectors) and negatively charged collector electrodes (cation collectors) (Table 1). These observations require a mechanism, or mechanisms, of transport other than, or in addition to, the one provided by the applied electric field. The observations led to a closer consideration of diffusion as the mechanism by which the ions are transported into the electrodes. Coincidentally, the fact that the soil beneath the electrodes was highly acidic after CHIM or APLOCHIM runs prompted the examination of acid leaching of the soil as a source of the ions. This hypothesis was tested using CHIM electrodes as diffusion cells.

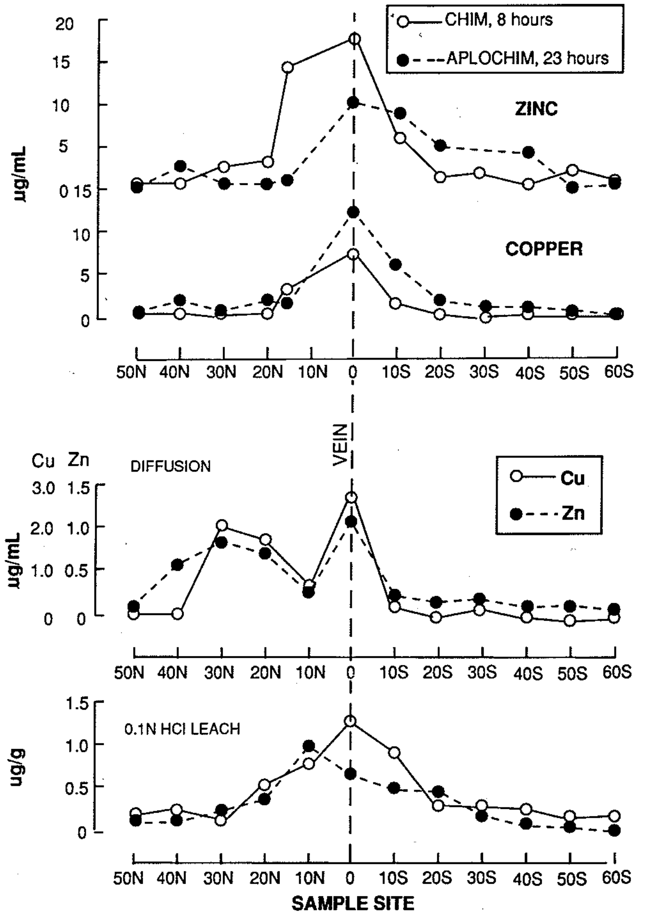

Figure 2. *Comparison of Cu and Zn collected by CHIM, APLOCHIM and diffusion at the Kokomo Mine near Central City, Colorado, and the Cu and Zn extracted from the minus 180-micron fraction of soils with 0.1N HCl. For CHIM and APLOCHIM, the electrolyte was 300mL of 4N HNO3 contained in 10-cm diameter electrodes. The CHIM run was conducted for 8 hours at an average current of about 500mA, the APLOCHIM run for 23 hours at an average of 6mA. For diffusion, the electrolyte was 50mL of 1N HCl contained in cells of 4-cm diameter. The diffusion was allowed to run for about 5 hours. The 0.1N HCl extraction was conducted by equilibrating 1g of sample with 25mL of the acid in a capped test tube for 1 hour in a horizontal shaker.All analyses were by flame atomic absorption.*

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Table 1. Quantity of metals accumulated in the cathode (-) and anode (+) collector electrodes at 5 of 13 sample sites of an APLOCHIM run at the Cross Mine near Nederland, Colorado. Both cathode and anode electrodes were 4-cm diameter and contained 50mL of 0.1N HCl. The run was conducted for a period of about 4½ hours. Analyses were by flame atomic absorption.

TOTAL MICROGRAMS ACCUMULATED

	CATHODE							ANODE					
SITE*	Na	Mg	Ca	Cu	Pb	Zn	mA **	Na	Mg	Ca	Cu	Pb	Zn
50N	45	365	2400	2.0	13	5.0	0.96	45	275	1900	1.5	15	5.0
30N	50	495	2350	3.5	45	72	1.48	45	320	2150	6.0	70	73
15N	30	195	1000	0.5	10	50	0.44	40	300	2350	9.5	50	41
30S	75	495	3450	2.5	10	11	1.63	60	345	2950	4.5	13	9.0
50S	35	650	3950	1.0	<5.0	2.0	0.98	40	415	2950	1.5	<5.0	2.0

*Samples sites in meters north (N) and south (S) of Site 0 (not listed).
**Average current in milliamperes.

Separate cells were filled with hydrochloric acid of varying concentration, 0.1N nitric acid, water, 0.1N NaCl, and 0.1N NaNO3. The cells were placed on the ground for four to five hours to determine: 1) the extent of accumulation of ions in the cell without the application of current, 2) the effect of acid concentration, and type, on the quantity of ions collected, and 3) the collection of metals using electrolytes that are non-reactive to the soil (at least in a relative sense). The quantity of ions thus

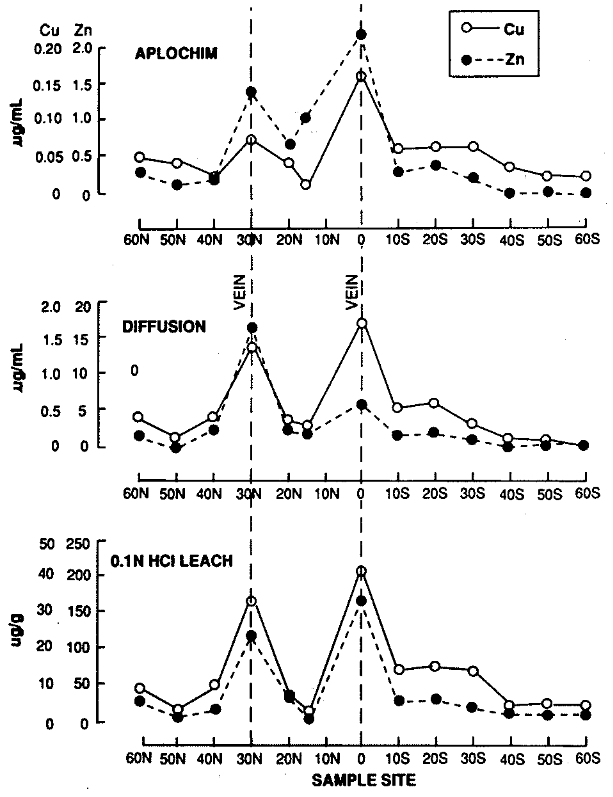

Figure 3. A similar comparison between APLOCHIM, diffusion, and acid extraction at the Cross Mine, Nederland Colorado. The APLOCHIM run was conducted for 5½ hours using an electrolyte of 50mL, 0.1N HCl, contained in 4-cm electrodes. Current range among the sites was 0.13 to 5.33mA. Diffusion was allowed to run for about 5 hours using 10-cm cells containing 100mL of 1.0N HCl.

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Table 2. Comparison of the quantity of metals accumulated by diffusion into 4 cm-diameter cells containing various electrolytes and the quantity of metals accumulated by APLOCHIM collector electrodes containing the same volumes and types of electrolytes (except for the 1.0N HCl and H2O). Diffusion was allowed to take place for 4 hours and the APLOCHIM run for 5¾ hours. Tests were conducted at site 30N, Cross Mine, near Nederland, Colorado.

TOTAL MICROGRAMS ACCUMULATED

DIFFUSION

Electrolyte	Fe	Ca	Mg	Na	K	Zn	Pb	Cu
0.01N HCl	5	440	120	65	135	12	<5	0.5
0.10N HCl #1*	20	1500	260	65	190	49	45	3.0
0.10N HCl #2*	50	1500	330	65	220	90	70	4.5
1.0N HCl	250	2700	230	90	310	1400	175	12.5
0.10N HNO_3	15	1200	270	90	130	1170	50	5.0
H_2O	<5	<5	1	<5	6	<0.5	<5	<0.5
0.10N NaCl	5	180	55	—	50	<0.5	<5	1.0
0.10N $NaNO_3$	3	130	33	—	50	0.5	<5	1.0

*Duplicate runs at about 2-meter spacing between collection cells.

APLOCHIM - Cathode

	Fe	Ca	Mg	Na	K	Zn	Pb	Cu
0.10N HCl	25	2350	495	50	200	72	45	3.5
0.10N HNO_3	40	4000	650	50	445	145	85	8.0
0.10N NaCl	5	300	120	—	55	<0.5	<5	0.5
0.10N $NaNO_3$	<5	450	55	—	75	<0.5	<5	<0.5

APLOCHIM - Anode

	Fe	Ca	Mg	Na	K	Zn	Pb	Cu
0.10N HCl	30	2150	320	45	250	73	70	6.0
0.10N HNO_3	45	1050	170	35	100	52	55	4.0
0.10N NaCl	5	200	35	—	30	1.5	<5	0.5
0.10N $NaNO_3$	<5	150	30	—	35	1.5	<5	1.0

AVERAGE CURRENT (mA) FOR APLOCHIM

0.10N HCl	1.48
0.10N HNO_3	1.17
0.10N NaCl	1.17
0.10N $NaNO_3$	0.87

---

collected by diffusion would be compared to the quantity of ions collected by APLOCHIM using the same electrolytes. Analysis of the recovered acid solutions showed that the quantity of metals collected by diffusion was similar to that collected during the electrically-energized APLOCHIM run (Table 2). In both the diffusion and APLOCHIM runs, the quantity of metals collected using water or neutral electrolytes was much less than for the acid solutions. This suggests that acid from the cells (or electrodes) reacted with the soil and solubilized metals which were then moved back into the cell by diffusion. In this test, water, NaCl, and $NaNO_3$ were ineffective as leaching agents and provided far fewer ions for diffusion. We speculate, however, that the ions collected in the cells with the neutral electrolytes are more representative of the metals dissolved in soil

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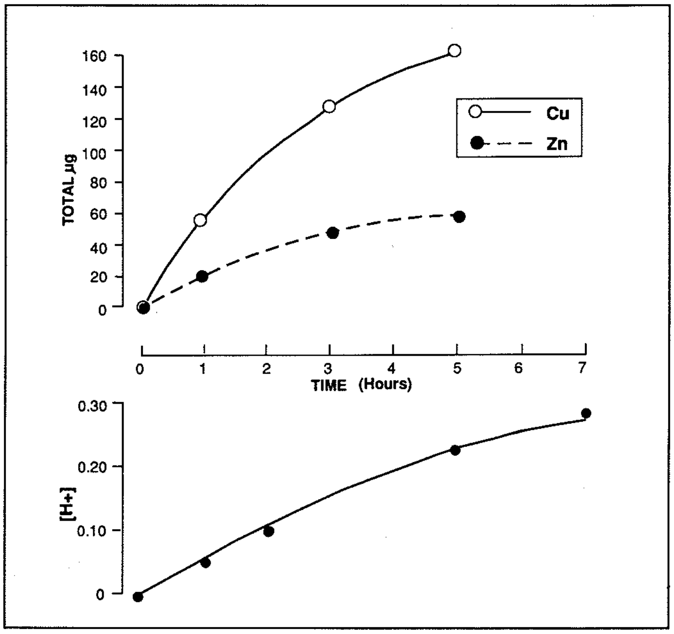

Figure 4. *The diffusion of Cu and Zn into 150 mL of 1N HCL, contained in a 4-cm cell, at site 0, Kokomo Mine, as a function of time and the rate of diffusion of H+ from 100 mL, 1N HCL into 100 mL water, both contained in 4-cm cells.*

moisture under natural conditions and, thus, are the desired target ions for a "true" CHIM extraction.

Additional support for the diffusion hypothesis is shown in a comparison of APLOCHIM, diffusion, and a dilute HCl extraction of soils at the Cross Mine (Figure 3). It should be noted that all three methods clearly define the veins at sites 0 and 30N. The marked similarity of diffusion results to those from the dilute acid extraction indicates that the diffusing ions are predominantly those generated by *in situ* acid leaching of the soil. Tests were conducted to show the relationship of the accumulation of metals in the cell as a function of time. The rate of accumulation of Cu and Zn into 1N HCL at the Kokomo Mine is typical of diffusive processes. The rates are compared to the rate at which H+ diffuses from 1N HCl through the parchment membrane into water, a simple experiment conducted in the laboratory (Figure 4). Acid concentration and the area of the diffusing-acid front (membrane surface area) are two variables which influence the collection of metals by diffusion (Tables 2 and 3). The effects of other variables, including physical and chemical characteristics of specific membranes, will be further studied.

Table 3. The accumulation of metals by diffusion into 50mL of 1.0N HCl over a 5-hour period, as a function of cell diameter (parchment membrane surface area). Test was conducted at site 0, Kokomo Mine, near Central City, Colorado.

		TOTAL MICROGRAMS ACCUMULATED			
Diameter	**Surface Area**	**Fe**	**Cu**	**Pb**	**Zn**
4cm	12.5cm²	800	135	150	56
10cm #1*	78.5cm²	3500	295	600	185
10cm #2*	78.5cm²	1700	185	255	95

*Duplicate runs conducted with cell separation of about 2 meters.

Concluding Remarks

Preliminary experiments suggest that diffusion may be a more important mechanism for the migration of ions into collector electrodes during a CHIM run than transport induced by an applied electric field. Ironically, our results indicate that a CHIM run may be just as effective, or perhaps even more so, if an operator inadvertently forgets to turn on the power. An

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investigation is being continued to more clearly determine the implications of these preliminary results and the authors would be grateful for any comments from CHIM researchers.

Acknowledgments

We gratefully acknowledge the participation and support of our partners at Newmont in this research. Solution Gold, Inc., Ben Parker, Jr., and the Hendricks Mining Company, Inc., Tom Hendricks, are thanked for permission to conduct field tests on their properties. Appreciation is also expressed sincerely to T.T. Chao, USGS Scientist Emeritus, for many helpful discussions.

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Technical Notes

Hidden Gems in the NURE Data: Placer Exploration Potential for Au, PGM, REE, and Other Metals in the Arctic Coastal Plain and Foothills Provinces, Alaska

Placer deposits of heavy minerals furnish a major part of the world's supply of Au, PGM (platinum-group metals), Zr and Hf (from zircon), Th and REE (rare-earth elements from monazite), Sn (from cassiterite), Cr (from chromite), and Ti (from rutile, anatase, and brookite). The larger deposits are found in beach ridges and dunes or their analogs preserved in older coastal-plain sediments. Large areas of the Arctic coastal plain are covered by similar sedimentary environments and may host heavy-mineral deposits.

Geochemical data from stream- and lake-sediment samples collected in Alaska as part of the Department of Energy's National Uranium Resource Evaluation (NURE) program are useful in exploring for placer mineral deposits. The NURE program involved a regional geochemical survey of Alaska in which over 61,000 samples were collected between 1975 and 1979 covering about 80 percent of the state's land area. The Los Alamos Scientific Laboratories (LASL), a contractor for the Alaska NURE program, published regional geochemical data for selected elements using color-contour images to display the data (LASL, 1983). Following is a discussion of the distribution of selected elements in the NURE sediment samples (LASL, 1983) that may be useful for placer exploration on the Arctic slope.

The distribution of La highlights the areas of known felsic terranes and also appears to show areas where these terranes have not been mapped or do not exist. Two areas contain La anomalies in the Coastal Plain and Foothills Provinces. The sediments are derived from Quaternary, Tertiary(?), and Cretaceous units. Lanthanum ranges from 50 ppm to 130 ppm, but the anomalies are not associated with any known or buried plutons. Hafnium, Th, and Zr anomalies (<11 ppm, <8.7 ppm, and <234 ppm, respectively) are associated with and overlap the areas of La anomalies. The major La anomalies lie in an arcuate-shaped area in wave cut terraces on former shorelines in Ikpikpuk River and Umiat 1° x 3° quadrangles.

The distribution of Au highlights the known gold districts and also includes areas where Au has not been previously reported. An area of scattered Au anomalies (0.06 to 1.35 ppm) lies in the Coastal Plain and Foothills Provinces. Major anomalies are in areas of Tertiary gravels and wave cut terraces on former shorelines in the Sagavanirktok and Umiat quadrangles.

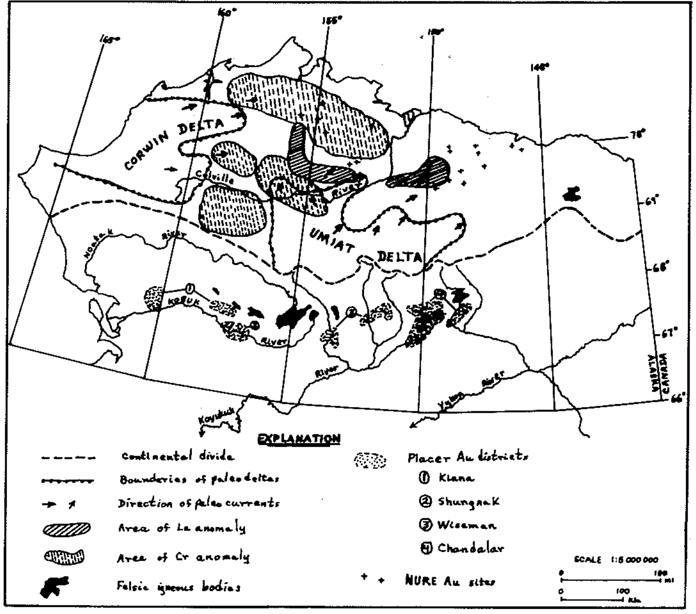

Figure 1. *Map showing areas of La and Cr anomalies, Au districts, paleodeltas, and other features in northern Alaska. Diagram modified after Nokleberg and others (1987) and Huffman and Ahlbrandt (1978).*

The distribution of Cr, Cu, Co, and Ni shows areas of known mafic and ultramafic terranes. We propose that this suite of elements can be used to delineate areas on the Arctic slope where placer exploration potential for PGM and chromite deposits is relatively high. Two large areas with anomalous Cr (160 to 580 ppm) trend southeast over several quadrangles from the Arctic Ocean to the Colville River. Cobalt Cu, and Ni (29 to 62 ppm, 48 to 120 ppm, and 47 to 115 ppm, respectively) occur in some areas with the Cr anomalies. It appears that the watershed of the Colville River contributes to a major role in the distribution of the Cr anomalies.

The U.S. Geological Survey has collected geochemical samples in limited areas of the Arctic slope and the resulting data supports the LASL (1983) data. Theobald et al. (1978) show an area with Cr anomalies, lying fan-like, from the Feniak Lake ultramafic body northward to the Colville River. They conducted a regional geochemical reconnaissance of the Misheguk Mountain and Howard Pass quadrangles located in the western Brooks Range where 567 sites provided heavy-mineral-concentrate samples. Analyses of the nonmagnetic fraction by semiquantitative optical emission spectroscopy (OES) shows Cr values of up to 5,000 ppm over much of the anomaly. The Cr data also highlights other areas probably containing ultramafic bodies. It is suspected that the Cr in the nonmagnetic fraction is hosted in either chrome diopside or olivine.

A pilot study on gold occurrences by John B. Cathrall and Jack C. Antweiler was conducted during 1987 in areas of the Coastal Plain and Foothills Provinces in the Umiat and Sagavanirktok quadrangles. They panned visible gold from 17 selected sample sites from the Colville River eastward to the Echooka River. Optical emission spectroscopy analyses of the gold shows that Pt is present in some gold samples (unpublished data).

The presence of anomalous La, Hf, and Th in the NURE samples from the Arctic slope (LASL, 1983) suggests to us that these elements are hosted in accessory minerals such as monazite, zircon, and allanite. A search in the archive storage

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for NURE samples containing anomalous La yielded one sample containing 300 ppm La that was suitable for recovery of the heavy-mineral fraction. An SEM (scanning electron microscope) scan conducted on the heavy minerals resulted in identification of monazite and zircon.

The sources of the Au, REE, Cr, and PGM-related elements found in the LASL (1983) data are conjectural, but we suspect that the minerals hosting these elements mostly came from mineralized areas that are now south of the Continental Divide. Although the present stream drainages run southward from the known mineralized areas, there is compelling evidence that ancient stream drainages ran north across the Umiat and Corwin delta, permitting them to carry ore-mineral-rich sediments to the Arctic slope (see Figure 1).

The La, Hf, and Zr anomalies that overlie the Arctic slope come from sediments derived from Quaternary, Tertiary, and Cretaceous units; we suggest that the sedimentary rocks within the area have their origin in the Brooks Range Province to the south. The Brooks Range Province comprises several ranges of rugged glaciated mountains. The southern part of the province contains Silurian limestone and Paleozoic and Precambrian metamorphic rocks. The northern part of the province is an east-striking fold belt of northerly thrusted, imbricated plates of Devonian and Mississippian rocks. Erosion has uncovered rare-earth-rich felsic plutons along the central core of the range. It is the plutons, such as those in the area of Mount Igikpak located in the Survey Pass quadrangle, that may have supplied a major part of the REE found in the NURE samples (LASL, 1983).

The anomalous concentrations of Cr and possibly PGM-related elements found in the NURE samples may have been derived from the Brooks Range Province. It is thought that the Brooks Range once contained extensive outcrops of mafic and ultramafic rocks, but now only small isolated klippen of such rocks exist. Theobald and others (1978) show that the major Cr anomaly associated with the Feniak Lake ultramafic body radiates northward crossing the Continental Divide and extending to the Colville River.

The source of the gold seen by Cathrall and Antweiler and the NURE sediment samples (LASL, 1983) we suspect, is in the Wiseman-Chandalar gold belt in the Wiseman and Chandalar quadrangles. Present-day streams flow southward from the gold belt, but a Continental Divide located south of the belt at an earlier time would allow gold from the belt to be transported north and deposited on the Arctic slope.

In summary, the LASL (1983) data highlight areas of the Arctic slope that contain anomalous concentrations of Au, Cr, and REE. Relatively recent geochemical exploration of limited areas of the Arctic slope by the U.S. Geological Survey shows that gold, monazite, zircon, and Cr-bearing minerals are found in anomalous concentrations in stream-sediment samples. We suggest that the NURE geochemical data are useful in areas of the Arctic slope to locate placer deposits of heavy minerals containing Au, PGM, Cr, and REE.

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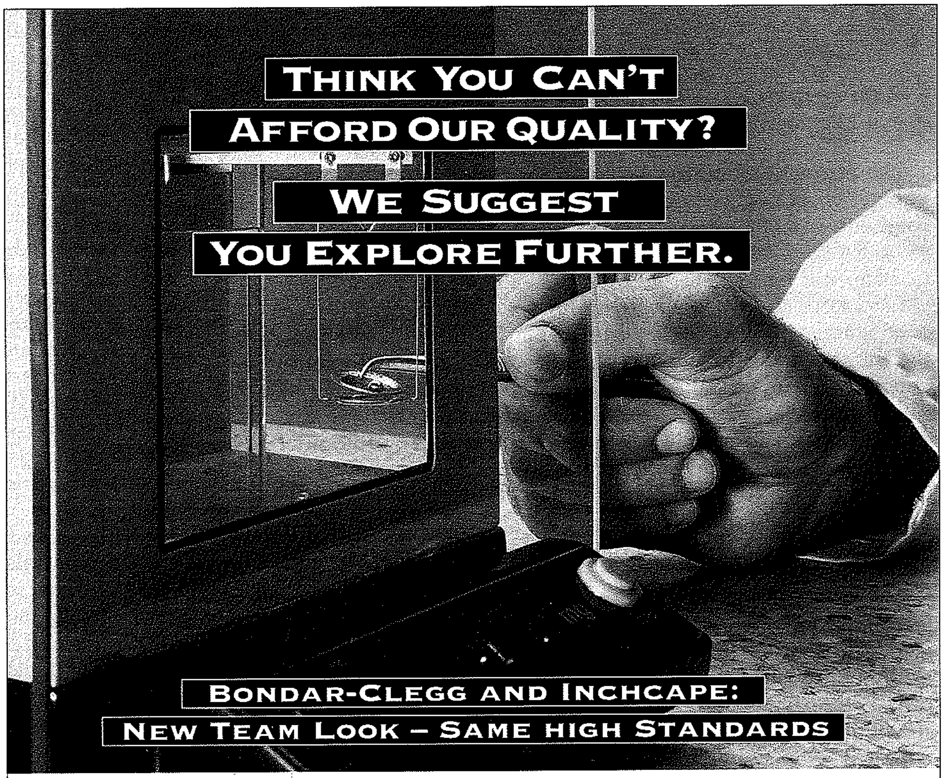

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A Review of Mechanisms for the Geochemical Transport of Precious Metals

The discovery of carbonaceous gold deposits prompted the investigation of relationships of organic material with gold solubility and deposition (Shacklette et al., 1970; Lakin et al., 1974; Radtke and Schreiner, 1970). Some evidence of this relationship was reported earlier by Allen and Day (1927).

On a large scale, a low temperature shallow convection cell of continental emplacement is postulated as the driving force for the transport, enrichment and deposition of disseminated gold deposits (Berger and Adams, 1986). Either, the gold-carrying fluids are alkaline and contain sulfides (Weissberg, 1970) or are acidic. Gold may precipitate from basic solutions by addition of carbon dioxide, loss of ammonia (Akright et al., 1969), or depletion of dissolved chelants (Tyurin, 1964). It may precipitate together with barite and humates by neutralization of acidic solutions, i.e. with calcium carbonate (Radtke and Schreiner, 1970). Other mechanisms such as an increase in salt concentration (Ong and Swanson, 1969; Kokta and Dvorackova, 1967) or boiling off water in a boiling thermal spring may precipitate gold but this mechanism seems ineffective with water depositing calcite (Allen and Day, 1927; Goleva, 1968). Substances found in carbonaceous ores suggest a combination of processes leading to simultaneous precipitation of gold with carbonaceous materials with loss of ammonia under reducing conditions (Berger and Adams, 1986).

It is possible that humic acids in carbonaceous matter were agents responsible for the solubilization, chelation and transport of metals. Indeed, humic acid residues and ammonia-containing compounds were observed in some low temperature hydrothermal deposits such as those containing opalites, arsenopyrite, cinnabar and also in deposits of carbonaceous gold ore (Allen and Day, 1927; Ong and Swanson 1969; Wilding et al. 1967; Slivko and Pavlishin, 1967; Zhuchkov et al., 1968; Mrna and Pavlu 1967). Mobilization of metals in ordinary soil and posterior uptake by vegetation was reviewed by Brooks (1972). Gold uptake was described by Curtin et al. (1968), Shacklette et al. (1970), and Lakin et al. (1974). Platinum and palladium uptake was studied by Fuchs et al. (1974), Pallas et al. (1978), and Kothny (1992, 1979). These observations indicate solubilization of precious metals under mild conditions.

Dissanayake et al. (1984) found that in a natural erosional cycle, dissolved gold seems to be absorbed by algal mats and peat together with iron and manganese hydrous oxides. This suggests active involvement of organic products in the "fixing" of gold. Platinum was not found in the same matrix with gold but was observed in the clastic fraction. The absorption process seems to be pH dependent (Darnall et al., 1986). In the Colorado river basin, a similar situation was observed by the author in unconsolidated diagenetically transformed sediments where gold is absorbed on occluded organic substances in clay, whereas platinum occurs as minute grains.

Although little is known about the composition of humic acids, the foremost chelating substances in nature, they are defined as a mixture of heteropolycondensates of oxidized polysaccharides, demethoxylated lignin and other residues (Ryan et al., 1984). They are anionic and contain aromatic rings with phenol and quinone reactive groups and possibly nitrogen and sulfur binding sites (Radtke and Schreiner, 1970). Peat, coal and soils are known to contain up to 0.5% humic acids and Poutanen and Morris (1985) found that humates account for up to 80% of the organic matter in some plankton-derived sediments.

Baker (1973) found evidence that more silver, copper, gold, lead and other metals are dissolved by neutral humates than by naturally occurring solutions of carbonic and other organic acids. A direct solubilization of gold by pure humates, however, could not be proved by Ong and Swanson (1969). In any event, solubilized gold (Gosling, 1971) taken up by vegetation, accumulates in forest litter (Curtin, 1968) from where it migrates into the underlying soil.

Although gold is found in solution in pristine waters as well as suspended on clay particles (Jones, 1970) in concentrations hardly reconcilable with mechanisms involving Cl^-, OH^-, or humates alone, it was thought that perhaps some missing ingredient was overlooked. As mentioned above, sulfur-binding sites in humates (Radtke, 1970) may play a role in migration

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of dissolved gold much as the presence of decaying plant proteins (such as histidine-containing proteins which bind Cu and Zn) evidenced by ammonia-containing substances in certain low temperature deposits mentioned earlier. Failure to recognize such substances as capable of influencing the solubilization process is probably a result of the static conditions used by most experimenters. It is possible that the minute amounts of sulfur-binding sites in humic acids were inactive at the moment the extracts were made for the solubilizing experiments.

This author has performfed experiments intended to approximate natural interstitial solutions, albeit in higher concentrations, to demonstrate the effectiveness of such solutions in solubilizing precious metals. From sulfur-containing substances tested, cystine proved to be most active, followed in decreasing order by thiourea and thiocyanate, whereas sulfate and methionine were inactive. Other naturally occurring anions, except chloride, were not tested. With additional redox buffers such as quinones, phenols, iron, copper and dissolved oxygen, the solutions more effectively dissolved the precious metals tested.

Gold, platinum and palladium were supported on mica powder. An acetate (pH 5 to 6) buffered mixture containing tannic acid and quinone, was stirred for 80 hours, then filtered through two Whatman # 42 filters. The leachate did not show platinum at the microgram level. The same solution containing an additional 0.002% cystine dissolved 75 micrograms platinum per liter. Gold (<100 ug/L) and palladium (<60 ug/L) dissolved whether or not cystine was present.

Minus 100 mesh gold stirred for 2 hours with a pH 6 solution containing cystine, p-quinone, iron and copper, dissolved 5 ug gold/Liter but there was about 1 mg of gold in colloidal suspension. Under similar conditions but at pH 10, the solution dissolved 3 mg gold/Liter and had about 7 mg/L of gold in colloidal suspension. Increased solubility at higher pH values corroborates an observation reported earlier by Listova et al. (1966).

Without tannic acid and quinones, the amounts of gold dissolved were one order of magnitude lower. Conditions used in these experiments may exist in natural environments and suggest plausible geochemical reactions for the dissolution, transport and deposition of precious metals in nature.

Acknowledgement: Encouragement for publication of the experiments and review of the manuscript review by J.H. McCarthy, Jr. (U.S. Geological Survey) is very much appreciated.

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NEW AEG SHORT COURSE

APPLIED BIOGEOCHEMICAL PROSPECTING IN FORESTED TERRAIN

Sheraton Hotel, Spokane, Washington, 29/30 November, 1993

Preceding and in conjunction with the Northwest Mining Association's (NWMA) 99th Annual Meeting, Dec. 1 - 3

INSTRUCTORS:

Colin E. Dunn - Geologist/biogeochemist, Geological Survey of Canada
Gwendy E.M. Hall - Analytical Chemist, Geological Survey of Canada
Robert K. Scagel - Botanist/forester, Pacific Phytometric Consultants, Surrey, B.C.

This course will discuss basic principles of biogeochemical prospecting and lead participants through to 'state-of-the-art' knowledge, leaning heavily upon the instructors' experience in the Pacific Northwest, British Columbia, and the boreal forests of Canada.

Topics to be included will be:

— plant components and element uptake (requirements, tolerances and toxicity - what to look for); plant physiology; biogeoclimatic zones; identification of trees and shrubs of value in biogeochemical prospecting;

— methods of sample collection, preparation, and analysis; analytical instrumentation; special procedures required for vegetation;

— case history studies of results obtained for precious metals, base metals, kimberlite, uranium, and rare metal pegmatites - examples will be mostly from British Columbia, Saskatchewan and the Maritime Provinces of Canada.

FEE: Fee structure has yet to be set - approximately US$300 for AEG and NWMA members, with a 50% reduction for registered full-time university students. It is expected that this course will be offered as a continuing education credit at East Washington University.

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NEW MEMBERS

To All Voting Members:

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

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

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JOURNAL OF GEOCHEMICAL EXPLORATION

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Identification of geochemical anomalies using principal component analysis and factorial kriging analysis. R. Jimenez-Espinosa (Granada, Spain), A.J. Sousa (Lisboa Codex, Portugal) and M. Chica-Olmo (Granada, Spain)

Preliminary studies of the CHIM electrogeochemical method at the Kokomo Mine, Russell Gulch, Colorado. D.B. Smith, D.B Hoover, and R.F. Sanzalone (Denver, CO, USA)

Distribution and behavior of platinum in soils, sediments and waters of the Tulameen ultramafic complex, southern British Columbia, Canada. S.J. Cook (Victoria B.C., Canada) and W.K. Fletcher (Vancouver, B.C., Canada)

Detailed geochemical survey in the Peloritani Arc (northeastern Sicily, Italy): Evidence of gold anomalies. B. De Vivo, A. Lima (Napoli, Italy), G. Catalano and A. Chersicla (Follonica Grosseto, Italy)

Scapania undalata (L.) Dum and other aquatic bryophytes as indicators of mineralization in Poland. A. Samacka-Cymerman (Wroclaw, Poland) and A.J. Kempers (Nijmegen, Netherlands)

Hydrothermal alteration of the Beira schists around the W-Sn specialized Regoufe granite, NW Portugal. A.J. Van de Haar, S.P. Vriend and P.F.M. Van Gaans (Utrecht, Netherlands)

Book Review

Progress in Hydrogeochemistry, by G. Matthess, F.H. Frimmel, P, Hirsch, H.D. Schulz and E. Usdowski (Editors) - I.D. Clark

RECENT PAPERS

This list comprises titles that have appeared in major publications since the compilation in **EXPLORE** Number 78. 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 (GSC OFR); Bulletin of the Canadian Institute of Mining and Metallurgy (CIM Bull); Transactions of Institute of Mining and Metallurgy, Section B: Applied earth Sciences (Trans IMM). Publications less frequently cited are identified in full. Compiled by **L. Graham Closs**, Department of Geology and Geological Engineering, Colorado School of Mines, Golden, CO 80401, Chairman AEG Bibliography Committee. Please send new references to Dr. Closs, not to **EXPLORE**.

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Mining, Exploration and the Environment '92 was the theme for the Pacific Northwest Mining and Metals Conference held in Bellevue, Washington last April 6 through 10. The conference featured a variety of sessions covering timely issues including: Exploration Strategies For the Nineties, Extractive Metallurgy, Environmental Considerations For the 90's, Heap Leach Pad and Tailings Design, Remediation of Mine Wastes, Surface and Underground Mining, New Discoveries/Case Histories, Acid Mine Drainage, Abandoned Mine Lands and Leading Edge Exploration Geochemistry; Exploration and The Environment, Modern Methods of Multi-element Analysis and Recent Advances in Stream Sediment Geochemistry. A book of abstracts from the conference can be purchased for $5.00 by contacting Carl Johnson: c/o SAIC, 18702 North Creek Parkway, Suite 211, Bothell, WA, 98011, USA, TEL: (206) 485-2818, FAX: (206) 487-1473.

ASSOCIATION OF EXPLORATION GEOCHEMISTS
APPLICATION FOR ADMISSION

Bentall Centre, PO Box 48270, Vancouver, BC, V7X 1A1, Canada

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Date ____________________

Field of interest selection 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐
(Insert number in box)

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

Specialty or topic of interest selection 1 ☐ 2 ☐ 3 ☐ 4 ☐
(Insert number in box)

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

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16TH INTERNATIONAL GEOCHEMICAL EXPLORATION SYMPOSIUM

Symposium general chairman XIE Xuejing and the Steering Committee invite you to participate in the 16th International Geochemical Exploration Symposium and the 5th Chinese Exploration Geochemistry Symposium. The 5th CEGS will be held on September 1 and 2, 1993, and the 16th IGES will be conducted from September 4 to 6. It is inspiring, and a great honor to Chinese exploration geochemists, that Beijing will be the first Asian city to host this prestigious event. In conferences and seminars, as well as informally, participants will have countless chances to exchange ideas and experiences to broaden international understanding. The symposia will be held at the 21st Century Hotel, a modern facility with excellent service. Everything possible will be done to ensure that all participants have a comfortable and enjoyable stay in Beijing. The prestigious steering, organizing, and technical committees, as well as an extensive selection of sponsors, co-sponsors, and supporting sponsors, are working to arrange technical programs, pre- and post-symposium excursions, sightseeing in Beijing, and social gatherings.

The official language of the 16th IGES is English. The official language of the 5th CEGS is Chinese, however texts, figures, slide captions and synchronous translation of all oral presentations will be available in English.

Sessions and posters are planned on the following topics:

1. Geochemical exploration methods in different geological and geographical environments.
2. Geochemical exploration for blind and buried ore deposits.
3. Geochemical exploration for gold and other precious metals.
4. Geochemical exploration for oil gas, and geothermal fields.
5. Environmental and agricultural geochemistry.
6. Regional geochemistry and international geochemical mapping.
7. Analytical techniques.
8. Data processing and interpretation of geochemical data.
9. Integrated methods in exploration and discovery.

Workshops are scheduled for the following topics:

1. Progress in Environmental Geochemical Exploration, led by Dr. I. Thorton, Center for Environmental Technology, Imperial College, morning September 1, (US$25.).
2. International Geochemical Mapping, led by Dr. A.G. Darnley, Geological Survey of Canada, afternoon September 1, (US$25.).
3. Analytical Methods in Exploration Geochemistry, led by Dr. G.E.M. Hall, Geological Survey of Canada, morning September 2, (US$25.).
4. Applied Biogeochemical Exploration, led by Drs. C.E. Dunn, G.E.M. Hall, and R. Scagel, Geological Survey of Canada, afternoon September 2, (US$25.).
5. Geochemical Prospecting for Gold, led by Dr. I. Nichol, Department of Geology, Queen's University, September 1, (US$25.).

A short course on geoanalysis in environmental geochemistry, geochemical mapping, and mineral exploration will be conducted by Professor QIAN Desun, Central Laboratory of Anhui Provincial Bureau of Geology and Mineral Resources, September 1 and 2, (US$150.).

Six post-symposia and one pre-symposia excursions will be arranged.

1. Beijing-Dunhuang-Urumqi-Fuyun-Beijing, September 7 to 12. Mogaoku grottos, Fuyun Cu-Ni deposit, regional exploration and discoveries in Xinjiang, glacial landforms in the Heaven Pool region, (US$1100.).
2. Beijing-Hohhot-Baotou-Baiyan Obo-Beijing, September 7 to 12. Hademan Gou gold deposit, geochemical surveys in arid areas, gold deposit in Dahuabei, Baiyan Obo Museum of Geology, REE-iron deposit, grassland scenery, overnight stay in an Mongolian yurt, (US$580.).
3. Beijing-Jinan-Tai'an-Yantai-Shanghai, September 7 to 12. Zhaoyuan gold deposit, including Linglong-type and Jiaojia-type gold deposits, Precambrian metamorphic rocks of Mount Tai, the Confucian Temple, (US$715.).
4. Beijing-Guilin-Liuzhou-Dachang-Guangzhou, September 7 to 12. Dachang tin deposit, Geochemical exploration in karst topography, Rudi (Reed Flute) Cave, Lijiang River, (US$890.).
5. Beijing-Chengdu-Lhasa-Yangbajin-Guangzhou, September 7 to 14. Ancient water conservancy project, Geochemical exploration in the geothermal field of Yangbajin, Roof of the world - Tibet scenery, the Potala Palace (Lamersery), The Summer Palace of Dalai-Lama, Tibet dance show and the Monarch Tomb, (US$1540. + $300.). *Note:* If the regulation which charges foreign visitors $300. for visiting Tibet is cancelled this year, the $300. will be refunded.
6. Beijing-Luoyang-Lingbao-Xi'an-Beijing, September 7 to 12. Jindui Cheng molybdenum deposit, Geochemical exploration for gold in western Henan, Shaolin Temple, Marshal art show, Linhu, Tonggou gold deposit, International Golden Apple Festival in Lingbao, Laozi Temple, ancient capital Ai'an, Chein Dynasty Museum of Terra-cotta warriors, (US$660.).
7. Beijing-Guiyang-Xingren-Beijing, August 25 to 31. Sediment-hosted gold deposits in southwestern Guizhou, including Zimudang, Getang and Yata Carlin-type gold deposits in Xingren County, Huang Guo Shu waterfalls, Dragon Palace, Minority Nationality Museum, (US$870.).

Expenditure includes travelling by air, train, and/or bus, hotel accommodates, full meals, admission tickets, and the train ticket to Hong Kong (from Guangzhou). To secure the air and train tickets, and hotel accommodations, please complete the "Registration Form" and return it to the 16th IGES Office with the tour fees before June 15, 1993. If the places you want to visit are not listed in above schedules and you wish to make other arrangements for travel in China, contact the secretariat at the IGES office (address listed below).

The following social programs will be arranged every day from September 2 to 6, at a cost between US$15.-30. per person, per day, including a meal and admission tickets:

1. The Great Wall and the Ming Tomb.
2. The Forbidden City and the Bei Hai Park.
3. The Summer Palace and the Heaven Temple.
4. The Beijing Zoo and downtown shopping.

Any organization interested in (1) booth space during the symposia for exhibiting equipment or services, (2) sponsoring a symposia function such as coffee breaks, wine and cheese reception, or printing of abstracts volume, or (3) advertising in the volume of abstracts, is asked to indicate an address to which further information should be sent.

VISAS

An invitation letter will be issued on request to those who need a visa for entrance to China. Please provide your name and passport number as well as those of accompanying persons to (preferably with the registration form):

Secretariat/16th IGES Office, 26 Bai Wan Zhuang Dajie,
Beijing 100037, CHINA, Telephone: 86-1-832-0276, or 86-1-832-3268
Telefax: 86-1-831-0894

Please apply for the entry visas with the official invitation to Chinese Embassies, China Consulate Generals (or visa Office of the Chinese Ministry of Foreign Affairs in Hong Kong) in the city designated in the invitation. For any questions and information about visas, please contact the secretariat at the above address.

TRANSPORTATION AND CURRENCY

Beijing Capital Airport can be reached by both domestic and international flights. A representative of the symposia secretariat will meet you at the airport from 8:00 to 24:00 on Tuesday, August 31. Currency for foreigners in China is called Foreign Exchange Certificate (FEC). You can easily exchange your foreign currency and traveller's cheques into FEC at the airport and hotels. Taxi fare from the Capital Airport to the hotel is about FEC 80 (US$15.).

REGISTRATION

The delegates registration fees include the abstracts volume, a participants list, the ice breaker party, morning and afternoon teas, the banquet, and souvenirs. No further registration fees are required to attend the 5th CEGS, however, an extra charge of US$15. is necessary to obtain the English version of the CEGS oral presentation. All payment due in respect to registration, accommodations, and excursions must be made in US dollars and payable to the 16th IGES. The following methods of payment are acceptable:

1. Bank drafts drawn on: The Secretariat/16th IGES Office, 26 Bai Wan Zhuang Dajie, Beijing, 100037, China
2. Bank transfer to: Langfang Branch, Bank of China, Langfang, Hebei 102800, A/C: 14824002, 16th IGES Office

We look forward to seeing you in Beijing!

REGISTRATION FORM — 16th IGES/CEGS
Beijing, China, 1-6 September, 1993

Please type or print in BLOCK letters in black. Please return by airmail where applicable

SECTION A:

Delegate Information

Title (Prof., Dr., Ms. etc.)	Family name	Given name	Sex (M/F)

Address: ______________________________

Country: ______________ Postal Code: ______________

	Country Code	Area Code	Number
Telephone:			
Facsimile:			

Organization: ______________________________

Position: ______________________________

Accompanying Persons

Title (Prof, Dr, Ms, etc.)	Family name	Given name	Sex (M/F)

Preferred Badge Name:

Preferred Badge Name:

Co-Chairmen

Do you wish to co-chair a session? ______________

If so, what session(s): ______________

Additional Information

Tick the appropriate box if you require more information

Rental of exhibition space ☐

Sponsorship of delegate(s) ☐

SECTION B:

Accommodations

1. I do not wish symposium organizers to arrange accommodations on my behalf. ☐
2. Please reserve accommodations according to my numbered preferences indicated below. Prices indicated are per room / per night. I enclose a deposit of one night's accommodation for my first priority selection. I understand that my deposit is not refundable in the event that I do not arrive on the date reserved. ☐

Code	Hotel	Type	Indicate preference	
01	21st Hotel (conference hall)	single	☐	$US 39
		suite	☐	79
02	Kulun Hotel	deluxe room	☐	80
		suite	☐	200

Please circle single/double/twin as applicable.

Kunlun Hotel is a five-star hotel located about a five minute walk from the 21st Hotel.

3. Arrival date: ______________ Departure date: ______________

Accommodation deposit (one night) $US______________

OVER....

REGISTRATION FORM — 16th IGES/CEGS - Continued

SECTION C:

Excursions

Excursion		Code	Cost	Payment
1.	Beijing-Urumqi	EUM	$US 1100	$US ______
2.	Beijing-Baotou	EBT	580	______
3.	Beijing-Yantai	EYT	715	______
4.	Beijing-Guilin	EGL	890	______
5.	Beijing-Lhasa	ELS	1840	______
6.	Beijing-Xi'an	EXA	660	______
7.	Beijing-Guiyang	EGY	870	______
Total excursion fees				$US ______

SECTION D:

Registration and Payment Details

		before 6/30/93	code	after 6/30/93	code	payment enclosed
1.	Registration Fee					
	AEG Members	160	RM	190	RML	$US______
	Non-members	210	RN	240	RNL	______
	Accopanying Member	48	RA	57	RAL	______
	Exhibitors	80	RE	90	REL	______
2.	Accommodations Deposit (Section B)					______
3.	Excursion Fees (Section C)					______
Total payment:						$US:

Registration by Chinese residents should be accompanied by a cheque.

Registration by non-Chinese residents should be accompanied by an international cheque or bank draft in US dollars.

All cheques should be made payable to the 16th IGES and bank drafts drawn on:

Secretariat of 16th IGES office
26 Bei Whan Zhuang Dajai,
Beijing 100037, China

Bank transfer to:

Langfang Branch, Bank of China
Langfang, Hebei 102800
A/C: 14824002, 16th IGES Office

Signature ______________________________ Date ______________

CALENDAR OF EVENTS

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

■ Apr. 1-30, '93 Computer-simulated **Mineral Exploration**, workshop, Fontainebleau, France, by UNESCO's Earth Sciences Division and French National Commission (L. Zanona, Ecole del Mines de Paris, CGGM-IGM, 35, rue Saint-Honor, 77305 Fontainbleau Cedex, France; TEL: (33 1) 64 69 49 30; FAX: (33 1) 64 69 47 01)

■ Apr. 13-16, '93 The **Environmental Geochemistry** of **Mineral Deposits**, short course and seminar, Denver, CO (G.S. Plumlee, U.S. Geological Survey, MS 973, Federal Center, Denver, CO 80225 USA; TEL: (303) 236-9224)

■ Apr. 17-20, '93 Integrated Methods in **Exploration & Discovery**, Conference, by the Society of Economic Geologists,Association of Exploration Geochemists, Society of Exploration Geophysics, and others, Denver, CO (J. Alan Coope, SEG conference '93, Box 571, Golden, CO 80402 USA; TEL/FAX: (303) 470-6289)

■ Apr. 18-21, '93 Canadian Quaternary Association (CANQUA) symposium on **Applied Quaternary Research**, Victoria BC, Canada (CANQUA '93, Environmental Geology Section, B.C. Geological Survey Branch, 553 Superior Street, Victoria, B.C., Canada, V8V 1X4, TEL: (604) 387-6249, FAX: (604) 356-8153)

■ Apr. 20-24, '93 International **Conference on Geoscience Education** and Training, South Hampton University, England (Dr. Dorrik A.V. Stow, Dept. of Geology, Unversity of South Hampton, South Hampton, SO9 5NH, England, TEL: (0703) 593049, FAX: (0703) 593052)

■ Apr. 25-30, '93 Geology of **Industrial Minerals**, symposium, Long Beach, CA (Dave Beeby, Calif. Division of Mines and Geology, MS 8-38, 801 K St., Sacramento, CA 95814 USA; TEL: (916) 323-8562)

■ Apr. 5-8, '93 **Geotechnica '93**, Congress-Centrum West KolnMesse, Germany (C.C.M. Cologne Congress Management GmbH, Postfach 180 180, W-5000 Koln 1, Germany, TEL: 02 21 / 92 57 930, FAX: 02 21 /57 93 93, TELEX: 8 881 783 ccmd

■ May 4-7, '93 **Geofluids '93**, International Conference on Fluid Evolution, Migration and Interactions in Rocks, Torquay, England (Sally Cornford, IGI Ltd, Hallsannery, Bideford, Devon, EX39 5HE, England; TEL: 44 (0)237 471749; FAX: 44 (0)237 421700)

■ May 17-19, '93 **GAC-MAC**, ann. mtg., Edmonton, Alberta (J. W. Kramers, Alberta Geological Survey, Box 8330, Station F, Edmonton, AB, T6H 5X2, Canada; TEL: (403) 438-7644; FAX: (403) 438-3364)

■ May 31-June 2, '93 **Applied Mineralogy**, int'l. mtg., Perth, Western Australia (Jim Graham, ICAM '93, Private Bag, P.O. Wembley 6014, Australia; TEL: (619) 387-0371)

■ June 3-5, '93 **Geostatistics**, int'l mtg., Montreal, Quebec (Conference Office, Suite 490, West Tower, 550 Sherbrooke St. West, Montreal, PQ, H3A 1B9, Canada; TEL: (514) 398-3770; FAX: (514) 398-4845)

■ June '93 Intl. **Precious Metals** Institute, Newport, RI (IPMI, 4905 Tilghman St., Suite 160, Allentown, PA 18104 USA, TEL: (215) 395-5855)

■ July '93 Russian acadamy of sciences, Geological institute of the Kola Science Centre, **The Kola Rare-Metal Deposits - II** (Dr. A.P. Belolipetsky, Geological Institute, Kola Science Centre of the Russian Acad. of Sci. 14, Fersman St. Apatity-184200 Russia: TEL: 37-292, TELEX: 126129 KOLSC SU

■ July 17-24, '93 The Malvern International Conference on **Geological and Landscape Conservation**, Great Malvern, England (Margaret Phillips, The Company, St. John's Renovation Centre, Cowley Road, Cambridge CB4 4WS, England; TEL: 44 (0) 223 421124; FAX: 44 (0) 223 421158)

■ July 19-25, '93 Geological Sciences in **Latin America**, int'l mtg., Campinas and Ouro Preto, Brazil, by International Union of Geological Sciences, and others (M.M. Lopes, IG/UNICAMP, Box 6125, 13081, Campinas, Brazil; TEL: 55 (192) 39-7352; FAX: 55 (192) 39-4717)

■ July 24-29, '93 Society for **Environmental Geochemistry and Health** mtg., New Orlean, LA (Dr. Howard Mielke, College of Pharmacy, Xavier University of Louisiana, New Orleans, LA 70215 USA; TEL: (504) 483-7523)

■ Aug. 1-3, '93 **Geochemistry of the Earth Surface**. Third International Symposium on Geochemistry of Weathering and Diagenesis of Sediments, University Park, PA (Dr. Lee R. Kump, Secretary General, GWDS-3, Department of Geosciences, The Pennsylvania State University, 210 Deike Building, University Park, PA 16802 USA; TEL: (814) 863-1274; FAX: (814) 865-3191)

■ Sept. 1-3, '93 International Symposium on **Mineralization Related to Mafic and Ultramafic Rocks** (IAGOD, Symposium Secretary/D. Ohenstetter, CRSCM, La rue de la Feqrollerre, 45071 Orleans, Cedex 2, France; TEL: 33-38-51-54-01, FAX: 33-38-63-64-88)

■ Sept. 2-13, '93 IUGS, UNESCO, IGCP **Precambrian crusts of Weathering**, Apatity, Russia (Dr. Arcady, A. Kalinin, Russia, 184200, Murmanske reg., Apatity, Fersman St., Russia, 14, TEL: 37 601 or 37 627, TELEX: 126129 KOLSC SU

■ Sept. 3-5, '93 16th International **Geochemical Exploration** Symposium, and Sept. 1-2, '93 5th Chinese Exploration Geochemistry Symposium, Beijing, China (Dr. Xie Xuejing, Honorary Director, Institute of Geophysical & Geochemical Exploration, Langfang, Hebei 102849, CHINA; TELEX: 22531 MGMRC CN; FAX: 86-1-4210628; and, Dr. Lin Cunshan, Deputy Director, Institute of Geophysical and Geochemical Exploration, Langfang, Hebei 102849, China; TELEX: 26296 LFPBL CN; FAX: 86-0316-212868)

■ Sept. 5-10, '93 **Trace Elements**, 2nd Int'l Conference on Biogeochemistry of Trace Elements, Taiwan, ROC (Dr. D.C. Adriano, University of Georgia, Savannah River Ecology Laboratory, Drawer E, Aiken, SC 29802 USA)

■ Sept. 9-11, '93 Application of Recent Geologic Concepts to **Exploration in the Northern Appalachians**, Third Anual CIM Geological Society Field Conference, Technical sessions and field trips (New Brunswick, Newfoundland, Maine, Quebec and Portugal), Bathurst, NB, Canada (S. McCutcheon, P.O. Box 50, Bathurst, NB, E2A 3Z1 Canada; TEL: (506) 547-2070; FAX: (506) 546-3994)

Continued on Page 26

Calendar of Events

Continued from Page 25

■ Sept. '93 International symposium '**Cultural Heritage Collected in Libraries of Geoscience**, Mining and Metallurgy - Past, Present and Strategy for the Next Millenium, Frieberg, Saxony, Germany (Dr. Peter Schmidt, Bibliotek, Bergakademie Freiberg, Schliessfach 47, D-)-9200 Freiberg, Germany)

■ Sept. 15-17, '93 **Mining Development**, int'l mtg., Philadelphia, by Society for Mining, Metallurgy and Exploration (SME, Meetings Dept., Box 625002, Littleton, CO 80162 USA; TEL: (303) 973-9550; FAX: (303) 979-3461)

■ Sept. 21-23, '93 **Andean Geodynamics**, int'l symposium, Oxford, England, by University of Oxford and Institut Franais de Recherche Scientifique pour le Dveloppement en Coopration (Orstrom). (Piere Soler, Orstrom, CS1, 213 rue Lafayette, 75480 Paris Cedex 10, France; FAX: 33-1-48 03 08 29)

■ Sept. 25 - Oct. 1, '93 International Association of- **Volcanology and Chemistry of the Earth's Interior**, mtg.,Canberra, AUSTRALIA (IAVCEI ACTS, GPO Box 2200, Canberra ACT 2601, Austraila, TEL: (61) 6-257-3299; FAX: (61) 6-257-3256)

■ Sept. 26 - Oct. 1, '93, **Analytical Environmental Chemistry**, Symposium on Analytical Chemistry incorporating the 3rd Environmental Chemistry Conference, Perth, WA (12 AC, The Conference Office, University of Western Australia, Nedlands, WA, 6009 Australia)

■ Sept. 28 - Oct. 1, '93 **Environmental Pollution**, int'l mtg., Barcelona, Spain, by European Centre for Pollution Research and others (ICEP Conference Office, ICTR Secretariat, 11-12 Pall Mall, London SW1Y 5LU, England: TEL: 44 71 930 6825; FAX: 44 71 976 1587)

■ Oct. 25-28, '93 **Geological Society of America**, ann. mtg., Boston, MA (Vanessa George, GSA, Box 9140, Boulder, CO 80301 USA; TEL: (303) 447-2020)

■ Nov. 14-20, '93 2nd Congress of **Geochemistry** of the Portuguese-Speaking Countries (II Congresso de Geoqulmica de dos Paises de Liingua Portuguesa) and 9th "Geochemical Week - Portugal", Porto, Portugal (Dr. Fernando Noronha, Mineralogia e Geologia, Faculdade de Ciencias, 4000 Porto Portugal; TEL: (351-2) 310 290; FAX: (351-2) 316-456)

■ Jan. 27-28, '94 International symposium on **Remote Sensing and GIS**, location as yet undetermined (Dr. Vern Singhroy, Canada Centre for Remote Sensing, 588 Booth Street, Ottawa, ON, K1A 0Y7, Canada) Call for papers: Publications Division, 1916 Race Street, Philadelphia PA 19103-1187 USA, TEL: (215) 299-5400

■ Feb. 14-17, '94 **Integrating Mining and the Environment**, SME, Annual Meeting, Albuquerque, NM (Meetings Dept., SME, PO Box 625002, Littleton, CO 80162-5002 USA; TEL: (303) 973-9550; FAX: (303) 979-3461)

■ Sept. 12-15, '94, 3rd Symposium on **Environmental Geochemistry**, Krak'w, Poland (Dr. Hab. Edeltrauda Helios Rybicka, Faculty of Geology, Geophysics and Environmental Protection, University of Mining and Metallurgy, Al. Mickiewicza 30, 30-059, Poland; TEL: (48) 12-333290; FAX: (48) 12-332936)

■ Sept., '94 Joint International Symposium on **Exploration Geochemistry**, Irkutsk: a tribute to Academician L.V. Tauson (Pavel Koval, Vinogradov Institute of Geochemistry, P.O.B. 701, 664033 Irkutsk, Russia; TELEX: 133 163 Taiga SU)

■ Oct. 25-27, '94 Geological Society of America, annual mtg., Boston, MA (Vanessa George, G.S.A., Box 9140, Boulder, CO 80301 USA; TEL: (303) 447-2020)

■ Apr. 10-13, '95 **Geology and Ore Deposits of the American Cordillera**, Geological Society of Nevada Symposium III (Bob Hatch, Geological Society of Nevada, P.O. Box 12021, Reno, NV 89510 USA; TEL: (702) 323-4569; FAX: (702) 323-3599)

■ May 10-14, '94 **Mining Latin America / EXPOMIN 94**, Santiago de Chile (The Conference Office, Mining Latin America, The Institution of Mining and Metallurgy, 44 Portland Place, London, W1N 4BR England; TEL: +44 71 580-3802, FAX: +44 71 436 5388)

■ May 15-19, '95 17th International Geochemical Exploration Symposium, '**Exploring the Tropics**', Townsville, Queensland, Australia (Russell Myers, 17 IGES, National Key Centre in Economic Geology, James Cook University, Townsville, QLD 4814, Australia; TEL: (077) 814486; FAX: (61) 77-815522)

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, DC 20052
USA
TEL: (202) 994-6194
FAX: (202) 994-0458

THE ASSOCIATION OF EXPLORATION GEOCHEMISTS

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