

# EXPLORE

Newsletter for the Association of Exploration Geochemists

NUMBER 85

OCTOBER 1994

## PRESIDENT'S MESSAGE

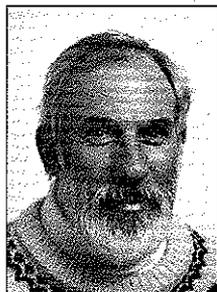
Two letters in the previous issue of **EXPLORE** have prompted musings on the funding of research and its effect on exploration geochemistry.

I have been privileged to work in a research organisation which has made many valuable contributions to exploration geochemistry. At the same time, I have had the opportunity to visit similar research organisations throughout the world many of which, like CSIRO, have received the majority of their funding directly from government. As a result of innovative research in universities, government instrumentalities, industry and consultancies, geochemical exploration is a mature science and many of its techniques are being applied in other fields.

Because of the significant improvements to, for example, exploration techniques, analytical equipment and high-speed computation of complex data sets, our founding fathers such as Goldschmidt and Vernadsky would have great difficulty in recognising the present practices of exploration geochemistry. These changes have not occurred overnight, but through a process of observation, learning, application, testing and communication, and often at significant cost to governments which until recently had a vision of national good.

However, funding of research in developed countries has undergone significant change thanks to the economic rationalists. Finance for basic research has dwindled and the user-pays principle means that research time is directed towards consultancies, problem-solving and seeking funding sources. All this can result in, is eventual intellectually bankruptcy. Other consequences are a marked decrease in the number of research institutions and teaching of exploration geochemistry, reduced communication due to industry confidentiality requirements, and loss of individuals 'free' time for refereeing, editing, preparation of conferences, field trips, workshops etc., or to the running of societies. We in the Association are facing such problems at the moment.

What research opportunities exist? Both letters in the recent **EXPLORE** highlight the sharp focus of AEG in fostering and improving the applications of geochemistry to exploration for mineral deposits. There is no doubt that we can further improve our exploration techniques, develop new analytical methods and find new and faster means to analyse the data. We can then apply these techniques to the search for natural resources in those countries with burgeoning foreign debts and rapidly increasing populations, where the need to develop natural resources is paramount to economic



survival. But how much of this is returned to the people in the form of a better standard of living?

For those of you who have read "Breakthroughs", by Nayak and Ketteringham of Arthur D. Little, Inc., some of the most innovative research has been done with minimal financial resources and often not directed at a specific need. The current trend of funding multi-disciplinary research may indeed focus on other clients but it would be amazing if we did not discover something of benefit to the exploration industry. Who knows, we might come up with the exploration equivalent of the Sony Walkman or 3M's Little Yellow Note Pads, whilst at the same time improving the environment, growing better crops, and generally improving the standard of living throughout the world.

Graham Taylor

## TECHNICAL NOTES

### Natural Aggregate - New Opportunities for Geochemists

The subject of industrial rocks and minerals traditionally has lacked the prestige commonly associated with most other fields of geology. Of the industrial rocks and minerals, the truly humble material is natural aggregate — crushed stone and sand and gravel. Most professional geologists, even those who work in the mineral-resource field, commonly ignore natural aggregate in favor of other more glamorous aspects of the geology; however, Robert L. Bates (1969) pointed out in the introduction to his book on the Geology of Industrial Rocks and Minerals, "The student of geology will find that the variety of processes involved in the formation of the industrial rocks and minerals, together with the problems

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## Information for Contributors to EXPLORE

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

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

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

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

All contributions should be submitted to:

### EXPLORE

c/o USGS, Box 25046, MS973, Denver Federal Center  
Denver, CO 80225, USA

## Information for Advertisers

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

EXPLORE is the most widely read newsletter in the world pertaining to exploration geochemistry. Geochemical laboratories, drilling, survey and sample collection, specialty geochemical services, consultants, environmental, field supply, and computer and geoscience data services are just a few of the areas available for advertisers. International as well as North American vendors will find markets through EXPLORE.

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# EXPLORE

Newsletter No. 85

OCTOBER 1994

Editor: Owen P. Lavin (303) 837-5820

Associate Editor: Sherman P. Marsh (303) 236-5521

Assistant Editors:

Steve Cone (303) 232-8371

Anne M. Leibold (303) 295-1101

J. Thomas Nash (303) 236-5515

Fredrick P. Schwarz (702) 758-9234

J. Stevens Zuker 011 (5655) 28 2164

FAX (303) 236-3200, ATTN: Sherman Marsh, USGS

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## NOTES FROM THE EDITOR

Now for something different. This issue of EXPLORE features our first article on natural aggregate. For those of you who may think this is out-of-place in a newsletter for exploration geochemists, I suggest you read the interesting and informative article by William Langer. This article is another timely reminder that geochemistry is an integral part of the world we live in.

Acting on a prompt from EXPLORE editors, Chinese authors have contributed their first article to EXPLORE. Readers interested in platinum-group elements will want to read the article by Zu Jiale et al.

Despite the gloom and doom predictions for exploration geochemistry in the future, major North American laboratories are reporting their best years since 1988. Surprisingly, only a small portion of this business is from South America. Anyone trying to get rapid turn-around in September will attest to this. Further, this issue of EXPLORE features an advertisement for a field-oriented geochemist. The truth is, "exploration geochemistry is alive and well". Because no young people are entering the field, I predict from this time forward that there will be a shortage of geochemists who are willing to work closely with exploration geologists in places that may not always be dry and comfortable. This will "catch up" to us very soon, if it has not already. Being an exploration geochemist should not necessarily mean that your hair is either white or gone. It is up to us to encourage young geologists to specialize in the very effective methods of geochemical exploration. Who else will help us out of the field every evening as we get lost more and more frequently?

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

Issue	Publication date	Contributor's deadline
86	January 1995	November 30, 1994
87	April 1995	February 28, 1995
88	July 1995	May 31, 1995
89	October 1995	August 31, 1995

Owen Lavin  
Editor EXPLORE



## Technical Notes

*Continued from Page 1*

of discovery and exploitation, make this broad field fully as fascinating as any other. In addition, for the inquisitive — and acquisitive — geologist, engineer, or chemist, there are innumerable beckoning avenues of research in the further use and adaptation of the industrial rocks and minerals." This article discusses one of the industrial minerals — natural aggregate — and identifies some of the beckoning avenues of geochemical research that relate to aggregate.

Natural aggregate makes up approximately half the volume of mined material in the United States. Over the past two decades aggregate usage has averaged approximately 2 billion tons per year, or approximately 8 short tons per person per year. In terms of dollars, aggregate production had a combined value during 1992 of approximately \$8.5 billion, which by far exceeds that of iron ore (\$4.1 billion), copper (\$4.2 billion), or the combined value of gold, silver, and the platinum-group metals (\$4.2 billion) (U.S. Bureau of Mines, 1993).

Crushed stone and sand and gravel are most commonly used as aggregate in the construction industry. As an example, an average six-room house requires approximately 90 tons of aggregate, and a four-lane interstate freeway requires approximately 85,000 tons of aggregate per mile. Municipal projects such as public buildings, bridges, dams, and airports require large quantities of aggregate, and as an example, the new Denver International Airport required approximately 5 million tons of aggregate (Langer and Glanzman, 1993).

Although geochemists are not commonly involved with the end-use of mineral resources, they can make significant contributions to research in new market areas for aggregate and aggregate byproducts. As an example, a variety of innovative uses for pond screenings (the fines washed from aggregate as it is processed) could be enhanced by geochemical studies (Stokowski, 1993). Certain types of pond screenings may be suitable for environmental uses such as controlling or limiting acid-mine drainage and controlling SO<sub>2</sub> emissions (Kumar and Hudson, 1993). Some pond screenings contain trace minerals that make them effective soil amendments. Geochemists could investigate the effectiveness of these applications, as well as research the chemical processes related to the use of these materials.

Natural aggregate varies greatly in quality, depending on the source. Suitable aggregate is composed of essentially clean, uncoated particles of proper size, shape, strength, and durability. Aggregate commonly is considered to be an inert filler, and, as such, should not change chemically once in place. Research in cement concrete technology shows, however, that many rocks contain minerals that react with or otherwise affect cement concrete. One of the most destructive chemical processes is the alkali-silica reaction (ASR). Under specific conditions, certain high-silica minerals readily react with the alkali hydroxide solutions in the cement pastes, producing alkali-silica gel. By water uptake, gel causes expansion of the aggregate and subsequent deterioration of the concrete (Dolar-Mantuani, 1983). Although the ASR has been extensively studied, there is a need for continued geochemical research.

In asphaltic concrete, the electrochemical properties of rock relate to the ability of the bitumen to adhere to the aggregate. Many investigators agree that siliceous aggregates become negatively charged in the presence of water (Hoiberg, 1965). In contrast, some types of aggregate such as limestone and other calcareous materials have a positive surface charge in the presence of water. Some rocks contain both silica, which imparts a negative charge, and calcium, magnesium, aluminum, or iron, which permits the surface to have a positive charge. The positive molecules in the water lower the interfacial tension and consequently lower the adhesion tension (Smith and Collis, 1993). If the electrochemical properties of the rock are known, additives can be mixed with the bitumen to prevent or limit stripping. Geochemists commonly investigate the electrochemical properties of rock and water-rock interactions and can apply those techniques to characterizing the electrochemical properties of aggregate and studying of processes related to the stripping of bitumen from aggregate.

Not only do geochemists research the alkali-silica reaction problems, they also utilize areal geochemical studies to help identify and characterize potentially reactive source rocks (and sand and gravel derived from those rocks) in the field. The metastable silica minerals opal, tridymite, and cristobalite, as well as the volcanic glasses, are among the most reactive varieties of rocks. Chalcedony is less reactive, and quartz is far less reactive than the metastable silica minerals. The expansion of chalcedony may be relatively slow, and that of quartz very slow; these two minerals usually produce less gel than the metastable silica subgroup

## PACRIM '95

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Abstracts due 31 December 1994

PACRIM '95 will examine the geology and ore deposits of the dynamic environment of the Pacific Rim. It will also examine the political, economic and environmental constraints on mining and exploration in this area of increased investment. The Congress will have eight main themes.

1. Metallogeny at plate boundaries
2. Case histories of recent discoveries
3. Mining and the environment
4. Mining geology: problems and solutions
5. Mining and metallurgy
6. Political and economic constraints
7. Structural geology, tectonics, geophysics and geodynamics
8. Petrology, geochemistry and volcanology

Abstracts (no more than 500 words) due by 31 December 1994. Abstracts and papers will be published in a proceedings volume which will be available at the conference. To express interest, and for more information: Mrs. Charmayne Perera, The Australasian Institute of Mining and Metallurgy, P.O. Box 660, Carlton South, Victoria 3053, Australia Phone: +61-3-662-3166, Fax: +61-3-662-3662 or E-mail: J.Mauk@auckland.ac.nz

## Technical Notes

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(Dolar-Mantuani, 1983, pg 87-88). Reactive volcanic rocks include shallow intrusive rocks that have a glassy or partially glassy groundmass such as cryptocrystalline, devitrified rhyolite, dacite, latite and some andesite, related microcrystalline porphyry, and tuff. The reactivity of these rocks is caused by the composition and texture of the groundmass and is enhanced by the large internal specific surface that develops when the volatile constituents of the rocks expand during eruption (Dolar-Mantuani, 1983). By understanding these relationships, the geochemist can help predict the location and characteristics of potentially reactive sources of aggregate.

Although a variety of laboratory tests are available to identify potentially reactive aggregate, the economics of scheduling construction projects sometimes conflicts with the extended time required for comprehensive tests. The construction industry has been forced to use such data as are available and to depend on service records of material that presumably has the same characteristics. These savings of time can have severe consequences. For example, concrete made with rocks containing the phyllosilicate mineral vermiculite (such as graywacke, phyllite, argillite, and siltstone) reacts very slowly, and expansion continues for many years. In Nova Scotia, concrete structures containing these rocks began forming expansion cracks after twelve years, and the cracks continued to form and widen at a

significant rate for 30 years or more (Dolar-Mantuani, 1983). In order to address the issue of slow, long-term reactions, the aggregate industry needs reliable methods to predict alkali reactivity. What distinguishes geologic studies from other resource investigations is the ability to predict geologic parameters without extensive sampling and testing. For example, the chemical properties of aggregate are closely related to its suitability for use in portland cement concrete. Through knowledge of the chemical and physical properties of key rock types, and by relating these properties to appropriate classification schemes, it may be possible to anticipate specific properties of potential aggregate resources prior to commencing extensive tests.

The interdependence of aggregate occurrence, physical and chemical properties, economics, technology, and policy is a complex topic understood only by serious students of the subject. Even professional geologists who work in the field of industrial minerals are inclined to overlook the difference between resources and supplies. The existence of an adequate aggregate resource base is only the first step in development of the resource. To actually produce and deliver aggregate also requires adequate public policy. Geologists can help to develop this policy. Geologists clearly have the responsibility to provide the earth-science information on which to base policy decisions. They also have the responsibility to communicate and explain that information to the policy makers. Beyond that, participation generally functions through the democratic process. For the geologist as a citizen, it remains a personal issue. It is time to shift paradigms, to implement new ideas and methods, to get involved. In doing so, the inquisitive geologist, engineer, or chemist, will soon recognize numerous challenging opportunities that make natural aggregate a subject as fascinating and rewarding as most any other aspect of geology.

### REFERENCES

- Bates, R.L., 1969, *Geology of the industrial rocks and minerals*: New York, Dover Publications, Inc., 459 p.
- Dolar-Mantuani, Ludmila, 1983, *Handbook of concrete aggregates, a petrographic and technological evaluation*: Park Ridge, N.J., Noyes Publications, 345 p.
- Hoiberg, A.J., ed., 1965, *Bituminous Materials — Asphalts, tars, and pitches, v. 2, pt 1*: New York, Interscience Publishers, 390 p.
- Kumar, D.S., and Hudson, W.R., 1993, *Potential uses for quarry fines*: Washington, D.C., National Stone Association, *Stone Review*, v. 9, no. 3, p. 13-15.

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## Technical Notes

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- Langer, W.H., and Glanzman, V.E., 1993, Natural aggregate — Building America's future: U.S. Geological Survey Circular 1110, 39 p.
- Smith, M.R., and Collis, L., eds., 1993, Aggregates — Sand, gravel and crushed rock aggregates for construction purposes: London, Geological Society Engineering Geology Special Publication No. 9, The Geological Society, 339 p.
- Stokowski, Steven, Jr., 1993, The many uses of pond screenings: Rock Products, v. 96, no. 1, p. 37-43.
- U.S. Bureau of Mines, 1993, Mineral commodity summaries: U.S. Bureau of Mines, 202 p.

This article is an excerpt from a presentation made at the 30th Forum on the Geology of Industrial Minerals, Halifax, Nova Scotia, Canada.

**William H. Langer**  
*U.S. Geological Survey*  
 MS 913, P.O. Box 25046  
 Denver Federal Center  
 Denver, CO, U.S.A. 80225-0046



## LETTERS

Dear Sir:

I read with interest Adrian Smith's letter in the July issue of **EXPLORE** (No. 84) concerning the Association and its focus, or lack thereof.

Governments should, and often do, respond to the wishes of their electorates. One of the recurrent messages that has been passed to politicians around the world is to do a better job of maintaining our environment. Geochemists in government are now becoming part of the solution, we have an intimate knowledge of the distributions of elements in the natural environment and the processes which control these distributions. This permits us to bring our geochemical expertise on natural chemical dispersion processes into environmental forums so that regulations, as unpopular as they may be, will be set in place that reflect nature's processes. We all laugh with derision at regulations that mandate levels in the environment that are lower than those that occur naturally. The very fact that these regulations came into place marks a failure of the geological and geochemical community to communicate what we have learned of natural processes to the regulators. In many countries it has been a long struggle for us to be listened to in the policy making process. We have been perceived as part of the problem, those with strong views and loud voices have equated geology with mining, and therefore we were not to be trusted or listened to. The time is long past when we can afford to snipe from the sidelines, if the situation is to be improved we have to become involved.

At the Geological Survey of Canada a number of us have been working with the Federal Department of Environment in preparing a national policy on both synthetic and naturally occurring toxic substances. This involvement has been

strongly supported by the Mining Association of Canada. It is clear, to us at least, that helping to establish a policy framework that recognizes that the background levels of naturally occurring toxic substances vary spatially as a result of geological, pedological and other natural processes, is as much a service to the mining industry, who will have to mine and remediate within that policy framework, as completing another geochemical map or developing a new analytical procedure. By such actions we hope that, to quote Adrian Smith, "Environmental geochemists (will not have to) spend their lives responding to ever increasing bizarre regulatory impositions and numeric criteria which have almost nothing to do with science ..."

Where does this put the Association and its members? I think we have to take a broader view. I expect many of us believe we have a commitment to the mining industry, the provision of mineral resources, and the application of geochemistry to society, that goes beyond the strict confines of exploration geochemistry or geochemical prospecting as defined 30 or 40 years ago. I have always considered myself an "Applied Geochemist" wanting to apply my knowledge to any pertinent problem. In the light of the current discussions, I admire the foresight of the institution that awarded me my graduate degree almost 30 years ago in Applied Geochemistry - not Exploration Geochemistry. I regret now that when we formed ourselves that we did not call ourselves the Association of Applied Geochemists, but that is all water under the bridge. There are few major differences in the science, study of processes, and even procedures, employed in exploration and environmental

### Discovery Oriented Geochemist

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## Letters

*Continued from Page 5*

geochemistry; the differences are in the initial mind sets of the investigators and how they approach problems. There is a clear need for the application of our knowledge in the environmental arena and establishing environmental regulations. Interestingly, the converse is also true, we have already one instance where the knowledge gained in an environmentally driven project has fed back to exploration geochemistry and is being applied in mineral exploration.

The composition of the Association's Council and committees is a function of the available professionals willing and able to commit time to the Association. For a number of years it has been more difficult to obtain the time of members in industry, and elsewhere. Many employers appear to see no benefit in their staff's commitments of time and energy to the Association. Neither has it helped that the exploration industry has in recent years not seen the benefits of employing full time geochemists. Perhaps we should be grateful that others have stepped in. The alternatives would have been more "re-cycled and re-used" Council and committee members, rather than new blood, or an Association that simply withered and died because everybody had an excuse not to become involved.

**Robert G. Garrett**

*Geological Survey of Canada  
Ottawa, Ontario*



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FAX/Modem: 303-420-6646

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Activation Laboratories, Ltd.  
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## 83 MISSING DOWN-UNDER

For some reason, delivery of EXPLORE No. 83 (April 94) to AEG members in Australia did not proceed, as planned. Some received their copy very late while others never did receive a copy of EXPLORE. We are not certain why this happened, but believe it was a one-time-only event relating to postal jealousies. Regardless, any AEG members who did not receive No. 83, or any other issue, should contact EXPLORE, or Graham Taylor in Australia. We will do what we can to make your library complete and up-to-date.

## UPCOMING JGE

VOLUME 51, NO. 3

SEPTEMBER 1994

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Research papers

Reconnaissance geochemistry and its environmental relevance.

S. Painter, E.M. Cameron, R. Allan and J. Rouse

Criteria for distinguishing between gold-bearing and barren ironstones at Tennant Creek, Northern Territory, Australia.

A.J. Stolz, R.R. Large, P. Robinson, and R. Wedekind

Ultra-low density sampling of overbank sediment in Fennoscandia

P. Eden and A. Bjorklund

Short note

Aquatic bryocophytes as bioindicators of arsenic mineralization in Polish and Czech Sudety Mountains

A. Samecka-Cymerman and A.J. Kempers

Contents Volume 51



## TECHNICAL NOTES

### Geochemical Exploration for Precious Metals (Au and PGE) in Gansu Province, China

**Rapid and Simultaneous Determination of Pt, Pd and Au**

After great advances were made in prospecting for gold in China, (Xie and Wang, 1991), Chinese geochemists began studying platinum group elements (PGE) which are more difficult to prospect for than gold. The first thing needed was to develop a rapid, simple, efficient and low-cost PGE analytical technique with a low detection limit. In 1990,

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## Technical Notes

*Continued from Page 6*

Chen and Jiang (1990) completed their research on Rapid Chemical-Spectral Analytical Technique (RCSAT) for simultaneously determining Pt-Pd-Au and Lin Yunan et al. (1990) developed the technique for the simultaneous spectrometric determination of subtrace amounts of Pt-Pd-Au by the lead-fire assay method. RCSAT was adopted in our survey.

The detection limits of RCSAT for Pt, Pd and Au are 0.3  $\mu\text{g/g}$ , 0.1  $\mu\text{g/g}$  and 0.1  $\mu\text{g/g}$  respectively, and the analytical precision ranges from 15 to 34 percent. This method was improved by Zhang Guofu of the Gansu Provincial Bureau of Geology and Mineral Resources in 1992. In the modified RCSAT, samples are first processed by wet decomposition, then the complexing agent "app" is added to make Au, Pt and Pd form "app" complexes and thereupon these metals can be absorbed and preconcentrated by active carbon. After being ashed at a high temperature, a certain amount of "ZIC" buffer is added to the test samples to lower the melting points of these metals. Finally, samples are determined simultaneously for Pt, Pd and Au by rapid emission spectrometry. The detection limit for each of these three metals can be lowered to 0.1  $\mu\text{g/g}$  using this technique. The accuracy is 0.02-0.16  $\mu\text{g/g}$ . Thus, the analytical requirements for geochemical exploration for PGE can be fully met.

### Geochemical Exploration for Pt, Pd and Au in Qilian Mountains, Gansu Province

The survey area is situated in the main Qilian Mountains, which are between 3000 and 5000 metres above sea level. Strata from Proterozoic to Quaternary outcrop in this area. Mafic and intermediate-mafic volcanic rocks occur in the Proterozoic Changcheng system, Cambrian system and Ordovician system. Intermediate-mafic volcanic rocks are well developed in the Cambrian system. Caledonian magmatism is very strong in the area. Well developed Caledonian ultramafic rocks occur as dikes or lenses that are found in two belts; i.e. the North belt and the South belt. There are several known Au-Pt placer occurrences in the upper reaches of the two main drainage systems distributed in the survey area, respectively (Figure 1). Ultramafic rocks occur along the North and South sides of the Pt-Au mineralization belt, which suggests that these rocks may have a genetic linkage to the Au-Pt placers.

Samples of fourteen types of rocks or ores in source areas were analyzed prior to the main survey. The results showed that ultramafic rocks and chromites had high Pt contents. Osmiridium was also found in panned concentrates from ores of chromite. So it can be deduced that placer Pt did come from ultramafic rocks and their chromites, while the sources of placer Au may be related to the intermediate-mafic volcanic rocks in the Proterozoic to Ordovician-aged rocks (Changcheng system, Cambrian system and Ordovician system) and Caledonian ultramafic rocks.

More than 1000 composite stream sediment samples were taken from an area of about 5000  $\text{km}^2$  in the hinterland of the

*Continued on Page 8*

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Continued from Page 7

Qilian Mountains and analyzed for Pt, Pd and Au by Gansu Provincial Bureau of Geology and Mineral Resources using RCSAT improved by the Zhang Guofu. The original sampling density was 1 sample/km<sup>2</sup>. Four samples were collected from each 4 km<sup>2</sup> grid cell and were composited into one sample for analysis. Good results have been obtained in this regional geochemical survey for Pt, Pd and Au.

Platinum, Pd and Au contents of all samples are above the detection limits of our method, which ensures the reliable delineation of Pt, Pd and Au anomalies. The most frequent Pt concentrations are from 0.4 to 0.7 µg/g, with a minimum of 0.1 µg/g and a maximum of 8.6 µg/g. The threshold is 1.5 µg/g. Two zones of anomalous platinum can be recognized, i.e., the North zone and the South zone (Figure 1). The South zone trends W-NW and corresponds with the South ultramafic-rock zone on the whole. Most of the Pt anomalies in the North belt are nearly isometric. Several Pt anomalies are distributed North and East of this zone. The main anomalies of these two zones have several

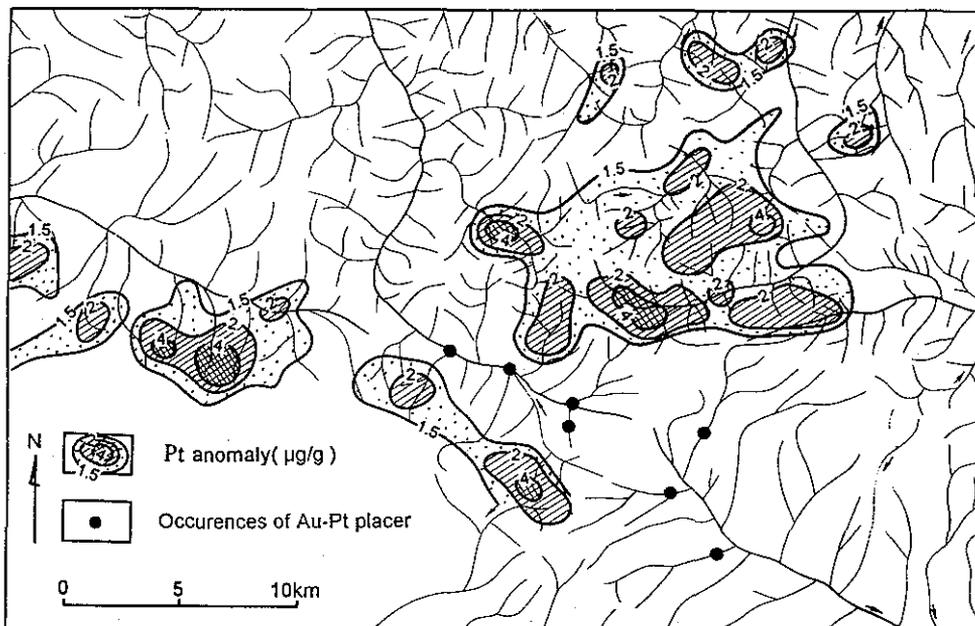


Figure 1. Regional geochemical anomalies of Pt in stream sediment.

concentration centers which coincide with ultramafic intrusives or Ordovician rocks. The source areas of Pt-Au placers can be indicated more clearly by comparison between Pt (also Au and Pd) anomalies and the drainage distribution.

For Pd, concentrations are most commonly from 0.6 to 1.0 µg/g with the minimum of 0.1 µg/g and maximum of 7.4 µg/g. The threshold is 2.0 µg/g. The characteristics of Pd anomalies are similar to Pt, but their extensions are smaller than the latter (Fig 2). For Au, most frequent contents are

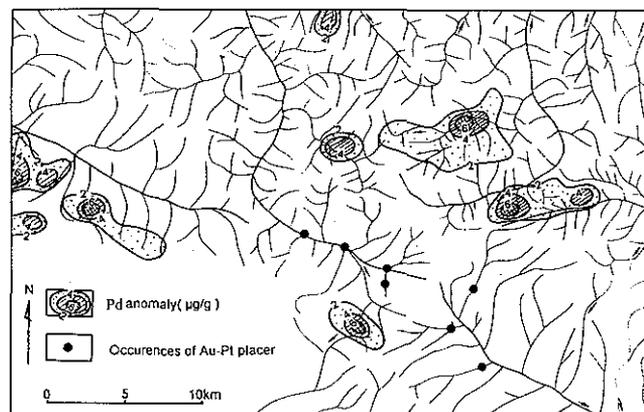


Figure 2. Regional geochemical anomalies of Pd in stream sediments.

from 0.3 to 0.6 µg/g with the minimum of 0.1 µg/g and maximum of 169 µg/g. The threshold is 1.3 µg/g. Gold anomalies can also be divided into two zones and even more importantly the South zone coincides with the distribution of Pt and Pd anomalies on the whole (Figure 3). Therefore, it appears that Au also has a comparatively close relationship with ultramafic rocks. The concentration centers of Au anomalies in the North zone partly correspond with Pt and

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## Technical Notes

*Continued from Page 8*

Pd anomalies, but the Au anomalies are mostly centered to the east of the Pt-Pd anomalies. So these Au anomalies have a closer relationship with intermediate volcanic rocks of Ordovician age than do those of Pt and Pd. By comparing anomalies with the drainage distribution, it can be seen that Au (also Pt and Pd) anomalies delineated in the northern part of the area do not belong to the same drainage basin in which Au Pt placers occur. So these Au anomalies may be new and promising areas for prospecting primary Au and PGE deposits.

### Concluding Remarks

This discussion concerns a preliminary regional geochemical exploration for Au, Pt and Pd, but undoubtedly it has proved the effectiveness of geochemical exploration, not only in gold prospecting, but also in the exploration for PGE deposits.

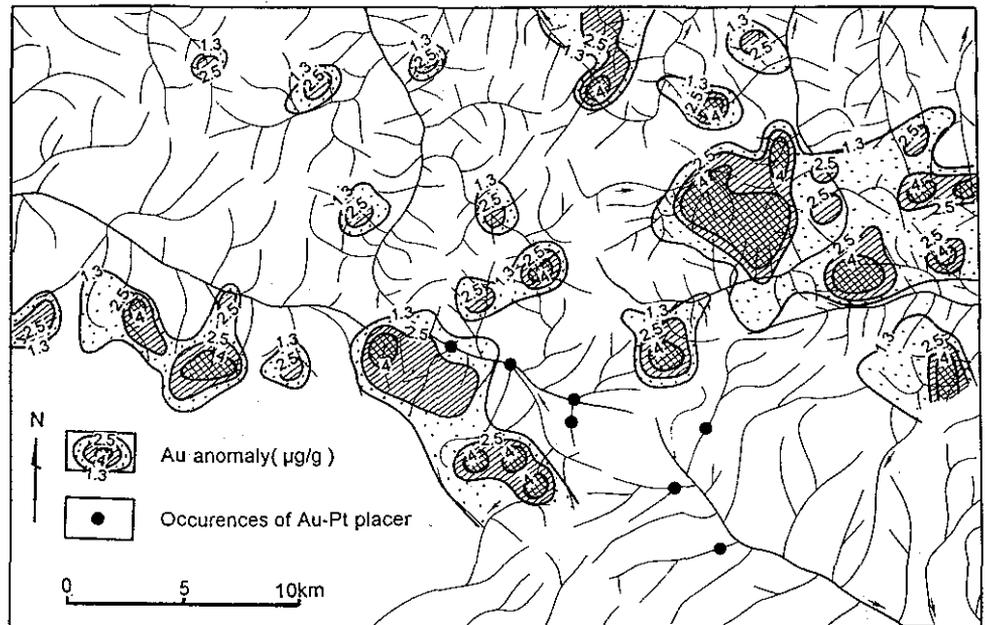


Figure 3. Regional geochemical anomalies of Au in stream sediments.

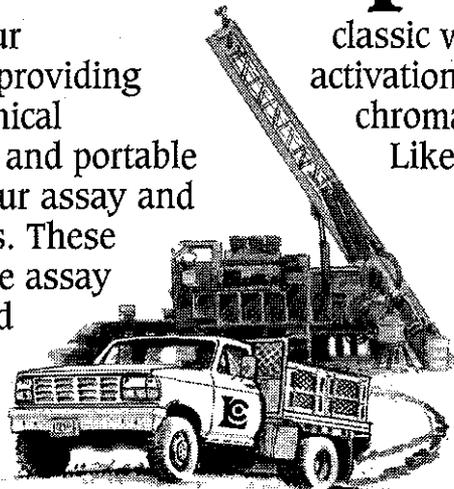
### Acknowledgement

Many thanks to Prof. Xie Xuejing for encouraging our research. Thanks are also due to Mr Shen Xiachu (IGGE) and Mr. Ren Fengshou (Chief Geologist, BGMR, Gansu) for revising and editing our manuscript.

*Continued on Page 10*

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### References

Cheng Fanglun and Jiang Jianhua, 1990. Rapid Chemical-Spectral Analytical Technique for Pt-Pd-Au simultaneous determination, Henan Provincial Central Laboratory, Unpublished Report.

Lin Yunan, Shen Zhenxing and Hu Jinxing, 1990. The simultaneous spectrometric determination of subtrace Pt-Pd-Au by lead fire assay method in geologic samples, Zhengzhou Institute of Multipurpose Utilization of Mineral Resources, Zhengzhou, Henan, Unpublished Report.

Xie Xuejing and Wang Xueqiu, 1991. Geochemical exploration for gold: a new approach to an old problem: in A.W Rose and P.M. Taufen (Editors), *Geochemical Exploration 1989*. J. Geochem. Explor., 40: pp.25-48.

Xu Jiale, Sun Shancai, Zhang Guofu and Fei Yiqing  
Bureau of Geology and Mineral Resources of Gansu Province,  
Lanzhou, Gansu 730000, China



## SOFTWARE REVIEW

P-RES is an integrated software program, developed at the University of British Columbia (UBC), with academic and industry support, for the specific purpose of assisting in the interpretation of multi-element geochemical datasets. P-RES has recently been documented and made available to the public by A. Bentzen and A.J. Sinclair of UBC. P-RES runs on MS-DOS computers and reads commercially supported dBase database files. The maximum number of data points allowed varies with computer configuration, but the program had no problem handling a test dataset with 1500 samples and 32 elements.

The plotting and analysis functions that are available in P-RES complement the earlier UBC program PROBLOT (Stanley, 1987), and provide a number of immediately useful capabilities. These include: basic statistics, binary graphs (X-Y plots), ternary diagrams, sample location maps, contour maps, histograms, correlation matrices, correlation

dendrographs, and Pearce element ratio plots. P-RES produces no hardcopy output other than screen dumps, but it can produce formatted output for PROBLOT and the UBC trend surface program "TREND" (O'Leary et al., 1966) although these options were not tested in this review.

The program is menu driven, but the interface is somewhat out-of-date and takes getting used to. For example, I inadvertently exited any number of times before I realized that the "Exit" and "Quit" menu options do exactly what they suggest—exit the program. Escape is the preferred key to abort menu choices. There is no on-line help, but a complete and well formatted manual is included on disk, and can be printed for anyone that really reads manuals.

When I ran P-RES, I had some difficulty reading my test dataset until I removed the data with missing results, and was, in general, disappointed with the low-resolution screen dump printer output; however, P-RES is available at a very low cost and may be of interest to users that do not have easy access to the large, commercially available statistical and graphical packages that are required for modern exploration geochemistry.

P-RES provides a number of good geochemical analysis tools, but is limited because of its lack of hardcopy capabilities and dated user interface. The dBase support is good, and dendrographs are quick and easy. This alone makes the program useful.

Anyone wishing to obtain a copy of P-RES should contact the Mineral Deposit Research Unit, Department of Geological Sciences, The University of British Columbia, Vancouver, BC V6T 1Z4, Canada. TEL: (604) 822-6136; FAX: (604) 822-6088, EMAIL: MDRU@geology.ubc.ca.

### References

- O'Leary, M., Lippert, R.H., and Spitz, O.T., 1966, FORTRAN IV and Map Programs for Computation and Plotting of Trend Surfaces for Degrees 1 through 6; State Geological Survey, The University of Kansas, Lawrence, Computer Contribution 3, 48p.
- Stanley, C.R., 1987, PROBLOT - An interactive computer program to fit mixtures of normal (or log-normal) distributions using maximum likelihood optimization procedures; Association of Exploration Geochemists Special Vol. 14, 40 p., 1 diskette.

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

■ Nov. 2-4, '94, **Western Surface Mining** conference, Denver (Maclean Hunter Presentations Inc., 12371 E. Cornell Ave., Aurora, Colorado 80014-9894)

■ Nov. 29-Dec. 2, '94, **Northwest Mining Association** convention and exhibit, Spokane, WA (Northwest Mining Association, Suite 414, 10 N. Post, Spokane, WA 99201-0772; TEL: (509) 624-1158; FAX: (509) 623-1241)

■ Feb. 20-22, '95, **Mineral Resources of Venezuela**, conf., Caracas, Venezuela by Institution of Mining and Metallurgy and Camara Minera de Venezuela (Conference Office, Institution of Mining and Metallurgy, 44 Portland Place, London W1N 4BR; TEL: +44 71 580 3802; FAX: +44 71 436 5388)

■ Feb. 20-25, '95, **South Asia Geological Congress**, Colombo, Sri Lanka (N.P. Wijayananda, GEOSAS II Secretariat, NARA, Crow Island, Mattakkuliya, Colombo 15, TEL: 941-522008; FAX: 941-522932)

■ Mar. 5-8, '95, **Prospectors and Developers Association of Canada** convention and trade show, Royal York Hotel, Toronto, ON, Canada (for information contact the PDAC at 34 King St. E., Toronto, ON M5C 2X8, Canada; TEL: (416) 362-1969; FAX: (416) 362-0101)

■ Mar. 6-9, '95, **SME Annual Meeting and Exhibit**, Denver, CO (Meetings Dept., SME Inc., PO Box 625002, Littleton, CO 80162-5002; TEL: (303) 973-9550; FAX: (303) 979-3461)

■ Apr. 3-7, '95, **Centennial Geocongress 1995**, Johannesburg, The Geological Society of South Africa (The Congress Secretariat, Centennial Geocongress, PO Box 36815, Johannesburg 0102, South Africa; TEL/FAX: 27 12 47 3398)

■ 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; TEL: (702) 323-4569; FAX: (702) 323-3599)

■ Apr. 11-13, '95, **Environmental Geochemistry**, conf., Aberdeen, Scotland, Environment Division, School of Applied Sciences, The Robert Gordon University, St. Andrew Street, Aberdeen AB1 1HG, Scotland, UK (Dr. Keith Nicholson; TEL: (+44-0224) 262821/262802; FAX: (+44-0224) 262828)

✦ ■ 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, Queensland 4814, Australia; TEL: (61) 77-814486; FAX: (61) 77-815522)

■ May 24-26, '95, **5th V.M. Goldschmidt Conference**, University Park, PA, USA (Technical Program Chair, Mike McKibben, TEL: (909) 787-3444; FAX: (909) 787-4324; E-mail: McKibben@UCRAC1.UCR.EDU)

■ June 3-6, '95, **International Field Conference on Carbonate-hosted Lead Zinc Deposits**, SEG Anniversary Field Conference (David Leach or Martin Goldhaber, USGS, Branch of Geochemistry, MS 973, PO Box 25046, Federal Center, Denver, CO 80225, USA, FAX: (303) 236-3200, e-mail: dleach@helios.cr.usgs.gov)

■ June 7-9, '95, **African Mining '95**, Windhoek, Namibia (IMM, 44 Portland Place, London W1N 4BR, UK; TEL: (071) 580-3802; FAX: (071) 436-5388)

■ Sept. 4-8, '95, **International Symposium on Environmental Biogeochemistry**, Rio de Janeiro, Brazil (Symposium Secretariat, Prof. Luis Henrique Melges, FAX: 55-(0)21-248-4870; e-mail: iseb@bruerj)

■ Nov. 6-9, '95, **Geological Society of America**, ann. mtg., New Orleans, LA (Vanessa George, 3300 Penrose Place, Boulder, CO 80301; TEL: (303) 447-2020; FAX: (303) 447-1133)

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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.

**Editor's 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.

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## AEG BIBLIOGRAPHY

Exploration Geochemistry Bibliography Supplement 2, compiled by H.E. Hawkes, was issued in 1987. A comprehensive bibliography, currently through the end of 1994, is being prepared for release at the Association's next IGES in Townsville in May 1995. It is anticipated that the bibliography will be available as both hard copy and as a dBase IV file. Costs to members and non-members are currently being determined by Council.

Citations contained in the three previous bibliographies have now been computerized via optical scanning technology. Editing and indexing are underway. Literature citations since 1987 are being added. The computerization task has been a painstaking process; however, future updates will be more readily accomplished. We are grateful to Dorthe Jacobsen and Eric Grunsky for their ongoing efforts in this process.

Individuals and organizations wishing to contribute citations to this compilation can send materials to Graham Closs. Provisions of your material on a Word Perfect 5.1 file would be much appreciated.

### L. Graham Closs

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## RECENT PAPERS

This list comprises titles that have appeared in major publications since the compilation in EXPLORE Number 84. 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 new references to Dr. Closs, not to EXPLORE.

An, P., Moon, W.M., and Bonham-Carter, G.F., 1994.

Uncertainty management in integration of exploration data using the belief function. *Nonrenewable Resources* **3**(1): 60-71.

Anderson, G.M. and Crerar, D.A., 1993. *Thermodynamics in Geochemistry: The Equilibrium Model*. Oxford. 588 p.

Anon., 1992. *Regional Geochemistry - Lake District and Adjacent Areas*. British Geol. Surv. 98 p.

Anthony, E.Y. and Titley, S.R., 1994. Patterns of element mobility during hydrothermal alteration of the Sierrita porphyry copper deposit, Arizona. *EG* **89**(1): 186-192.

Averill, S.A. and McClenaghan, M.B., 1994. Distribution and character of kimberlite indicator minerals in glacial sediments, C14 and Diamond Lake kimberlite pipes, Kirkland Lake, Ontario. *Geol. Surv. Canada OFR* 2819. 48p.

Bell, K. and Franklin, J.M., 1993. Application of lead isotopes to mineral exploration in glaciated terrains. *Geology* **21**(12): 1143.

Bennett, S.A., Atkinson, W.W., Jr., and Kruse, F.A., 1993. Use of thematic mapper imagery to identify mineralization in the Santa Teresa District, Sonora, Mexico. *Intern. Geol. Rev.* **35**: 1009-1029.

Burns, R.G., 1993. *Mineralogical Applications of Crystal Field Theory*. 2nd Ed. Cambridge. 551 p.

Cameron, E.M., 1993. Precambrian gold: Perspectives from the top and bottom of shear-zones. *Can. Mineralogist* **31**(4): 917-945.

Clarkson, R., 1994. The use of nuclear tracers to evaluate the gold recovery efficiency of sluice boxes. *CIM Bull.* **87**(979): 29-37.

Dissanayake, C.B., Rupasinghe, M.S. and Mendis, D.P.J., 1994. Geochemical exploration for gem deposits in Sri Lanka - application of discriminant analysis. *Chemie der Erde* **54**(1): 33-47.

Dobbe, R.T.M., 1994. Geochemistry of cordierite-anthophyllite rocks, Tunaberg, Berglagen, Sweden. *EG* **89**(4): 919-930.

Ewers, G.R., Mackenzie, D.E., Wyborn, D., Oversby, B.S., McPhie, J., and Andrew, A.S., 1994. Regional <sup>18</sup>O depletions in igneous rocks from the Northern Drummond Basin, Queensland, Australia, and their implications for epithermal gold mineralization. *EG* **89**(3): 662-673.

*Continued on Page 14*

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Firman, J.B., 1994. Paleosols in laterite and silcrete profiles: Evidence from the South East Margin of the Australian Precambrian Shield. *Earth-Sci. Rev.* **36**(3/4): 149-179.

FitzPatrick, E.A., 1993. *Soil Microscopy and Micromorphology*. Wiley. 304 p.

Fletcher, P., 1993. *Chemical Thermodynamics for Earth Scientists*. Wiley. 464 p.

Gasparrini, Claudia., 1993. *Gold and Other Precious Metals - From Ore to Market*. Springer-Verlag. 336 p.

Gowen, J., Christiansen, O., Grabl-Madsen, L., and Pederson, J., 1993. Discovery of the Nelunaq gold deposit, Kirkespirdalen, S.W. Greenland. *Intern. Geol. Rev.* **39**: 1001-1008.

Grechishnikov, N.P., 1994. Defining geochemical criteria for predicting gold-silver mineralization. *Geochem. Intern.* **31**(1): 104-109.

Gulson, B.L., Mizon, K.J., Law, A.J., Korsch, M.J. and Davis, J.J., 1994. Source and pathways of lead in humans from the Broken Hill Mining Community - An alternative use of exploration methods. *EG* **89**(4): 889-908.

Habashi, F., 1994. The discovery and industrialization of the rare earths - Part 1. *CIM Bull* **87**(976): 80-86.

Habashi, F., 1994. The discovery and industrialization of the rare earths - Part 2. *CIM Bull* **87**(977): 71-76.

Habashi, F., 1994. The discovery of metals - Part 1. *CIM Bull* **87**(979): 69-74.

Habashi, F., 1994. The discovery of metals - Part 2. *CIM Bull* **87**(980): 112-117.

Hall, G.E.M. (Ed.), 1993. *Geoanalysis 90. An International Symposium on the Analysis of Geological Materials*. *Can. Geol. Surv. Bull.* **451**, 166 p.

Hedenquist, J.W., Matsuhisa, Y., Izawa, E., White, N.C., Giggenschach, W.F., and Oaki, M., 1994. Geology, geochemistry and origin of high sulfidation Cu-Au mineralization in the Nansatsu District, Japan. *EG* **89**(1): 1-30.

Hummel, J.H. (Ed.), 1993. *The GIA Diamond Dictionary*, 3rd Ed. *Gemological Institute of America*. 275 p.

Jaireth, S., 1992. Solubility of gold and silver in oxygen-saturated fluids and the formation of high fineness gold grains in the lateritic profile. *J. Geol. Soc. India* **40**(6): 152-.

Jovic, V., 1993. Thallium in rocks, soils and plants: Past progress and future needs. *Neues Jahrbuch fur Mineralogic* **166**(1): 43-52.

Killops, S.D. and Killops, V.J., 1993. *An Introduction to Organic Geochemistry*. Longman. 265 p.

Kirchner, G. and Tan, B., 1994. Key Lake: the trail of its discovery. *CIM Bull.* **87**(982): 57-61.

Klusman, R.W., 1993. *Soil Gas and Related Methods for Natural Resource Exploration*. Wiley. 483 p.

Koljonen, T. (Ed.), 1992. *The Geochemical Atlas of Finland*, Part 2. *Till. Geol. Surv. Finland.* 218 p.

Konhauser, K.O., Fyfe, W.S., Ferris, F.G., and Beveridge, T.J., 1993. Metal sorption and mineral precipitation by bacteria in two Amazonian river systems: Rio Solimoes and Rio Negro, Brazil. *Geology* **21**(12): 1103-.

Leon, J.S., 1994. Origin of placer gold nuggets and history of formation of glacial gold placers, Gold Creek, Granite County, Montana. *EG* **89**(1): 91-104.

Madonna, J.A., 1994. Vocational and technical education in geosciences with an emphasis on geochemical exploration skills. *Min. Eng.* **46**(2): 128-131.

Marakushev, A.A. and Gorbachev, N.S., 1993. Geochemical types of traps in the context of the genesis of copper-nickel deposits of the Noril'sk region. *Geologha Rudnykh Mestorozhenii* **35**(3): 284-.

McClenaghan, M.B. and DiLabio, R.N.W., 1993. Till geochemistry and its implications for mineral exploration: Southeastern Cape Breton Island, Nova Scotia, Canada. *Quaternary Intern.* **20**: 107-122.

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- Nystrom, J.O. and Henriquez, F., 1994. Magmatic features of iron ores of the Kiruna type in Chile and Sweden: Ore textures and magnetite geochemistry. *EG* 89(4): 820-839.
- Page, T.C., Miller, M.A., Gibson, P.C., and Sell, J.D., 1994. Geology and geochemistry of the Yarnell gold deposit. *Min. Eng.* 46(9): 1061-1064.
- Percival, T.J. and Radtke, A.S., 1993. Thallium in disseminated replacement gold deposits of the Carlin-type: a preliminary report. *Neues Jahrbuch fur Mineralogie* 166(1): 67-76.
- Potts, P.J., Tindle, A.G. and Webb, P.C., 1993. *Geochemical Reference Material Compositions*. CRC Press. 313 p.
- Putnis, A., 1992. *Introduction to Mineral Sciences*. Cambridge U. Press. 452 p.
- Rendu, J.M., 1994. 1994 Jackling Lecture: Mining Geostatistics - forty years passed. What lies ahead? *Min. Eng.* 46(6): 557-558.
- Saunders, J.A. and Swann, C.T., 1994. Mineralogy and geochemistry of a cap-rock Zn-Pb-Sr-Ba occurrence at the Hazlehurst salt dome, Mississippi. *EG* 89(2): 381-390.
- Schrijver, K., Zartman, R.E. and Williams-Jones, A.E., 1994. Lead and barium sources in Cambrian siliciclastics and sediment provenance of a sector of the Taconic Orogen, Quebec: a mixing scenario based on Pb-isotopic evidence. *Applied Geochem.* 9(4): 455-476.
- Shangang, L., Zonghua, W., and Jimin, L., 1993. Nonconventional geochemical exploration of gold deposits in Xinjiang and Henan Provinces, China. *Intern. Geol. Rev.* 35: 1130-1136.
- Singh, A., Singh, A.K., and Flatman, G., 1994. Estimation of background levels of contamination. *Math. Geol.* 26(3): 361-388.
- Skarpelis, N., Laskou, M., and Alevisos, G., 1993. Mineralogy and geochemistry of the nickeliferous lateritic iron-ores of Kastoria, N.W. Greece. *Chemic der Erde* 53(4): 331-339.
- Skirrow, R.G. and Franklin, J.M., 1994. Silicification and metal leaching in semi-conformable alteration beneath the Chisel Lake massive sulfide deposit, Snow Lake, Manitoba. *EG* 89(1): 31-50.
- Sobott, R.J.G., 1993. Environmental aspects of thallium. *Neues Jahrbuch fur Mineralogie* 166(1): 77-90.
- Stollenwerk, K.G., 1994. Geochemical interactions between constituents in acidic groundwater and alluvium in an aquifer near Globe, Arizona. *Applied Geochem.* 9(4): 353-369.
- Stowe, C.W., 1994. Compositions and tectonic setting of chromite deposits through time. *EG* 89(3): 528-546.
- Stromberg, B. and Banwart, S., 1994. Kinetic modelling of geochemical processes at the Aitik mining waste rock site in northern Sweden. *Applied Geochem.* 9(5): 583-595.
- Tardy, Y., 1993. *Petrologie des Laterites et des Sols Tropicaux*. Masson S.A. 459 p.
- Teigler, B. and Eales, H.V., 1993. Correlation between chromite composition and PGE mineralization in the critical Zone of the Western Bushveld Complex. *Mineralium Deposita* 28(5): 291-302.
- Tistl, M., 1994. Geochemistry of platinum-group elements of the zoned ultramafic Alto Condoto Complex, northwest Columbia. *EG* 89(1): 158-167.
- Uspenskiy, Y.I. and Aleshin, A.P., 1993. Patterns of scheelite mineralization in the Muruntau gold deposit. Uzbekistan. *Intern. Geol. Rev.* 35: 1037-1051.
- Voronkevich, S.D., 1994. Engineering geochemistry: problems and applications. *Applied Geochem.* 9(5): 553-559.
- Wakefield, T. and Closs, L.G., 1994. *Geochemistry (Annual Review)*. *Min. Eng.* 46(5): 406-407.
- Webster, J.D. and Duffeld, W.A., 1994. Extreme halogen abundances in tin-rich magma of the Taylor Creek Rhyolite, New Mexico. *EG* 89(4): 840-850.
- Wenrich, K.J. and Aumentz-Modreski, R.M., 1994. Geochemical soil sampling for deeply-buried mineralized breccia pipes, northwestern Arizona. *Applied Geochem.* 9(4): 431-454.
- Whateley, M.K.G. and Harvey, P.K., 1994. *Mineral Resource Evaluation II: Methods and Case Histories*. Geol. Soc. (London) Pub. 79. 272 p.
- Williamson, M.A. and Parnell, R.A., Jr., 1994. Partitioning of copper and zinc in the sediments and porewaters of a high-elevation alkaline lake, east-central Arizona, USA. *Applied Geochem.* 9(5): 597-608.
- Woodall, R., 1994. Empiricism and concept in successful mineral exploration. *Aust. J. Earth. Sci.* 41(1): 1-.
- Yu, T.R. and Ji, G.L., 1993. *Electrochemical Methods in Soils and Water Research*. Pergamon.
- Yusupov, R.G., 1994. Geochemical features and accessory-mineral parageneses for orogenic-region diamonds: The central and south Tian Shan. *Geochem. Intern.* 31(1): 83-92.
- Zhu, B., 1993. Tri-dimension spatial topological diagrams of ore lead isotopes and their applications to the division of geochemical provinces and mineralizations. *Geochimica* 3: 216-225.

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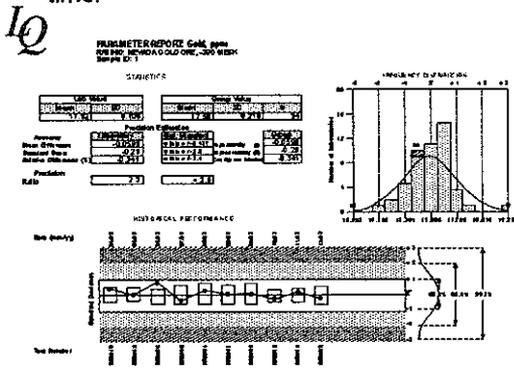
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