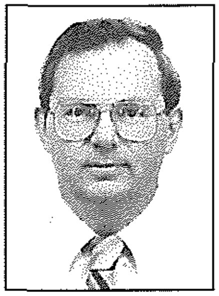
EXPLORE

Newsletter for the Association of Exploration Geochemists

NUMBER 91 APRIL 1996

PRESIDENT'S MESSAGE



Bill Coker

I have now made the transition from the Geological Survey of Canada back into industry with BHP Minerals. The past couple of months have been extremely busy as I have been getting up to speed on BHP's exploration activities, which, in turn, has involved a fair amount of travel. In fact, as I write this message I am sitting in a plane on my way to Denver having just returned from Australia. While our Australian colleagues informed and showed me that exploration geochemistry is alive and well in Australia, they also expressed their concern regarding the education of geochemists. In my January message I expressed my concern about this situation in North America but as I talk to more and more of you I am convinced that it is a concern worldwide. In this regard, discussions are currently underway to examine the establishment of a chair in "exploration geochemistry" at a Canadian university.

On the environmental front, feedback from the "Environmental and Legislative Uses of Regional Geochemical Baseline Data for Sustainable Development," organized by Peter Simpson of the BGS, and cosponsored by the AEG, indicates that the meeting was successful in informing those tasked with developing environmental guidelines and regulations of the existence, relevance and need to consider geochemical baseline information in their work. Peter is congratulated for his foresight and effort in organizing and running this meeting. Peter has also agreed to step forward and serve, pending ratification at the next Council meeting, as Second Vice President of the AEG for 1996.

AEG members are firmly entrenched in planning for a rather large group of AEG-backed meetings in 1997 including: the 18th IGES in Jerusalem, Israel, May 25-27; Exploration '97 in Toronto, Ontario, Canada, September 14-18; and the 4th ISEG in Vail, Colorado, USA, October 5-10. Details about these meetings are in the Calendar of Events.

I am in the process of reviewing the By-laws of the AEG, as there are now some anomalies in them due to changes in the start and length of term served by the President relative to the election and appointment of Councillors. Also the number of Regional Councillors needs to be re-examined. I hope to be able to bring some suggestions for revisions to Council soon. Anyone who has any suggestions or concerns regarding the By-laws is welcome to express such to me, or any member of the executive or council. Also, please feel free to contact me or any member of the executive or council on any matter to do with the AEG - we definitely seek your input and participation in your AEG.

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TECHNICAL NOTES

Geochemical Exploration in the Former Soviet Union

by Boris B. Kotlyar

Introduction

Geochemical studies in the former Soviet Union were extremely widespread and, in many instances, all encompassing. The issues described here are based on information up to 1991, the year of the collapse of the Soviet Union. After that date, geological exploration, including geochemical surveys, decreased dramatically. The author's personal experience shows that field investigations in the Ukraine, as well as in the other parts of the former Soviet Union (FSU), during 1991–1994 were not more than 30–40 percent of previous "normal" years. In the last few years, moreover, most geological branches of the former Geological Survey of the Ukraine terminated most of their field investigations. However, during the previous active years a huge amount of confidential prospecting information was assembled in the archives of the Geological Survey of the FSU, which is empowered to publish some of the data, but also to archive almost all of the geological, geochemical, and geophysical information previously gathered. The information, including millions of geochemical sample assays, is stored in local archives. Any derivative reports may be stored in local, in regional, or in central (Moscow) archives.

Many mineral resources in the FSU are attractive potential targets to Western mining companies. Private exploration and development enterprises need, on the one hand, practical geological information, previous estimates and evaluations of the size and tenor of deposits, and, on the other hand, a comprehensive understanding of the exploration level of the deposits and occurrences in the FSU, such as recently described by Diatchkov (1994). This is especially

Continued on Page 3

CONTENTS

Information for Contributors to EXPLORE

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

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

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

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

All contributions should be submitted to:

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EXPLORE is the newsletter of the Association of Exploration Geochemists (AEG). Distribution is quarterly to the membership consisting of 1200 geologists, geophysicists, and geochemists. Additionally, 100 copies are sent to geoscience libraries. Complimentary copies are often mailed to selected addresses from the rosters of other geoscience organizations, and additional copies are distributed at key geoscience symposia. Approximately 20% of each issue is sent overseas.

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NOTES FROM THE EDITORS

Sherman Marsh and Tom Nash

This issue of **EXPLORE** contains articles demonstrating change. Our President Bill Coker has a challenging new position that takes him far from his former base in Ottawa. The Technical Note on geochemical exploration in the former Soviet Union by Boris Kotlyar carries information that once was forbidden, and Boris tells us about just a few of the many opportunities in mineral exploration on that continent. Simpson and Cartwright tell us that despite much work and new instrumentation, problems abound in the seemingly routine analysis for antimony. Garnett and Butler describe a new method for analysis of gold: controversy that is healthy for our science. And, we report on ominous changes in the U.S. Geological Survey and in the Geological Survey of Canada: two proud surveys that are losing political support.

And there are others signs that some things do not change. Once again, the Council elections were disappointing in that only 49% of the eligible voting Fellows cast their ballots. Although this represents about the average turn out for our elections, it is disturbing that only 49% of our Fellows are concerned enough about the affairs of the Association to vote. Voting is one of the rights of a Fellow in The Association of Exploration Geochemists and is a time when Fellows can express their choices and participate in the running of the organization. Basically this election means that 49% of the Fellows are running the organization, whereas the rest have no voice (or chose not to speak). When **EXPLORE** doesn't arrive or the JGE isn't delivered, we hear about it almost at once; when we ask for your vote, over half of you are silent. The Council elections are held every year and we hope that next year participation will be better.

Sherm and Tom

NEWS OF MEMBERS

Bob Beeson, previously with Acacia Resources, has joined North Limited as Chief Geologist, Exploration. Bob is based in Melbourne and can be reached at (03) 207-5111.

Technical Notes

continued from page 1

true in order that valid comparisons may be made using a common, well-understood language during negotiations, subsequent investments, and trading processes in the FSU. A starting point in such discussions should be the concepts of resources and reserves detailed by the U.S. Geological Survey (USGS) and U.S. Bureau of Mines (USBM, now [1996] abolished) in their classification system (U.S. Bureau of Mines and U.S. Geological Survey, 1980).

Many mining companies are primarily interested in facts about deposits, including the availability of reserve data. Reserve calculations in the FSU have been similar to those in the West, except for choice of cutoff grades. Because current price was not an important factor under a socialist economy, cutoff grades were often chosen some what arbitrarily. This information is a result mainly of physical exploration, including drilling and mining. Meanwhile, mining companies (for example, Archangel Diamond, BHP, Gulf International Minerals, Santa Fe Minerals Corp., and many others) recently have been extending their interests from specific deposits to deposit-hosting terranes and prospective areas in the FSU, including Kazakhstan, Russia, Tadjikistan, and Uzbekistan. Prognostic or speculative resources in these terranes are of major importance, and allow explorationists the opportunity to perform preliminary evaluations of the selected terranes and prospective areas. Thus, the availability of geologic maps, results of previous prospecting, and especially data of geochemical surveys become the major sources of information for evaluation. Speculative and prognostic resources in the FSU were based primarily on geological information, in association with geochemical data. For that reason, specifics of geochemical surveys during geological exploration and of the system of prognostic resource estimation employed in the FSU are important.

Prognostic resources in the FSU

Prognostic resources include four classes: mineral potential, P_3, P_2, and P_1 (Table 1-see page 4). Prognostic resources can be part of evaluated or explored deposits but the main usage of prognostic resources is in conjunction with geologic mapping and follow-up physical prospecting for actual deposits. An evaluation of the prognostic resources in an area precedes the determination of the presence of reserves in a deposit, and *in sensu lato*, reserves are primarily part of the resources. The quality of prognostic resource estimates improves and becomes more accurate and reliable from stage to stage during geologic mapping and progress of prospecting by increasing density of geological, geochemical, and geophysical investigations, as well as drilling and trial mining. Estimation of prognostic resources in the FSU is similar to evaluation of potential resources based on deposit models (Cox and Singer, 1986; Kirkham and others, 1993). Descriptive characteristics and selection of respective deposit type or world-wide known analogs (as used in the FSU) or deposit models (as used in the USGS, and the Geological Survey of Canada (GSC)) are similar. The grade and tonnage models with probabilities of undiscovered deposits (as used in the USGS, and GSC) and subjectively inferred range of deposit size (small, medium, or large, as used in the FSU) are major differences between the two systems. Resource estimation based on geochemical data is common in the FSU.

Geochemical surveys during geological exploration

Geochemical surveys accompany geological investigations at all stages of exploration, which, in the FSU, combine specific types, scales, and intensities of geological investigation and result in required products in a certain order. Geochemical surveys and geochemical survey targets have changed over time, according to the most recent geochemical concepts:

- individual anomalies formed the major targets of geochemical surveys until the middle of the 1980s, and geochemical surveys followed certain statistical procedures that allowed a focus on specific anomalous samples by statistical methods;
- complex haloes were the major targets of geochemical surveys from the middle of the 1980s to the early 1990s, and the interpretation of geochemical surveys included the use of computer software that focused on correlations among elements and their zonation, as well as the identification of complex haloes that show specific ratios of distal and proximal metals as indicators;
- geochemical fields, their structure, and an empirical hierarchy of elements in the geochemical fields, which might correlate with certain metallogenic units including ore regions, zones or trends, ore districts, deposits, and ore bodies, became the major targets of geochemical surveys in the 1990s.

Geological exploration, as the term is used in the FSU, includes three major stages: geologic mapping, prospecting, and mining, where the latter is beyond the scope of this short

Continued on Page 5

Technical Notes *Continued from Page 3*

Prognostic Resources in the Former Soviet Union

Table 1

Exploration Stage	Metallogenic Structure	Prognostic Resources Type	Prognostic Resource Description	U.S. Resource Category*
Small-scale mapping (from 1:500,000 to 1:200,000)	Region, zone, or trend (10^{3-4} sq. km)	Mineral, or geological potential, and P_3	Subjectively inferred ("quality assessment") resources of metal in an ore region, which is divided into high, medium and low categories; based on general geological situations, geological structures, rock types, and broad anomalies in stream sediments. Mineralogical potential could be a result of reevaluation of well-known areas on the basis of application new or different deposit models.	Speculative and hypothetical resources**
Large-scale mapping (from 1:50,000 to 25,000)	District (10^{2-3} sq. km)	P_3 (2)	Rough estimated resources of metal in an ore district, which are based on inferred mineralized rocks in cross-sections, haloes in bedrock, broad anomalies in secondary haloes, and geophysical anomalies. These resources may be based on proven or probable applicability of a specific deposit model.	Speculative or inferred resources
Prospecting (>1:10,000)	Deposit (10^{1-2} sq. km)	P_2 (1)	Quantified resources of metal in an ore deposit have been confirmed by presence of mineralized rocks with subeconomic or economic grades in several cross sections, partly based on geochemical haloes in bedrocks (in exposed regions, such as Kazakhstan, Uzbekistan, and eastern part of Russia). These resources are based on proven deposit models, their morphology, tonnage, and grade.	Inferred or indicated resources
Detailed prospecting (or prospect-evaluation)	Bodies (10^{0-1} sq. km)	P_1-(C_2)	Precisely estimated (reserve estimation methods) resources in delineated ore bodies, which are based on detailed geological studies, a network of drill holes, or single mines. Grid spacing of the net depends on deposit type. Model has to be present in three-dimensional view. These estimates provide basic data for preliminary exploration. C_2 is a category of reserve, which is characterized by the lowest grid of mining or drilling.	Indicated or measured resources

★ Geological Survey Circular 831 (1980); ** As shown, categories are overlapping because of inexact correlations between prognostic resources in the former Soviet Union and resource category in USA.

Technical Notes

Continued from Page 3

note. Each stage is subdivided on the basis of scale, and on the basis of required geologic products, where resource and reserve assessment is a major purpose (Table 1).

Geologic mapping includes small- (from 1:500,000 to 1:200,000 scale), and large-scale (from 1:50,000 to 1:25,000 scale) geological surveys. The former were conducted mainly in 1960s and 1970s. Stream-sediment sampling and collection of various types of panned concentrates are the major types of geochemical surveys at this stage. The density of sampling varied from 1 to 0.1 sample per square km. Any geochemical haloes, which could be correlated with an ore region, zone or trend, had to be recognized and ranked during this type of work. It was not required to estimate resources at the time, but recently, small-scale geologic mapping or remapping has been accompanied by a statement of the mineral potential or a P_3 resource assessment of the region being studied, as well as the testing of any previous mineral potential inferred by previous workers.

Large-scale geologic mapping was performed mainly from the 1980s until recent times, and such studies found most exposed deposits. Geological surveys at a scale 1:25,000 are carried out only in mining districts. Large-scale geologic mapping could include various types of geochemical surveys, including broad soil or bedrock sampling with grids that range from 500x100 m to 100x20 m. Rapid drilling of shallow holes along traverse lines in lateritic terranes is common in the colluvial-covered regions of Kazakhstan, Russia, and Ukraine, especially if any unexposed deposits or geologic structures with mineral potential are the major target of the surveys. Other types of geochemical surveys, including plant, groundwater, and soil-gas sampling, are rarely used. Geochemical haloes, which can be correlated with similar haloes in mining districts elsewhere or with individual deposits, are screened, ranked, and tested during this stage. This stage of exploration is accompanied by $P_{2\text{-}3}$ resource assessments and testing of any previous mineral potential, or P_3.

Prospecting includes investigations at different scales, and is represented by prospecting and detailed prospecting (or prospect-evaluation) at scales from 1:25,000 to 1:2,000. Prospecting generally is performed within the boundaries of an already established ore district or mining district or within inferred ore fields or on their flanks. Broad sampling of bedrock on the surface or core sampling in shallow drill holes within the boundaries of the prospect are the major type of geochemical surveys; soil sampling is common also. The density of sampling varies from 500 (100x20 m) to 2,000 (20x20 m) samples per square km. Geochemical haloes, which could reflect the presence of ore deposits, and possible ore bodies are selected during detailed geochemical surveys. These endeavors are accompanied by P_2, P_1, and C_2 resource and reserve estimates and testing of any previous resource evaluations.

Historical cases

Geochemical surveys in the FSU accompanied geological exploration commonly from the 1930s, when the earliest "copper" surveys were performed, and a number of discoveries of porphyry copper and molybdenum deposits resulted from the geochemical surveys. For instance, the Balikti porphyry copper deposit in the Almalyk district (Figs. 1, 2) was discovered after a "copper" survey, which included chip sampling of all scattered sparse outcrops, and widely-spaced shallow drill holes in weakly exposed areas that include cover rocks more than tens of meters thick. This survey was accomplished in 1932-1933 (Zenin, 1937) in an area close to the well-exposed, world-class Kalmakyr, and smaller Dzhanibek and Akchoku copper-gold porphyry deposits, and was one of the first successes of geochemical surveys in the FSU.

Recently, geochemical surveys have focused not only on metal anomalies and halo detection, but on their evaluation, including an evaluation of any inferred resources present, as well as an estimate of the erosion level of any potential mineralization present. Interpolation methods, which are based on comparisons between distribution and content of metals in endogenic haloes, and ore bodies, and metal content in secondary haloes, as well as the possibility of leaching of molybdenum and copper, now are commonly applied during geochemical surveys in the FSU. Calculated metal ratios or coefficients are important in the P_3 and P_2 resource estimations, which may be expressed by the formula: $P = M \times C$, where the P is a prognostic resource, M is a content of metal in a sampled layer, and C is a variable coefficient, which is based on the mobility of the respective metal (molybdenum or copper, for example) in the oxidized zone and soil in the respective climate zone being sampled (arid, humid, or polar). This method was applied to weathered rocks particularly during soil sampling at many porphyry deposits including Kounrad, Koktenkol, Sorskoe

Continued on Page 8

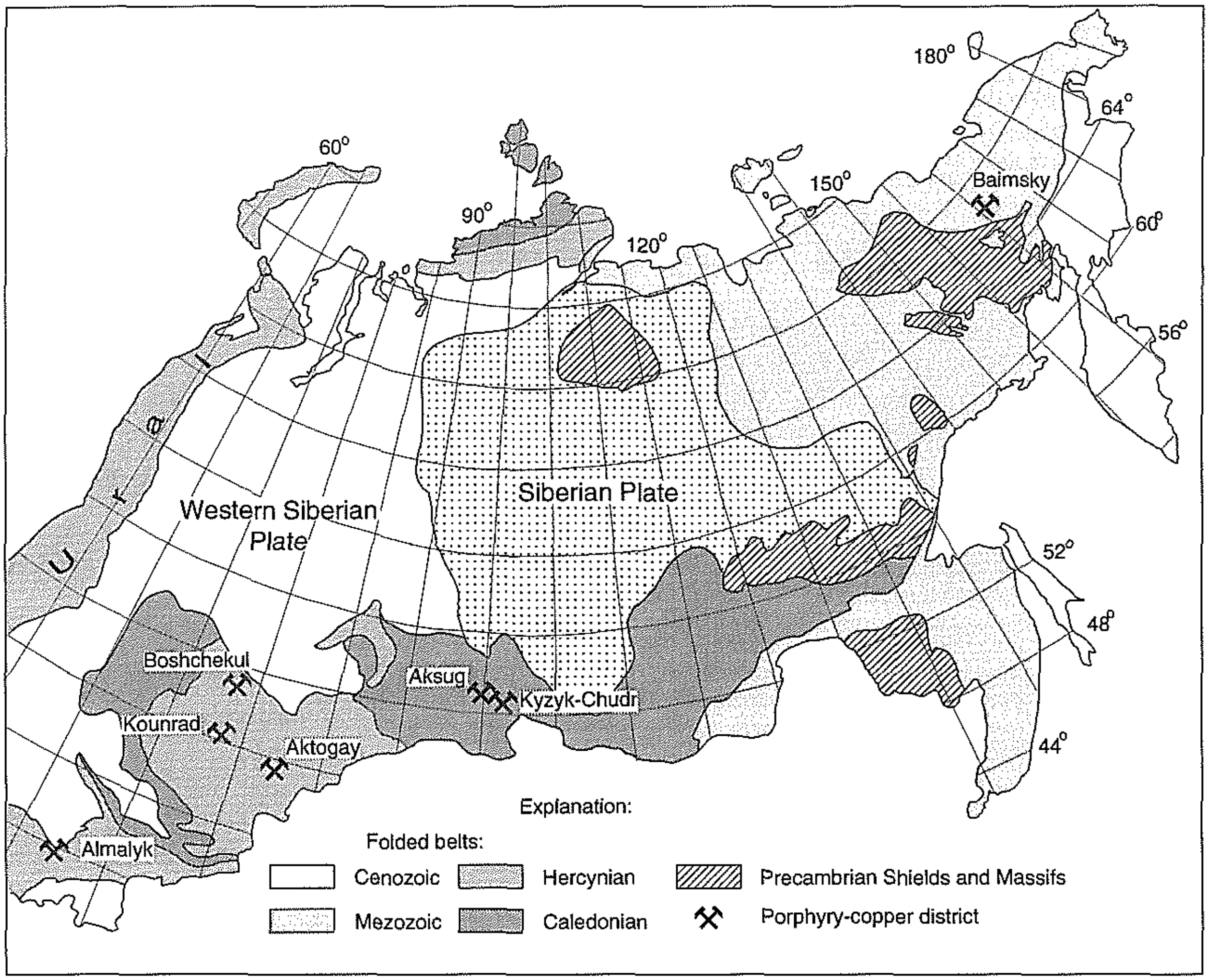

Figure 1. Major porphyry copper districts of the Asian part of the former Soviet Union (modified from Zvezdov and others, 1993).

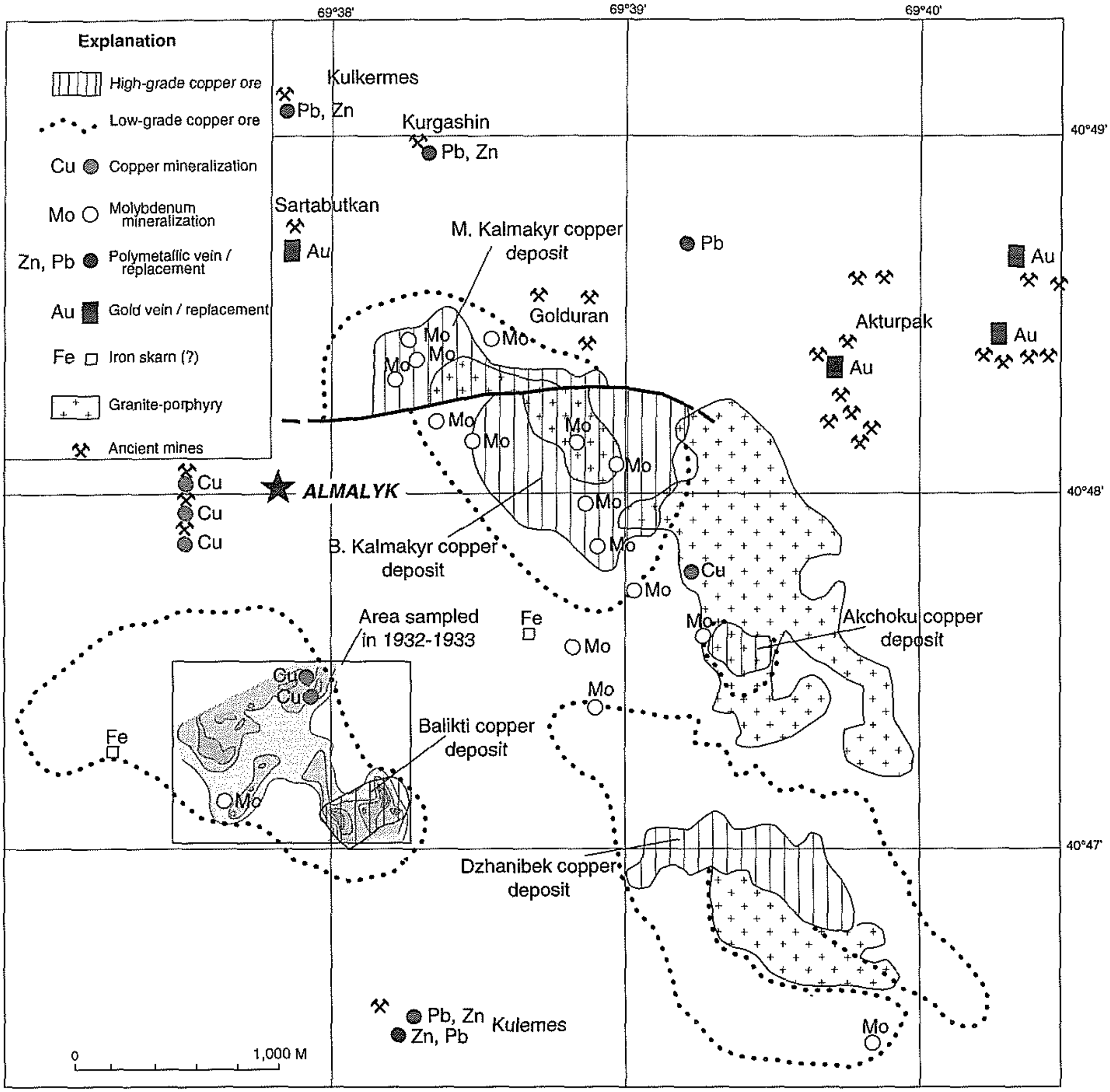

Figure 2. Almalyk porphyry copper district (modified from Zenin, 1937). Increasing intensity of gray shades within the area sampled in 1932-1933 indicates increasing abundance of copper.

Technical Notes

Continued from Page 5

(all in Kazakhstan) (Pokalov, 1984); Verba (Ukraine) (Voynovski and Kotlyar, 1988; Kotlyar and others, 1995); Peschanka in the Baimsky district (Fig. 3) (Kaminskiy and others, 1988), and numerous other mining districts in the FSU (Fig. 1). The Peschanka discovery is significant because it extended the area of porphyry copper potential from Central Asia to the Far East of Russia.

As previously known, the major porphyry copper districts in the Asian part of the FSU were confined to Kazakhstan (Kounrad and Boshchecul districts), and Uzbekistan (Almalyk district). In spite of permissive geologic environments, the Far East of Russia for a considerable time was characterized as having a lack of significant copper and copper-molybdenum deposits (Zvezdov and other, 1993). Small-scale reconnaissance mapping performed in these regions during the 1960s and 1970s discovered only subeconomic low-grade molybdenum-copper deposits in central Kamchatka and Chukotka (Laznicka, 1976). Therefore, it was concluded by many (Radkevich, 1984), that the Russian Far East and the Alaskan part of Circum-Pacific ring are characterized by a general lack of major deposits of copper and molybdenum in comparison with the Central American and particularly South American parts of the ring. Nevertheless, numerous porphyry copper occurrences and deposits were discovered in the Russian Far East during subsequent large-scale geologic mapping and geochemical prospecting, involving significant stream sediment and soil sampling, during the last decade. These prospects are clustered mainly in the Baimsky district (Fig. 1) (Migachev and others, 1984; Kaminskiy, 1987, 1989; Kaminskiy and others, 1988; Nokleberg and others, 1995). The Peschanka deposit (66°35'52"N; 164°29'55"E) contains 940 million metric tonnes of ore at 0.51 percent Cu, and 0.42 ppm Au (W. J. Nokleberg, oral commun., 1996), and its location demonstrates significant potential in this part of the world. Soil samples over the Peschanka deposit are characterized by relatively low contents of copper and other metals over both barren rocks and ore-bearing porphyry monzodiorite (respectively, >50 ppm and 70-120 ppm Cu). The values for other elements analyzed include molybdenum (2 ppm and 3-5 ppm), gold (4 ppb and 10-65 ppb), silver (12 ppb and 17-36 ppb), lead (11 ppm and 16-35 ppm), and zinc (52 ppm and 80-160 ppm). These metal contents in soil at the Peschanka deposit are from 10 to 20 times lower, for example, than respective concentrations in soil samples from the Tanama and Helecho deposits in Puerto Rico (Learned and others, 1992). This relation could reflect significant dispersion and oxidation of copper in a permafrost environment, a process that has been pointed out by other researchers (e. g., Ptitsyn and Sysoyeva, 1988). However, contour maps of these elements exhibit perfect zonation, where a proximal group of metals, (including copper, molybdenum, gold, and silver) form haloes over the major ore bodies, and distal haloes of lead, and zinc, as well as some gold and silver probably reflect polymetallic or gold vein and (or) replacement mineralized rocks.

Continued on Page 10

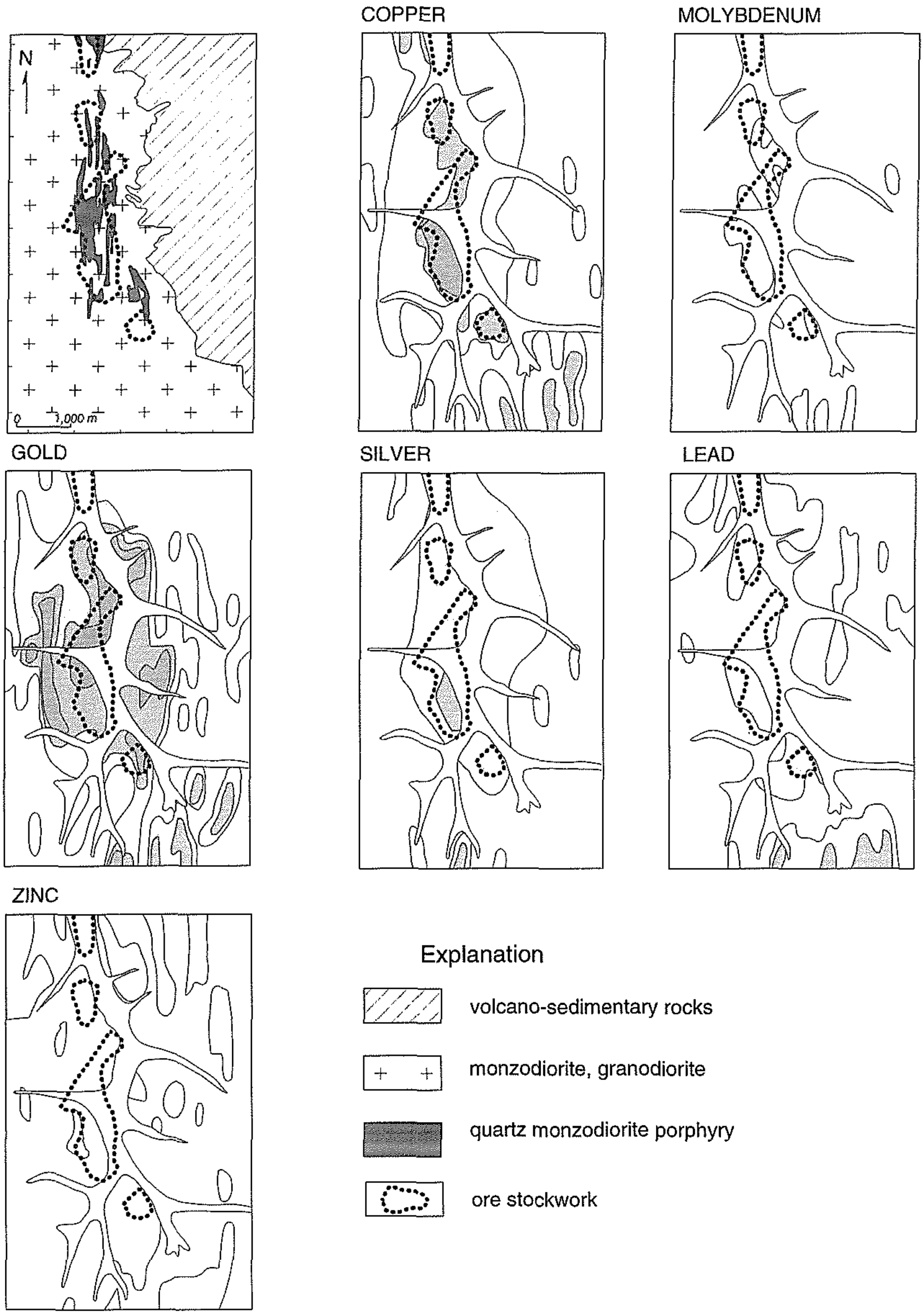

Figure 3. Metal distribution in soils at the Peschanka porphyry copper-gold deposit (modified from Kaminskiy and others 1988; Migachev and others 1984). Increasing intensity of gray shades indicate increasing abundance of respective metals present.

Technical Notes

Continued from Page 8

In addition, there is another factor that affects the discovery of ore-bearing plutons in the Russian Far East. Ore-bearing and altered plutons, which commonly have areas less than 1.5 square km, are typically characterized by relatively high porosity. These rocks generally are confined to small depressions, small valleys, or to the lowest parts of slopes in the present landscape. The rocks do not crop out well and could not have been discovered without geochemical surveys and drilling because of the permafrost. All these data suggest that previous negative evaluations of the copper potential in the Russian Far East could result from a lack of adequate geochemical surveys and drilling.

Conclusion

A general understanding of the various stages of *geological exploration employed and the particulars of* prognostic resource estimates in the FSU is critical to evaluating existing geological information, the accuracy of inferred resource estimates, and the overall level of exploration in certain areas. Nonetheless, in some cases it must be emphasized that prognostic resources P_1, and (or) its combination with C_2, could be compared to indicated or even measured reserves in the USBM and USGS classification scheme, because it was a common practice in the FSU to over-explore mineral deposits (Serenko and Kordestani, 1996) and occurrences.

It is obvious that any long term investment in the mineral industry of Russia today is associated with a variety of risks, including the political situation and an unstable legal framework, economic chaos, cultural differences, and conflict between local and federal interests. There is also some geologic risk for private companies that are interested in concessions in the potential areas. I believe that areas where large-scale geological surveys with prognostic resource estimates with a P_2 designation provide a relatively high risk of investment. In contrast, those areas where prospecting, and especially detailed prospecting (or prospect-evaluation) efforts resulted in prognostic resources classes P_1 and the presence of reserves C_2, provide the safest opportunities for investment.

Acknowledgments

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GEOCHEMISTRY IN BRAZIL

The Fifth Brazilian Geochemical Congress was held at the Federal Fluminense University, Rio de Janeiro, October 23-27, 1995. The well attended meeting included major sessions on : Lithogeochemistry (37 papers, 22 posters), Environmental geochemistry (23 papers, 36 posters), and Isotope geochemistry (22 papers, 3 posters). Other sessions were held on Geochemical analysis and Exploration geochemistry.

The meeting also included invited lectures, round table discussions, and a short course on geochemical mapping. Lectures were given by Dr. A.G. Darnley, Geological Survey of Canada (International Geochemical Mapping) and J. Fortescue (Aspects of Global Geochemistry-1995). The round table discussions were on Perspectives for Geochemical Exploration in Brazil, International Geochemical Mapping (IGM) Project phases I/II. Abstracts and proceedings of the Congress are available on compact disk.

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NEW BOOK BY AEG FELLOW

Natural and Anthropogenic Hazards in Development Planning by Frederic R. Siegel has been published by Academic Press. The monograph deals with a broad range of geoscience issues in development planning, including volcano hazards, earthquakes, landslides, floods, hazardous wastes, and water. Siegel points out that many environmental hazards need to be anticipated in the planning stages of development rather than fixing them when something goes bad. The book can be obtained from Fred (202-994-6194; e-mail: ndfrs@gwuvm.gwu.edu) for $7 or through Academic Press.

ELECTION RESULTS

The Association's annual election of Councilors was in January and four new Councilors were elected. In addition, one previous Councilor was reelected for a second two year term and our "ex officio" President, Gwendy Hall, becomes a Councilor. The newly elected Councilors are; Steven J. Cook, Richard K. Glanzman, Beth McClenaghan, and J. Thomas Nash. Eric F. Weiland was reelected to a second two year term. Out of the 352 Fellows eligible to vote 173 cast their ballots. This represents a 49% voter turn out. Somewhat disappointing but about average for the last few elections.

NOTE ON REGIONAL COUNCILORS

Our thanks to Russell Birrell for promoting the interests of the AEG while he was Regional Councilor for Western Australia. His term has now expired and we welcome Leigh Bettenay and Nigel Radford as joint replacements for this region. We also welcome three other new Regional

Continued on Page 12

Election Results

Continued from Page 10

Councilors: Mark Elliott (eastern Australia); Tawsaporn Nuchanong (south-east Asia) and Yan Guang- sheng (China).

The positions of Regional Councilor Europe, Northern Countries and Southern Africa are currently vacant. Please contact David Garnett or Sherman Marsh if you would like to volunteer for one of these.

David Garnett

REDUCTION IN FORCE AT USGS

In October, 1995, an unprecedented reduction in force (RIF) impacted 775 of 2,192 people in the Geologic Division of the U.S. Geological Survey. The RIF was required when there were insufficient funds for program operations, caused by gradual inflation of salaries and fixed operating costs contrasted with essentially level funding. The RIF resulted in the termination or involuntary retirement of 466 permanent and non-permanent employees, downgrading of 124 positions, and reassignment of 169 people. The RIF impacted scientists and support staff at all USGS centers and field offices, but there was a higher percentage of RIF's at the Menlo Park, CA center. The terminations, demotions, and reassignments were effective October 15, 1995.

Concurrent with the RIF was a structural reorganization that emphasizes several Geologic Division programs, including geologic hazards, characterization of abandoned mine lands, and geologic influences on sources of water supply. Chemical laboratories have been reorganized, staff cut, and many functions transferred to central labs in Denver, CO. Following reorganization the majority of geochemists are now in three programs: 1). global change, 2) environmental aspects of energy resources, and 3) mineral resources surveys that include sub-programs for resource assessment, deposit investigations, geo-environmental studies, and baseline characterization.

The RIF, driven by the need to identify programs with inadequate current and anticipated funds, hit staff of energy and mineral resources programs especially hard. Scientists formerly involved in uranium and radon studies were either reassigned or RIF'ed. Geochemists in applied studies of environmental-geochemical hazards tended to be retained, whereas many ranking pure research geochemists were separated. The current staff of Mineral Resources Surveys is approximately 250, down from more than 600 in 1992, as a result of numerous early retirements, reassignments and separations. Some notable losses were AEG members Howard McCarthy (Reno) and James Erdman (Denver). Fortunately, the USGS expanded its emeritus program to allow hundreds of career scientists including McCarthy, Erdman, T.T. Chao, Gary Nowlan, and Paul Theobald continued use of offices and facilities.

GSC: MAKING A DIFFERENCE IN GEOSCIENCE

A handsome new publication, *Geoscience Making a Difference*, describes the downsizing and redirection of the Geological Survey of Canada (GSC) for many of us who have heard only rumors of change. Although the colorful booklet tries to be upbeat, its best efforts can not brighten the sunset of this productive and relevant organization. The Honourable Anne McLellan, Minister of Natural Resources, introduces the new agenda: "..balancing the need for the best...information...against the long-term federal commitment to fiscal restraint." She continues: "A rigorous rethinking of past services is underway...what has emerged is a validation of the need for a national geoscience infrastructure delivered in collaboration with the provinces and territories." On February 27 major reductions in spending over the next three years were announced: the budget for Natural Resources Canada "will fall from C$1.012 billion to C$435 million. As part of this, the GSC will experience a 32% reduction in overall resources over this period. Reductions of this magnitude mean significant staff reductions and will alter the way the Survey does business." Ouch. Our sympathies to GSC scientists and to industries the GSC has served so well.

New directions include transfer of responsibilities to the provinces and increased cost-sharing with clients. Sadly, this comes at a time when provincial surveys also are struggling for support and the private sector is shifting effort to countries outside North America. The GSC plans to "maintain its commitment to national programs connected to energy and minerals deposits research, resource assessments, marine geoscience, bedrock and surficial mapping, the development of new exploration technology, and research

Continued on Page 13

GSC: Making a Difference...

Continued from Page 12

linked to natural hazards, climate change and groundwater."

Programs highlighted for recent successes include a geochemical survey in the Yukon that led to the discovery of a new polymetallic deposit by Cominco; several geochemical research programs that aid exploration for diamonds and several kinds of metal deposits; studies of seafloor hydrothermal systems and ancient analogues; and geological maps of the world (one of stratiform copper deposits) on CD-ROM. Do we see a paradox here? These and other accomplishments of which the GSC is justly proud were based on years of good support for staff, fieldwork, and lab studies (including essential geochemical work), support that will be difficult or impossible to sustain in austerity. Do politicians and the public believe that effective geoscience can be done from desktops? As the booklet says, "The minerals and metals industry makes important contributions to the economic well-being of Canadians." The GSC has played an important role in the discovery of many ore deposits; the investment in the GSC studies has been repaid many times in taxes paid by the mining companies and thousands of employees in the mining and service industries. The political system must continue to invest adequate funds to make the difference.

Looks like hard times ahead for many friends in Canada. *Too few, with too little, asked to do too much. Good luck.*

JTN

TECHNICAL NOTES

Analysis for Antimony: geochemists beware

Steven Simpson and George Cartwright

INTRODUCTION

Antimony is a common associate of many types of gold deposits and is a potentially useful pathfinder. During the past ten years, exploration geochemists have switched to multi- element packages that provide a large suite of elements at a low price. The current norm, in North America, is to run gold and a multi-element inductively coupled plasma-emission spectrometry (ICP-ES) analysis. However, many geochemists have discovered that an ICP-ES technique does not provide sufficient sensitivity for the determination of Sb.

The crustal abundance of Sb is about 0.2 ppm and Xie and Yin (1993) have pointed out that the threshold value of regional anomalies is 1.0 ppm to 2.0 ppm. This sensitivity is not provided by direct ICP-ES measurement and an alternate procedure is necessary. For Sb, better sensitivity can be obtained by neutron activation analysis (NAA) or by hydride analysis or by using pre-concentration before measurement or by ICP-MS. Most explorationists are not aware that chemical problems cause low and erratic results

Continued on Page 14

Technical Notes

Continued from Page 13

for antimony analysis by these three latter techniques. The consequence is that Sb is often ignored as a pathfinder for gold because analytical problems disguise the true patterns.

Although X-ray fluorescence (XRF) analysis is less sensitive, it still may be an applicable method when the Sb levels are elevated. Both XRF and NAA measurements are normally made directly on solid samples. These physical procedures report total values, although some samples still require extra attention. For exploration samples, NAA may have difficulty with Sb analysis, such as in samples containing arsenic at per cent levels. This may cause peak overlap but the complication is recognized immediately, because NAA is a multi-element technique. Since it is based on radioactive decay, the peak resolution improves when the samples are recounted several days later after the arsenic signal has decayed significantly. A longer-lived Sb isotope can also be used to confirm the result.

Analytical problems exist for all methods of antimony analysis, and we propose no new fool proof innovations. We will discuss the problems and warn geochemists to be careful when selecting a method. For now the best methods are XRF and NAA because they do not encounter problems such as incomplete dissolution or unstable analyte solutions.

RESULTS AND DISCUSSION

The chemical methods (ICP-ES, hydride and pre-concentration) depend upon attacking the sample matrix to put the element(s) of interest into solution and keeping it in solution for measurement. Therefore, chemical techniques are vulnerable to the solution chemistry of Sb and there are significant problems.

Most laboratories are aware that Sb generated by chemical procedures gives consistently low results. Table 1 below lists the values for a mineralized control standard analysed by three techniques over a period of several months by one laboratory:

Technique	Average	Rel. Std. Dev.	No. of Measurements
NAA	70.2 ppm	3%	182
Hydride-AAS*	47.1 ppm	9%	30
ICP-ES*	43.5 ppm	38%	692

*aqua regia digestion

Table 1: Comparison of results from three techniques for a mineralized control sample

These chemical techniques appear to be providing a partial analysis from the aqua regia digestion. The hydride method produces good precision at 67% of the NAA (total Sb) value. The ICP-ES average is also low and, in addition, ICP-ES shows an unacceptable spread of values about the mean. The partial extractions provided by these chemical techniques can still define a geochemical pattern but not if they are inconsistent.

Low results for Sb can be caused by decomposition problems or by instrumental problems. There are good reviews that address aspects of these problems by Bajo (1992), Chao and Sanzalone (1992) and Dolezal, Povondra and Sulcek (1966). One problem is that antimony oxychloride (SbOCl3) hydrolyses over time from an aqua regia digestion. This problem is a concern in a production laboratory because the time between digestion and reading is not always constant. Antimony readings can be undervalued by as much as 90%, if the digests stand for four days before measurement (Figure 1). Although a special digestion with potassium chlorate or tartaric acid can control this hydrolysis, this means that Sb requires separate handling.

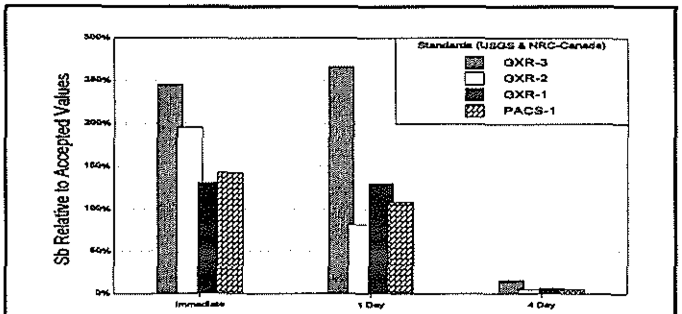

Figure 1: Changes in ICP-ES measurements over time (aqua-regia digestion)

Another analytical problem illustrated here is the use of inappropriate or unsuitable instrumentation. In Figure 1, the initial results for Sb are greater than the accepted values for the standards. These high results may be due to poor calibration procedures and/or interferences in the plasma

Continued on Page 15

Technical Notes

Continued from Page 14

(Jarvis and Jarvis, 1992). The erroneous ICP-ES results shown on the two graphs in Figure 2 are likely due to interferences from other elements.

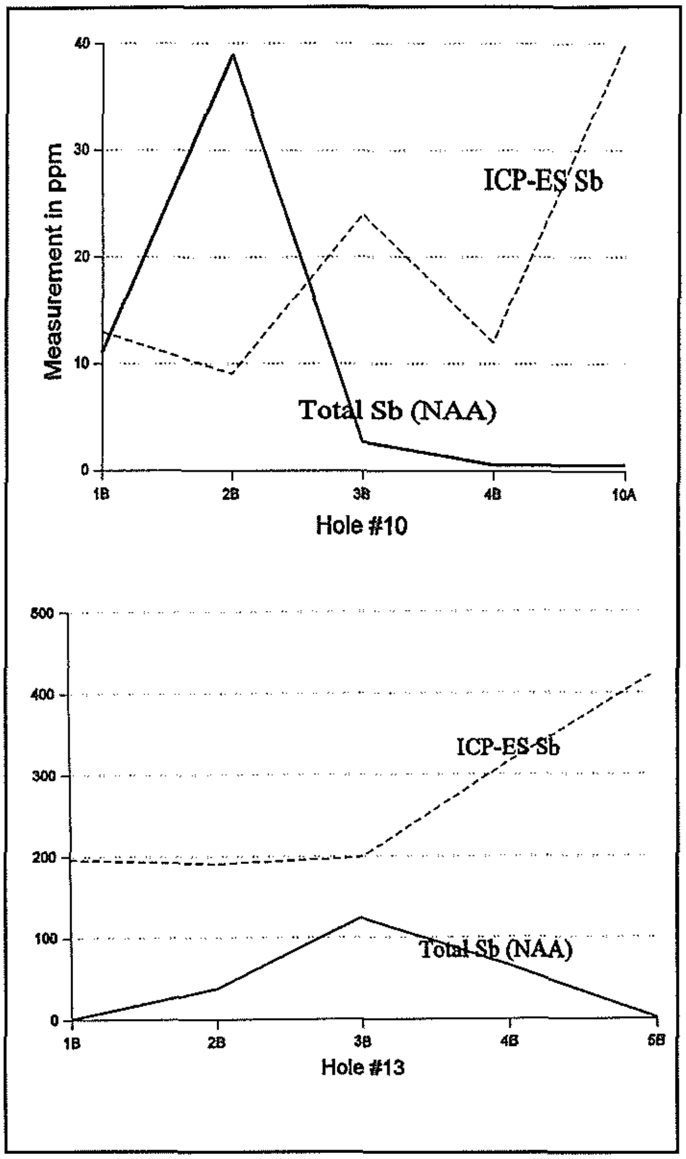

FIGURE 2: Sb by direct ICP-ES vs. NAA on environmental assessment samples

These landfill samples had a high metal content and were analysed by an environmental laboratory using the accepted protocol of an aqua regia digestion. In Hole #13, these results are high by hundreds of ppm. This high bias for the ICP-ES results is likely due to another element giving a false reading for Sb.

Besides the digestion problems, the hydride generation process is very complex and prone to interferences. Most transition metals cause liquid-phase interferences by precipitating as the metal and causing the hydride to break down or by precipitating as metal antimonides. This means that Sb hydride results may be low when the base metals are high. Gas-phase interferences may also occur due to the formation of diatomic particles such as AsSb. Some of these interferences can be controlled, if they are recognised. Hydride analysis for Sb is inexpensive and the perception is that the low detection limits indicate accurate results. However, this technique is not as robust as others such as fire assay for gold, atomic absorption for copper or NAA. These latter procedures are not as affected by different sample matrices or variable analysis conditions.

Figure 3 shows selected results from a series of drill holes samples submitted to different labs for analysis. Only *samples with Sb levels that were 50-100 times background* are plotted. The chemical results are plotted as a percentage of the total results by NAA/XRF. The analysis by chemical techniques did not detect the high Sb values for the samples A-65 through A-235. Note that the two chemical analyses give similar results despite a different digestion and measurement but clearly these are partial analyses. This could still have geochemical relevance, if the partial analysis values are not erratic. However, it is apparent for these samples that the chemical procedures did not provide consistent extractions on different samples. At the top of drill hole A, the extraction is 52% but drops as low as 2%, as one goes deeper, then increases again to 95% at depth. This appears to be a sample dissolution problem.

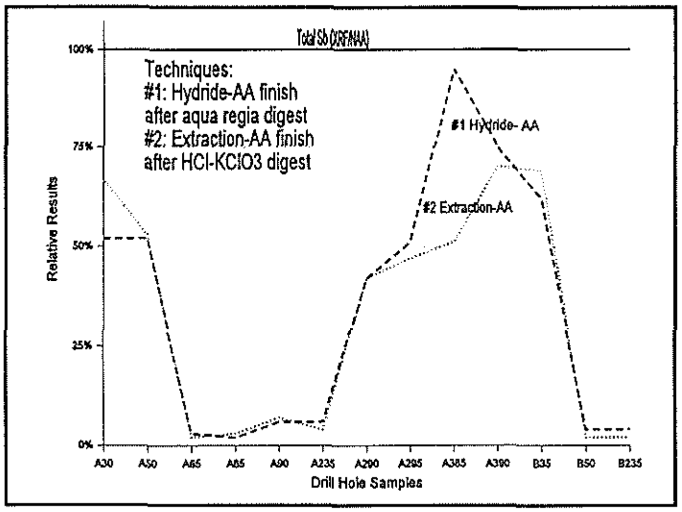

Figure 3. Sb by chemical techniques relative to total Sb

A possible explanation is that the variable extraction is due to changes in the Sb mineralogy. Antimony occurs in many different forms: as sulphides (eg. stibnite); as oxides; as sulphosalts; and combined with metals as antimonides. The mineral acids attack only some of these forms. The physical techniques do not depend upon the form of the Sb. Because a broad mineralogy is often found in hydrothermal systems, a mineral acid digestion is not suitable. Unfortunately, a digestion with a strong oxidant such as perchloric acid may cause loss of Sb by volatilization (Bajo, 1992).

CONCLUSIONS

Antimony analysis using routine chemical techniques often delivers results that have no relationship to the total Sb in the sample. These procedures can suffer from incomplete digestion and/or solution and/or instrumental problems consequently reporting background instead of elevated values. The chemical analyses may provide useful informa-

Continued on Page 16

Technical Notes

Continued from Page 15

tion such as a change in mineralogy but data interpretation is difficult at best. Although routine Sb digestions sometimes provide total values, special digestions or possibly fusions are probably needed for chemical techniques. In contrast, NAA and XRF analysis provide total values for Sb and NAA is commonly used as a reference procedure for the certification of standard materials.

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Gold collector for "No-see-um"/ undetectable gold

by David Garnett and Dean Butler

Geochemists are cautious people. Claims that there is much more gold in a sample than can be measured by conventional techniques tend to be rejected out of hand and little or no attempt is made to explain what might be causing the discrepancy in values. Is there more gold in a sample than is indicated by conventional assays, and if there is not, what is responsible for generating the high values reported by "no-see-um" gold supporters? At the Analytical Methods workshop of the 18th IGES in Townsville Dean Butler described his modified leach technology (MLT). The method was briefly described in EXPLORE No.88. The MLT method has yielded a value of 6.15 ppm Au for Canmet Standard MA2 (recommended value: 1.86 ppm Au), while another sample giving a value of 0.22 ppm Au by conventional analysis gave 14.6 ppm Au using MLT. Too good to be true? Here are details of the MLT gold extraction process and we hope that at least some readers will attempt to replicate it.

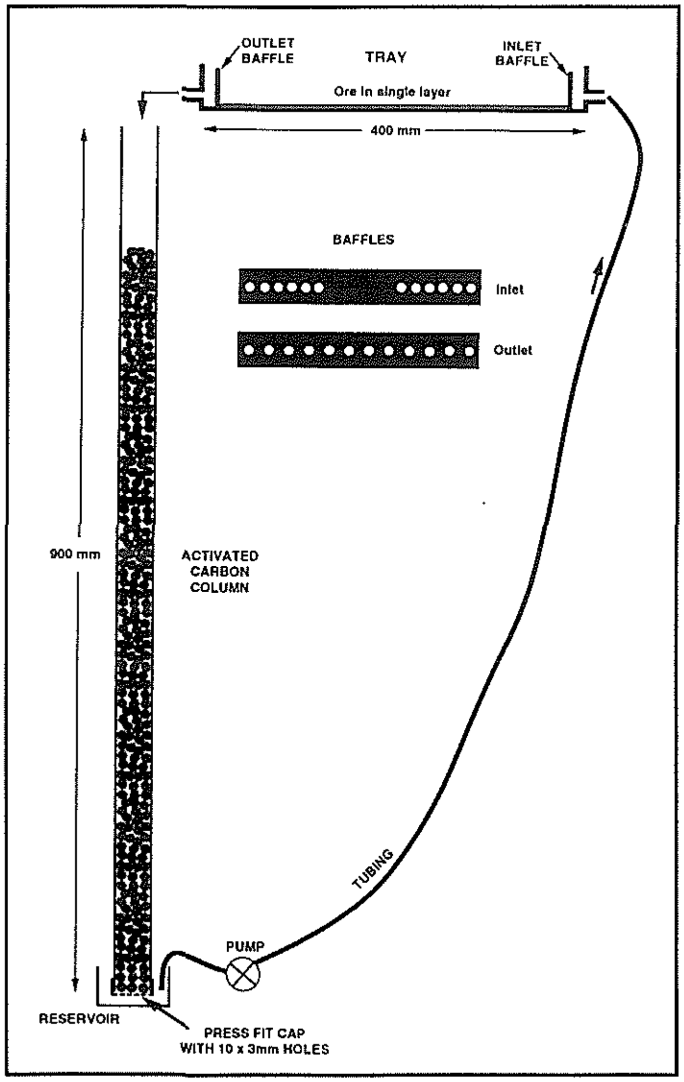

Figure 1. Schematic diagram of apparatus for gold extraction.

The equipment (Figure 1) can be constructed from readily available materials.

1. Plastic tray of approximate dimensions 400mm x 250mm x 50mm.
2. Two baffles made from strips of plastic 250mm wide x 20mm high x 4mm thick, with twelve holes of 3mm diameter at a height halfway up strip. The inflow baffle has the holes offset to the ends so that the entering liquor is deflected when striking the solid section in the centre of the strip. The baffles are glued across the tray approximately 30mm from each end. They are there to prevent

Continued on Page 17

Technical Notes

Continued from Page 16

agitation of the ore particles by the liquor flow. Any floating particles are prevented from fouling the carbon by the baffle at the exit end of the tray. It is of the utmost importance that no ore particles are allowed to be washed into the carbon column.

3. Plastic pipes (about 10 - 13mm black poly pipe irrigation fittings) glued into each end of the tray as close to the bottom of the tray as possible. The inlet pipe is connected to a pump as in Fig 1. An adaptor may be required to connect the delivery hose to the pump. NOTE: The glue used must be of the hot melt type. Do not use two part epoxy or other liquid glues since these can easily scavenge gold from the liquor. For example, jewelers glue can extract enough gold to allow it to be burnished.
4. Activated carbon column. PVC tube (900mm high by 30mm ID) with a push fit cap drilled with 10 x 3mm holes covering the base. This rests in the pump reservoir while the upper end remains open and receives the liquor flow from the tray outlet. Water wash approximately 500ml Pica G210 AS carbon from a freshly opened pack in order to remove fines, using a suitable screen. Place this in the PVC tube.

Extraction of gold is done in the following steps.

1. Size the ore sample to +38 mm (up to about 200 mm is acceptable, but ideally it should be mainly close to 38 mm). Spread about 10g of this between the inlet and outlet baffles on the tray in a layer a single particle thick.
2. Introduce 2.5 to 3 litres of 1 g/L NaCN or KCN into the system and circulate at a flow rate near 500 ml per minute. No other chemicals are used and pH is maintained by the cyanide alone.
3. Circulate the solution for at least three days.
4. Remove the carbon and ash in an electric muffle at 600 C. Digest the ash in aqua regia, extract the gold with DIBK/ Aliquat 336 and read against standards on flame AAS.
5. Analyse the liquor for the very low level of gold it will be carrying. In order to obtain a reliable reading this generally requires acidification of 200 ml of the liquor with 10 ml of HCl in a fume hood, followed by extraction into 5 ml of DIBK.

Dangers of contamination

Extreme care must be taken to avoid contamination, particularly at the ashing and digesting stages. Glassware, crucibles and muffle used in this work should be dedicated solely to it. Both crucibles and glassware should undergo a double contact with aqua regia, with water rinse between. A third aqua regia contact should then register zero Au. The standard contamination test is to carry out the entire procedure, including heating the crucibles in the muffle and aqua regia washing of the cooled crucibles, without carbon present. If the crucibles and glassware have been used in previous gold analytical procedures it will take at least one full cleaning cycle to remove all gold from the utensils. Once the carbon and glassware have reported zero the leaching circuit should also be run, without ore present, first without carbon and then with carbon present. Once the entire circuit has reported zero the extraction is then ready to proceed.

Comment

This approach is somewhat different from many of those reported previously in that it relies on a single, extended extraction to generate the measured gold content of the sample. Previous methods often depended on summing the apparent gold content of many cycles of extractions, using dilute solutions that may well have been close to the detection limits of the analytical system. These would be vulnerable to the claim that the 'gold' reported was simply the sum of a lot of analytical noise. In this case a single measurement is made. Dean Butler has offered to supply a sample that reports about 0.1 ppm Au using conventional analytical techniques. Butler has run this sample using the above, and has obtained about 0.5 ppm Au after three days; about 1.0 ppm Au after five days; or about 2.0 ppm Au after ten days. Contact Butler if you would like to obtain some of this sample or have any queries. Alternatively, use your own sample. Please send any relevant results and/or comments to **EXPLORE**,.

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NEWS AND INFORMATION ON THE WEB

Many new sites on the World Wide Web provide information of interest to geochemists at no charge. The AEG will soon have a site, thanks to the efforts of Gwendy Hall and Erik Grunsky. Two sites of possible interest include: 1). NEWSMINE, for distribution of mining-related news releases at: www.info-mine.com 2). MINE DRAINAGE Interest Group, chiefly scientists in the USGS, at: http://www.water.wr.usgs.gov/mine/home.html.

Readers who have found useful web sites are encouraged to spread the word through EXPLORE. Just send a short note to Sherm or Tom.

CALENDAR OF EVENTS

International, national and regional meetings of interest to colleagues working in exploration, environmental, and other areas of applied geochemistry.

■ Apr. 15-19, '96, **Integrated Mining and Land Reclamation**, short course, Reno, NV (Yung Sam Kim, Nevada Institute of Technology, Box 8894, Reno, 89507; TEL:(510)-757-2000; FAX: (510)-757-7997).

■ April 22, '96, Societal Needs and the Environment: **Earth Sciences and Public Health**, Forum, Washington, D.C. (Frederic R. Siegel, Department of Geology, George Washington University, Washington, D.C. 20052; FAX: 202-994-0450; E-mail: NDFRS@GWUVM.GWU.EDU)

■ Apr. 22-23, '96, **New Developments in Metallogenic Research**, Townsville, Queensland, Australia, by EGRU (Pat Williams, TEL: 077/815223; FAX: 077/251501)

Continued on Page 18

Calendar of Events

Continued from Page 17

■May 19-21, '96, **Industrial Minerals**, ann. forum, Laramie, Wyoming (Ray E. Harris, Wyoming State Geological Survey, Box 3008, University Station, Laramie, 82071; TEL: (307)-766-2286; FAX: (307)-766-2605).
■May 27-29, '96, **Geological Association of Canada/ Mineralogical Association of Canada**, joint ann. mtg., Winnipeg, Manitoba (G.S. Clark, Dept. of Geological Sciences, University of Manitoba, Winnepeg, R3T 2N2; TEL: (204)-474-8857; FAX: (204)-261-7581).
■July 22-28 '96, **Geochemistry of the Earth's Surface**, int'l symp., Ilkley, Yorkshire, England (GES-IV Conference Secretariat, Dept. of Continuing Professional Education, Leeds University, Leeds LS2 9JT, England; TEL: 01132-333-241; FAX: 01132-333-240)
■July 29-Aug. 2, '96, **Proterozoic Evolution** in the North Atlantic Realm, Goose Bay, Labrador, by Int'l Basement Tectonics Assn. (Charles F. Gower, Newfoundland Department of Natural Resources, P.O. Box 8700, St. John's, Newfoundland A1B 4J6, CANADA; TEL: (709) 729-2118; FAX: (709) 729-3493; E-mail: cfg@zeppo.geoserv.gov.nf.ca)
■Aug. 4-14, '96, **30th International Geological Congress**, Beijing, China (Prof. Zhao Xun, Deputy Secretary General, 30th International Geological Congress, P.O. Box 823, Beijing 100037, P.R. China; TEL: 86-10-8327772; FAX: 86-10-8328928; E-mail: zhaox@bepc2.ihep.ac.en)
■Sept. 4-11, '96, **Age and isotopes of South American Metallogenic Provinces**, mtg., Salvador, Bahia, Brazil (M. Zentilli, Department of Earth Sciences, Dalhousie University, Halifax, B3H-3J5, Canada. TEL: (902) 494-3873; FAX: (902) 494-6889; E-mail: marcos.zentilli@dal.ca)
■Sept. 17-19, '96, **Andean Geodynamics**, int'l mtg., St. Malo, France (Denis Gapais, ISAG '96, Geosciences Rennes, Université Rennes 1, 35042 Rennes cedex, France; FAX: (33) 99 28 67 36; E-mail: isag96@seth.univ-rennes1.fr)
■Sept. 22-25, '96, The **Interactions between Sediments and Water**, 7th Int'l Symp., Baveno (Stresa), Italy (Dr. E.D. Ongly, NWRI, 867 Lakeshore Rd., P.O. Box 5050, Burlington, Ontario, Canada L7R 4A6; TEL: (416) 336-6439; FAX: 7th Int'l Symp. in Italy: 39-2-33220299)
■Nov. 10-14, '96 **Society of Exploration Geophysicists**, mtg., Denver (AAPG Convention Dept., Box 979, Tulsa, OK 74101; TEL: (918) 584-2555)
■May 19-21, '97, **Geological Association of Canada/ Mineralogical Association of Canada**, joint mtg., Ottawa, Ontario (Secretariat, Geological Survey of Canada, Room 757, 601 Booth St., Ottawa, K1A 0E8; TEL: (613) 947-7649; FAX: (613) 947-7650; E-mail: ottawa97@emr.ca)
■May 25-29, '97, **18th International Geochemical Exploration Symposium**, Jerusalem, Israel (Organizing Committee, International Geochemical Exploration Symposium, P.O. Box 50006, Tel Aviv 61500, Israel; TEL: (972 3) 5140014; FAX: (972 3) 5175674/660325; E-mail: iges@mail.gsi.gov.il)
■Sept. 14-18, '97, Fourth Decennial **International Conference and Exhibition on Mineral Exploration** with a theme of **Geophysics and Geochemistry at the Millenium**, Toronto, Canada
■Oct. 5-10, '97, 4th **International Symposium on Environmental Geochemistry**, Vail, Colorado (4th ISEG, c/o USGS/ CEGG, Federal Center, Box 25046, MS 973, Denver, CO 80225; FAX: (303) 236-3200; E-mail: iseg@helios.cr.usgs.gov)
■June 29-July 1, '98, **International Platinum Symposium**, IAGOD/CODMUR, Johannesburg, South Africa (C.A. Lee, Box 68108, Bryanston 2021, South Africa; TEL: (2711) 4112253; FAX: (2711) 6923693)

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

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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, Colorado 80225, U.S.A.

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

FELLOW

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Geochemist
Steffen, Robertson and Kirsten
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Continued from Page 18

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RECENT PAPERS

The list comprises titles that have appeared in major publications since the compilation in **EXPLORE** Number 90. Journals routinely covered and abbreviations used are as follows: Economic Geology (EG); Geochimica et Cosmochimica Acta (GCA); the USGS Circular (USGS Cir); and Open File Report (USGS OFR); Geological Survey of Canada Papers (GSC Paper); and Open File Report (GSC OFR): Bulletin of the Canadian Institute of Mining and Metallurgy (CIM Bull); Transactions of Institute of Mining and Metallurgy, Section B: Applied Earth Sciences (Trans IMM). Publications less frequently cited are identified in full. Compiled by **L. Graham Closs**, Department of Geology and Geological Engineering, Colorado School of Mines, Golden, CO 80401-1887, Chairman AEG Bibliography Committee. Please send references to Dr. Closs, not to **EXPLORE**.

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Contributors's deadlines for the next four issues of **EXPLORE** are as follows:

Issue	Publication date	Contributor's Deadline
92	July 1996	May 31, 1996
93	October 1996	August 31, 1996
94	January 1997	November 30, 1996
95	April 1997	February 28, 1997

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Introduction

Since the 3rd Symposium in Krakaw, Poland, 1994, interests in envirnmental geochemistry have developed in areas that are driven by human and ecosystem health considerations. For example, in the Rocky Mountains of North America, abandoned mines on public lands and mine drainaige that affects surface and ground water resources, as well as wildlife, are of great concern. Air quality is being affected by rapidly growing urban centers and the high reliance on the automobile for transportation. Radon gas that is emitted naturally from certain geologic terranes is being mapped and the effect is might have on human health is debated. Hazardous materials disposal (including radionuclides) remains a hotly debated issue and an understanding is needed of the processes and technologies that confine toxins. Experience has shown that interaction needs to be strengthened between scientists and regulators of environmental laws—especially at this time when revisions to laws are being made.

Proposed Themes

1. Environmental analytical techniques
2. Mine-drainage formation and geochemistry
3. Use and determination of baselines and backgrounds
4. Natural and man-made radiogenic hazards
5. Methods of geochemical monitoring, modeling, and mapping
6. Geomedical research
7. Industry/government cooperation
8. Environmental models (mineral deposits, global change, pollution migration, waste disposal)
9. The "acid" problem (air deposition, natural and mine drainage, ecosystem buffering)
10. Trace substances, ecosystems, and bio-accumulations
11. Environmental geochemistry and health
12. The importance of geology in environmental geochemistry.

Venue

The Westin Resort and Convention Center, Vail, Colorado, is located 160 km west of Denver, Colorado, in the scenic Rocky Mountains. It is easily accessible by public transportation from Denver International Airport (DIA). Vail village is world-renowned for its beauty, outdoor activities, shops, and accommodations.

Accommodations

Full details and a booking form will be included in the next circular. The Westin Resort in Vail is a 5-star hotel with more than 300 rooms and first-class meeting facilities. They are offering a very attractive conference rate for this Symposium.

Publishing

Papers presented by invited and volunteer speakers and poster presenters will be published, following peer review, in special issues of Environmental Geochemistry and Health and (or) the Journal of Exploration Geochemistry.

Deadlines and Key Dates

Return of First Circular	Jan. 1, 1996
Second Circular mailing/call for papers	June 1996
Submission of abstracts	March 1997
Final registration and payment	March 1997
Confirm payment and hotel	May 1997
Final Circular and preliminary program	July 1997
Submission of manuscripts	Oct. 6, 1997
Symposium	Oct. 6, 1997
Publication of papers	July 1998

Language

English

Registration Fees

This information will be included in the Second Circular.

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