EXPLORE

Newsletter for the Association of Exploration Geochemists

NUMBER 95 APRIL 1997

PRESIDENT'S MESSAGE

David Garnett

What do you get if you replace an Irish engineer with a Scottish engineer? If the two gentlemen in question were responsible for laying railway lines across Australia in the last century the answer would be 'confusion'. In their infinite wisdom, and under the guidance of the aforementioned engineers, different states adopted different gauges for the lines with the result that a traveler could expect to encounter five breaks of gauge in his or her journey across the continent. A hundred years later the situation has improved, though it's still not perfect.

I am reminded of this when I survey the present movement towards professional registration of geoscientists. To the best of my knowledge four Canadian provinces/territories have enacted legislation providing for registration while others are moving actively towards it. In the United States at least twenty three states have registration requirements. In the United Kingdom professional geoscientists have the option of registering as chartered geologists, chartered engineers, European geologists or European engineers. In South Africa registration is available under the Natural Sciences Act and in Australia we now have, or will shortly have, the choice of registering as either a chartered practicing geologist or a registered professional geoscientist. I have no doubt that similar proposals are under discussion, or are already in place, in other countries.

Given that many geochemists tend to be nomadic, this plethora of registration requirements would seem to represent a serious barrier to their normal migratory habits. Hopefully, greater reciprocity between registration schemes will be established in time but until it is we seem to be suffering from a bad attack of 'Australian rail-gauge syndrome'.

At this stage, registration is often voluntary, under the umbrella of a self-regulating professional body, although in some cases, e.g. British Columbia, it is mandatory for all professional geoscientists. It is probably true to say that the move towards registration has been met with somewhat less than overwhelming enthusiasm by many of the scientists for whom it was put in place. They make the point that as members of a professional body, such as the AEG, they are already bound by entry qualifications and a code of conduct which are similar to those that are now proposed under the various schemes for registration. On the other hand, supporters point to the fact that many of the registration schemes go beyond simple maintenance of standards. They attempt to improve them through continuous professional development and through establishment of a stronger voice in the corridors of power. This in turn should lead to greater

Continued on Page 3

TECHNICAL NOTE

SEARCHMAP — Interactive Map Interpretation System for Mineral Exploration

Douglas E. Pride
John M. Memmi
Jeremy Loomis
Roni Yagel

INTRODUCTION

Exploration is an integrative exercise, combining aspects of geology, geochemistry, geophysics, and biology to highlight regions that may contain important mineralization. Data exist as distributions of rocks, regolith and soil; concentrations of minerals and lithophile and chalcophile elements; and remotely-sensed information on physical properties such as reflectance, density, magnetic susceptibility, and conductivity. Large volumes of data must be integrated logically to provide the best chance for mineral discovery, and this is especially true when decisions concerning field programs are involved. Also, data should be archived appropriately so that they may be recalled for consideration in the light of new exploration concepts.

Regardless of the amount of data, they must be interpreted correctly, and this is where experience is essential. Explorationists are trained to integrate information from a lot of sources, and except perhaps for luck, experience triumphs nearly every time.

SEARCHMAP CONCEPT

SearchMap is an outgrowth of the belief that there should be simple and meaningful ways to graphically integrate conceptual and quantitative map information (Pride, et al.,

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:

EXPLORE
c/o J.T. Nash, 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 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.

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**.

The **EXPLORE** newsletter is produced on a volunteer basis by the AEG membership and is a non-profit newsletter. The advertising rates are the lowest feasible with a break-even objective. Color is charged on a cost plus 10% basis. A discount of 15% is given to advertisers for an annual commitment (four issues). All advertising must be camera-ready PMT or negative. Business card advertising is available for consultants only*. Color separation and typesetting services are available through our publisher, Network Graphics, Inc.

Full page	254h x 178w mm	(10h x 7w in) US $ 880
Half page	254h x 86w mm	(10h x 3-3/8w in) US $ 480
	124h x 178w mm	(4-7/8h x 7w in) US $ 480
Third page	254h x 58w mm	(10h x 2w in) US $ 380
	178h x 86w mm	(7h x 3-3/8w in) US $ 380
Quarter page	124h x 86w mm	(4-7/8h x 3-3/8w in) US $ 270
	254h x 41w mm	(10h x 1-5/8w in) US $ 270
Eighth page	60h x 86w mm	(2-3/8h x 3-3/8w in) US $ 170
Business Card*	51h x 86w mm	(2h x 3-3/8w in) US $ 70

Please direct advertising inquiries to:
Owen Lavin
NEWMONT EXPLORATION
2600-1700 Lincoln St.
DENVER, CO 80203
USA
TEL: (303) 837-5820
FAX: (303) 837-5851

EXPLORE

Newsletter No. 89 OCTOBER 1995

Editors: Sherman P. Marsh (303) 236-5521
J. Thomas Nash (303) 236-5515
Assistant Editors:
Steve Cone (303) 232-8371
Anne M. Leibold (303) 295-1101
Fredrick P. Schwarz (702) 758-9234
J. Stevens Zuker (303) 989-6608
Business Manager: Owen P. Lavin (303) 837-5820
FAX (303) 236-3200, ATTN: Sherman Marsh, USGS
e-mail: smarsh@helios.cr.usgs.gov

EXPLORE is published quarterly by the Association of Exploration Geochemists, P.O. Box 25046, MS 973, Denver Federal Center, Denver, CO 80225.
EXPLORE is a trademark of the Association of Exploration Geochemists.
EXPLORE is typeset by Vivian Heggie, Heggie Enterprises, Thornton, CO (303) 288-6540.

NOTES FROM THE EDITORS

Sherman Marsh and Tom Nash

Spatial analysis of geochemical information has always been important in our profession. Geochemical maps have been the hallmark of our work. In an era of proliferating databases, multi-variate and multi-disciplinary interpretations are active fields of research. Efficient and effective maps are required to examine data and to search for derivative meanings for exploration or environmental assessment. And effective maps are required to present geochemical information to managers and investors, professionals and laymen. We encourage discussion, and especially would welcome technical contributions describing effective methods for spatial analysis or 'visualization', the current jargon for this hot computing topic.

Doug Pride and associates at Ohio State describe for us their work on mapping of conceptual information. As shown herein, this is a promising arena that merits our attention. This is a variety of 'artificial intelligence' computing that is advanced in the medical profession and in its infancy in geology. This is one way to capture the expertise of senior geologists and geochemists, before we become senile. Some say these methods have 20-20 hindsight, re-discovering deposits that already are known. But there are signs that the younger generation of computing wizards can find ways to make this method produce more than the sum of the data layers. Pooling and publication of professional insights and experiences can make a difference in research such as this. We will gladly give you this podium.

Sherm and Tom

President's Message

continued from page 1

status for the professional geoscientist and greater security for both employers and the public. Realists would be justified in adding that the move towards registration appears to be so strong that it would be foolish to ignore it, and that any professional body would serve its members best by participating in the process in order to achieve the best outcome for its members.

In the case of the AEG, I believe that it would be foolish to attempt to set up our own registration scheme. We fit naturally and comfortably within the broader group of geoscientists and should try to work with them, not against them. I would be particularly interested to hear members' thoughts on professional registration. Some of you have lived with it, perhaps for several years. Others are only now beginning to grapple with it, while for others that pleasure lies in the future. For those who are already registered I have three questions. Do you think the system is working? Do you view registration as a positive development or a necessary evil? Do you feel that there is any danger that the governing body could become dominated by an 'old-boys club' - who will guard the guards? If I can inject one personal note, on which I would appreciate comment, I find it disturbing that in at least one case the legislation extends as far as requiring that universities adhere to a syllabus that is laid down by the external body responsible for registration. Is this not too prescriptive? Does it not usurp the freedom of the university to go in new directions, to decide what it will teach and how it will teach it?

As I write, news is breaking on allegations of serious fraud involving the Busang gold deposit in Indonesia, with claims that reserves were over-stated because of "invalid samples and assaying of those samples." No doubt more details will have emerged by the time you read this, but the allegations as they stand now reflect badly on the professionalism of geochemists. What can we learn from this? Is there any way that it could have been avoided?

The 18th IGES in Jerusalem is upon us. Even at this late date there is still time to register and I urge you to participate. I look forward to meeting many of you there.

David Garnett
PMB 1, Menai, NSW 2234, AUSTRALIA
Tel: (612) 9543 2644
Fax: (612) 9543 2655
email: naa@bq.com.au

Technical Note

continued from page 1

1996). Quantitative data are relatively easy to visualize, but conceptual information is difficult to handle meaningfully. SerchMap is grid-based and employs a "search kernel" to create a new layer of information-a SearchMap-from one or more input data layers. The kernel is a filter that sweeps each layer of data, stopping at every pixel to look around for significant information within a search radius that is defined by the user. Users weight the importance of data with respect to distance from the center pixel in the filter; and they weight the importance of each layer of data with respect to every other layer in the interest matrix (fig. 1).

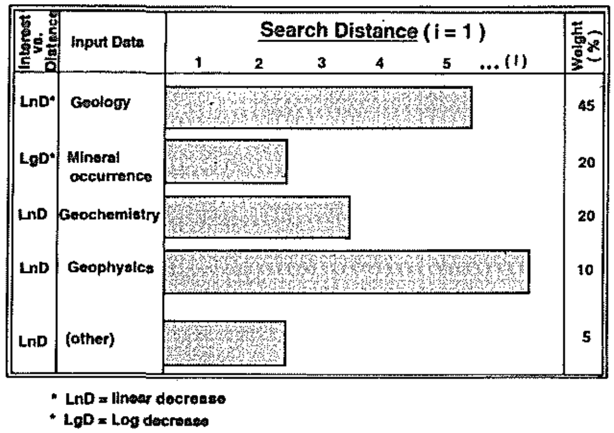

Figure 1. Schematic illustrating interest within and among input data layers.

A model or interest matrix, as in figure 1, drives the SearchMap for a region of unknown mineral potential. An explorationist has placed most of his/her faith in geology and mineral occurrence, plus geochemistry. Geophysics and "other" forms of data complete the matrix. Note that the explorationist feels that geology and geophysics provide broad information, whereas mineral occurrence and geochemistry are most useful when found near the center cell in the search filter. The user in this example has chosen "linear decreasing" interest with respect to the center cell, except for mineral occurrence, which he/she feels is particularly important if samples are very near the center of the filter.

Several categories of information may exist under each of the general headings; for example, structure, rock type, and rock age under "geology". The relative weights assigned to each category and subcategory are at the discretion of the user, and they can be modified until he/she is satisfied with the result. Once satisfied, the next step is to examine highlighted localities using high resolution data.

At this time, the SearchMap software is a "research code" system (i.e., not yet ready to be offered to the public). It currently is implemented on Silicon Graphic "Indy" and HP 9000/715 workstations, but it is designed for use on any UNIX system. The software is written in C++ using the graphic interface library "Forms", and it supports both color and gray scale images. Datasets and input files are text files, and the software is event-driven, so user actions guide computational flow.

Continued on Page 4

Technical Note

Continued from Page 3

CREATING A SEARCHMAP

Users specify how each data value is to be displayed, and all appropriate parameters are specified using standard interface elements such as pull-down menus and dialogue boxes. Important subsets of the data are extracted, influence spreading is defined, and, finally, the relative weights among layers are supplied to produce the SearchMap configuration. Changes made by the user automatically trigger appropriate recalculation and re-display. Recalculations are fast, allowing users to experience the effects of changing weights within and among input data layers interactively, and the parameters for intermediate steps are saved, preserving the "train-of-thought", which is available for display and reconsideration at any time.

The expression in figure 2 illustrates the manipulations that are involved in producing a SearchMap. Pixels containing significant attributes are reclassified using a binary code

Equation:

$$\hat{P}_{i,j} = \sum_{k=1}^{n} WT_k \sum_{x=1}^{l+1} \sum_{y=1}^{l+1} wt_{x,y} \cdot P^k{}_{i-l/2+x,\,j/2-l+x}$$

where

i, j	index scanning the input maps P^k and the resulting SearchMap $\hat{P}$
$P^k{}_{i,j}$	The pixel value at (i, j) in layer k
$\bar{P}_{i,j}$	derived value of the pixel at (i, j) in the SearchMap
x, y	index scanning the weight mask wt
$wt_{x,y}$	weight assigned to a pixel at (x, y) displacement from the center pixel
$l+1$	the size of the weight mask. Commonly, $l+1$ is an odd number.
WT_k	the weight applied to the k^{th} input layer.

Figure 2. Expression illustrating manipulations involved in calculating a matrix of SearchMap pixels.

that defines attributes either as important or not important. To compute the contributions of the important pixels in a data layer to a pixel at (i,j), we superimpose a two-dimensional filter such that the center of the filter lies directly over the pixel at (i,j). The filter contains a radial interest function that represents the relative importance of the surrounding pixels to the center pixel in the filter — the weighted values of all significant pixels that lie within the search distance defined by the user. The interest may take any of several forms (e.g., linear or log decreasing, even increasing) with respect to distance from the center pixel in the search filter. The final value of each pixel in the SearchMap is determined by adding the contributions of each of the input layers (inner two summations), summed over the weights assigned to each layer (outermost summation).

The computations required by the interest matrix and defined by figure 2 are accomplished layer by layer. Following binary reclassification, each input layer is "convolved" with the radial interest function (the filter) to produce an image that represents the spread of influence about each of the pixels or groups of pixels carrying attributes of interest. The significant pixels are mapped as a constant value, and the spread of influence occurs as "blurring" around the pixels of interest, the width and intensity of the blurring equal to the search distance and the interest with respect to distance from the center pixel in the filter.

The process of convolution can be viewed as passing the filter incrementally over each row and column of pixels. The SearchMap is derived by adding the convolved layers, multiplied by their weights for each pixel (i,j). In this way, a new matrix of pixels is derived for each set of search distances and weights; and a new Map is generated each time one or more of these parameters is changed.

EXAMPLE USING DIAMOND EXPLORATION DATA BASE

In diamond exploration, the age of crystalline basement rocks and the thickness of the lithosphere, together with the presence of crustal lineaments and occurrences of bedrock and alluvial diamonds are important to developing an exploration plan. Explorationists, however, may disagree on the relative importance of these attributes, and as to whether or not additional attributes should be included in the model. For example, how significant is the occurrence nearby of carbonatite bodies; are cryptoexplosion structures present in the vicinity; is the presence of sedimentary and/or glacial cover in areas suspected to contain primary diamond deposits important; and is crustal thickness of interest in such terrain? With SearchMap, these features can easily be included, weighted, and examined to develop the best exploration plan.

Economic diamond-bearing kimberlite magmas penetrate Archean basement in regions of thick (>150 km) lithosphere. Large-scale fractures apparently provide a focus for the mantle-derived magmatism. Kimberlites occur in clusters, and they bring to the surface high chromium garnet and diopside, in addition to diamonds. Economic lamproite intrusions are genetically similar to kimberlites, but to date have been found only in Early Proterozoic (1.6-2.5 Ga) terrain. Overlying strata may dissipate the explosive power of both types of intrusions before they reach the surface. Upon reaching the surface, or following exposure by erosion, both kimberlite and lamproite release diamonds and associated minerals into the surface environment, where they are redistributed by surface processes.

Figure 3 presents an exploration scenario in which several features that are germane to primary diamond deposits are present, and the two sets of search arcs demonstrate how the evidence may be accessed to develop an exploration SearchMap. A matrix of new pixels is produced as the search filter sweeps the input data for geology (rock ages, lineaments, lineament intersections), known occurrences of kimberlite and lamproite, and alluvial diamonds and indicator minerals.

Memmi (1993) examined a 2.9×10^6 km^2 region of the north-central United States and southernmost Canada for its potential to contain economic kimberlite and lamproite deposits. Combining geology, structure, mineral occurrence, geochemistry, and geophysics, he was able to isolate four regions that may contain economic intrusions: (1) Wisconsin-UP Michigan, (2) SE Wyoming, (3) NE North Dakota-N Minnesota-S Ontario, and (4) NW Iowa.

The data from the study by Memmi have been re-evaluated using the SearchMap software. Table 1 presents a search matrix designed by Memmi for the region, plus a

Continued on Page 5

Technical Note *Continued from Page 4*

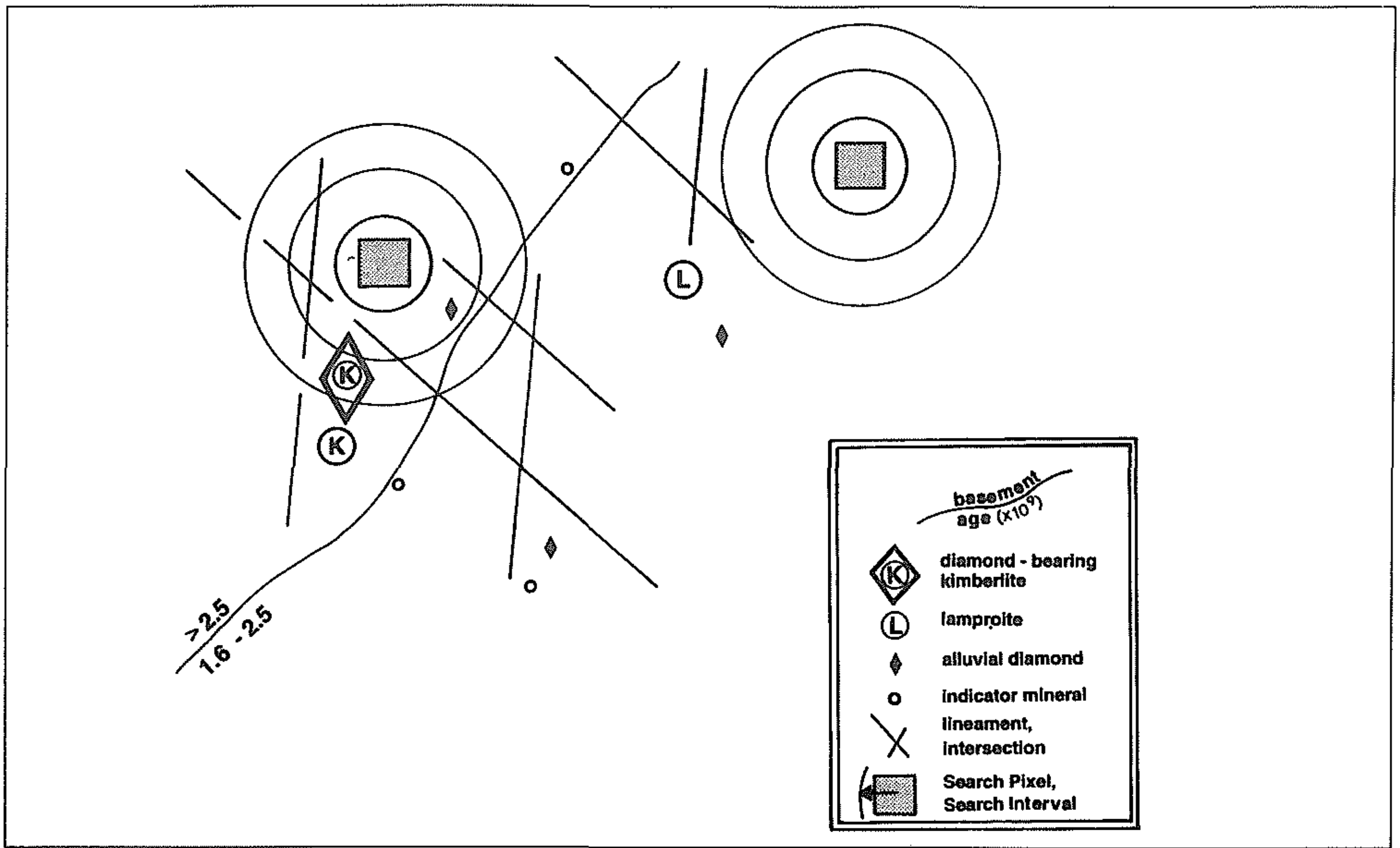

Figure 3. Features of interest to diamond explorationists, and search pixels situated to access the information and create pixels in SeearchMap matrix.

matrix designed by Pride for the same data. Both matrices stress the importance of basement age and lithospheric thickness, and the significance of kimberlites that carry diamonds, whatever the size and grade. Pride feels that the presence of alluvial diamonds also is important, whereas Memmi does not assign particular significance to them (most alluvial diamonds have been found in regions of Pleistocene

TABLE 1
DIAMOND EXPLORATION SEARCH MATRICES

	Memmi		Pride	
Attribute	Dist.(*)	Int.(*)	Dist.	Int.
basement age	20km	24%	80km	25%
lithospheric thickness	12	16	100	15
diamond-bearing kimberlite	40	15	80	15
kimberlite or lamproite	40	12	60	10
alluvial diamonds	52	3	80	10
basement fault or lineament	12	10	20	15
basement flexure axes	20	10	20	2
surface flexure axes	20	2	20	2
carbonatite	100	5	60	2
cryptoexplosion structure	20	3	60	4
		100%		100%

(*) Dist. refers to search distance considered by the user to be significant with respect to the center pixel in the search filter; Int. refers to relative importance of each layer of data to the center pixel.

Continued on Page 6

Technical Note *Continued from Page 5*

glaciation). Conversely, Memmi feels that the presence of basement flexure axes is much more significant than does Pride. Positive flexure axes may represent crustal upwarps such as domes, anticlines, and horsts, which are recognized as favorable sites for the emplacement of kimberlite and lamproite magmatism (Dawson, 1964; Gold, 1984; Mitchell and Bergman, 1991).

A maximum search distance of 100 kilometers was chosen (25 pixels with diameter 4km), and the interest versus distance function is linear decreasing in all cases. In practice, the search distance can be varied by reducing the interest to zero (e.g., Memmi is not interested in basement faults and lineaments unless they are within 12 km of the center of the search kernel). Inspection of the matrices reveals considerable variation in search distance, but, overall, Memmi is more conservative than Pride. Figure 4 is the SearchMap based on the interest matrix defined by Memmi, and figure 5 is the map produced from input by Pride. The northern 60 percent (approx.) of both figures is underlain by rocks that are Early Proterozoic or older, within lithosphere that ranges to more than 150 km thick (Memmi, 1993). This is the canvas upon which the other clues to diamond occurrences (e.g., lineaments, kimberlites and lamproites, and alluvial diamonds) are painted to yield the patterns seen in the figures. The southern 40 percent of both figures does not contain significant targets within the context of the current exploration models.

The gray scale renderings (figs. 4, 5) present considerable information, but it should be noted that regions of 80% and 90% interest are present within the areas of ≥70% interest. Both Memmi and Pride highlight strongly anomalous areas (≥70%) in the Upper Peninsula (UP) of Michigan, and in southeastern Wyoming, but the latter anomaly extends into northern Colorado only on the map by Pride. Kelsey Lake, CO, is the site of a commercial diamond mine, and diamond-bearing kimberlite has been found at Crystal Falls in the UP Michigan. Both localities lie within the most strongly anomalous areas on the map by Pride, and the locality in UP Michigan is highlighted by Memmi. However, the highlighted regions on both maps are considerably larger than the individual deposits.

The maps by Memmi and Pride identify anomalies in Wisconsin, although the region in west-central WI that is highlighted by Pride does not show up on the map by Memmi — the Rock Elm disturbance is located in this general vicinity (Cordua, 1985), and 14 alluvial diamonds with a total weight of 12.2 carats have been recovered from the area (Gunn, 1968). On the other hand, several "bright spot" anomalies show up in northern Minnesota and southern Ontario on the map by Memmi, but Pride did not identify any of these. The anomalies (fig. 4) average about 1000 km^2 (32km x 32km), and occur along a northeast trend that approximates the boundary between Archean and Early Proterozoic rocks in the region — a setting similar to that of the Argyle lamproite in northwest Australia.

Continued on Page 7

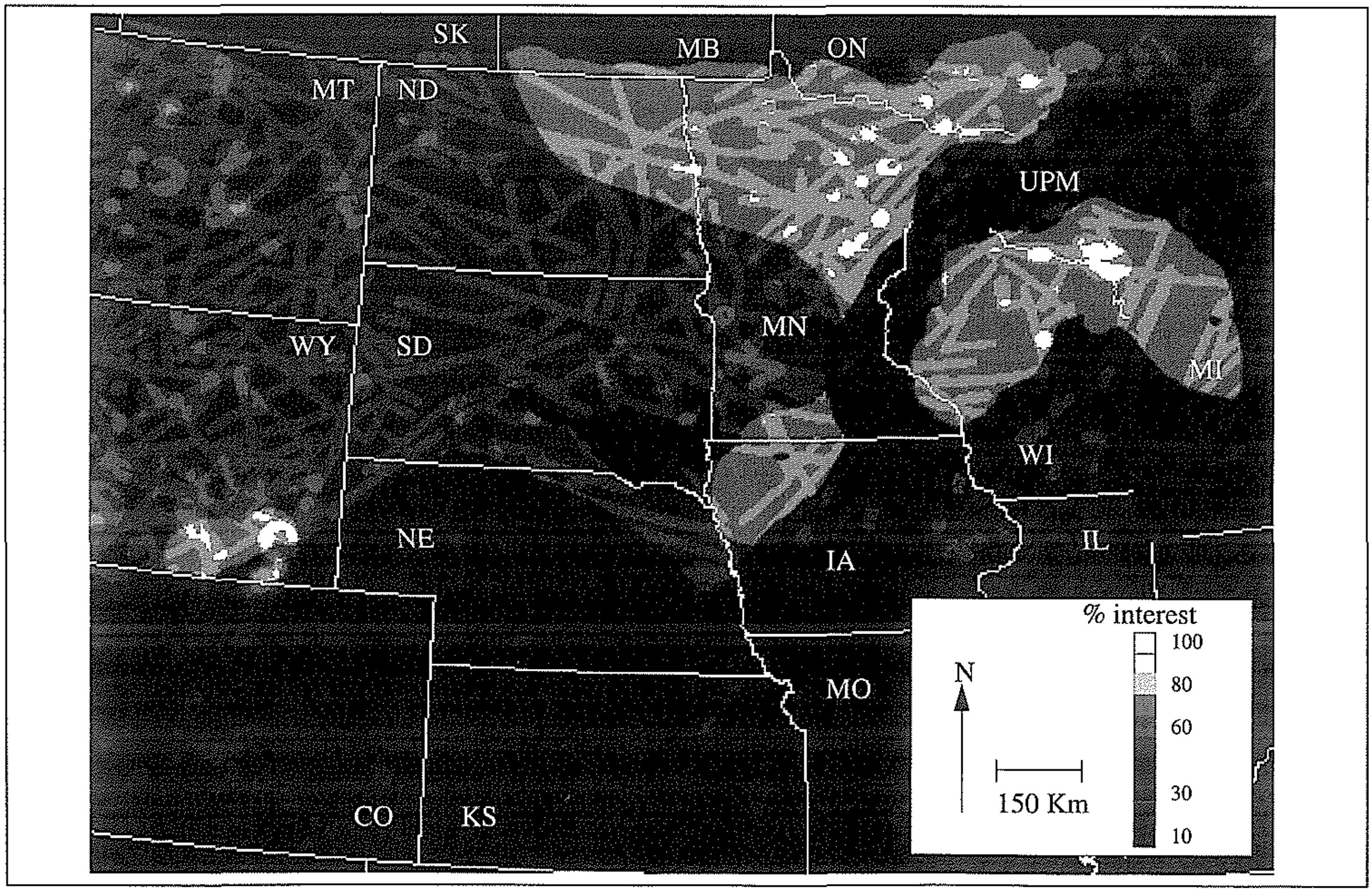

Figure 4. SearchMap based on the interest matrix of Memmi. Bar scale represents percent coincidence of attributes (the "exploration focus" as determined by Memmi). Gray lines are basement faults and lineaments defined by Saunders and Hicks (1976).

Technical Note *Continued from Page 6*

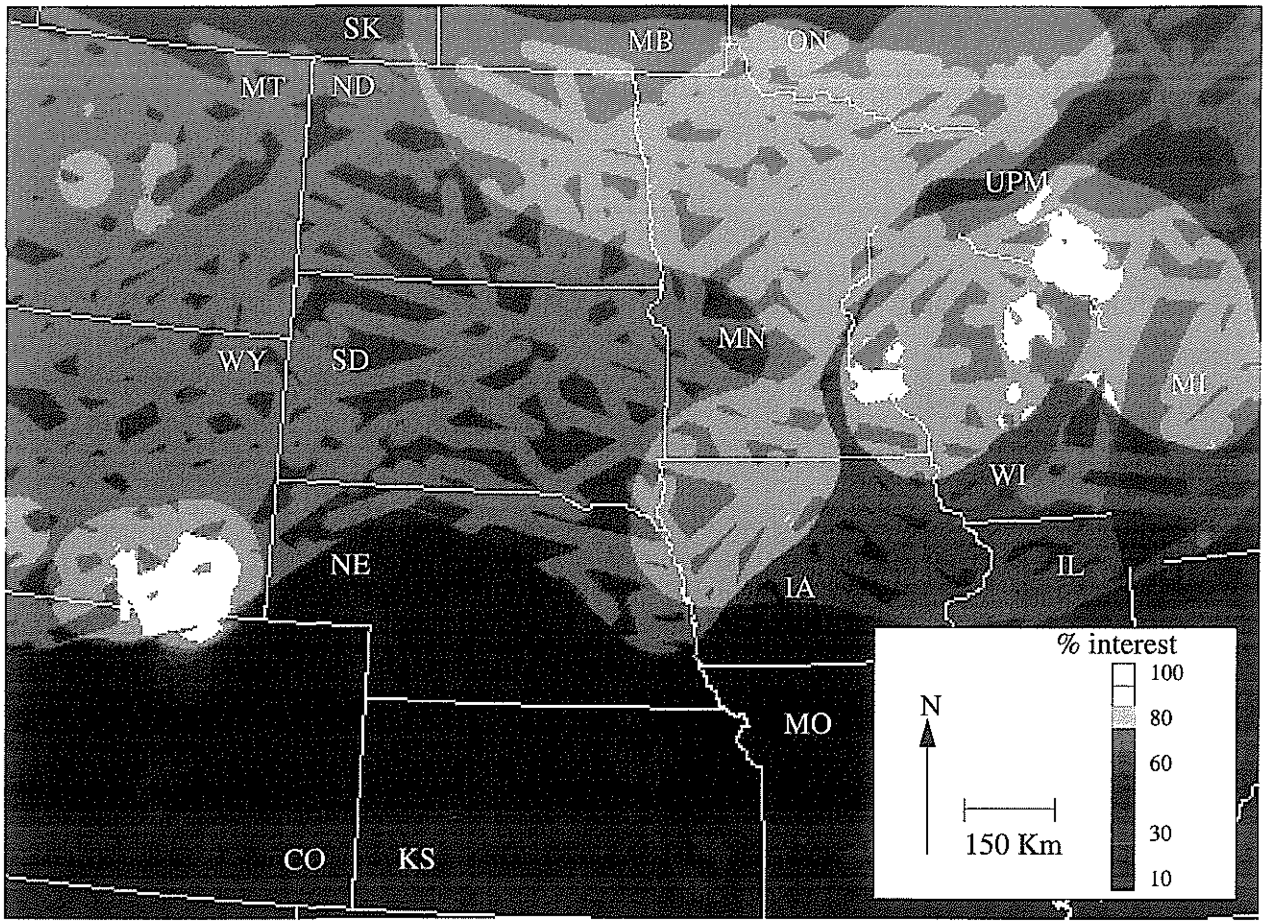

Figure 5. SearchMap based on interest matrix of Pride. Bar scale represents the exploration focus determined by Pride.

Early Proterozoic rocks are present in southern Minnesota and northwest Iowa, and both Memmi and Pride highlight the area for its potential to host economic diamond-bearing (lamproite) intrusions. Both also highlight areas in central and eastern Montana. Lamproite has been described in the Smoky Butte and Froze-to-Death Butte fields of northeastern Montana, and in the Yellow Water Butte field of east-central Montana (Mitchell and Bergman, 1991). The Williams kimberlite cluster (Hearn, 1968) and the Rocky Boy carbonatite (Woolley, 1987) are present in north-central Montana.

The Great Plains region of western Minnesota, North and South Dakota, eastern Montana, and northeastern Wyoming is underlain by Archean and Early Proterozoic basement, and lithosphere that ranges to more than 150 km thick. Kimberlite and lamproite intrusions might be expected to occur there, although none have been reported to date. The Great Lakes tectonic zone (Sims, et al., 1980), which trends northeast from central South Dakota through central Minnesota is cut by several major structures (Saunders and Hicks, 1976). Most notable among these are the Lewis and Clark (SE Wisconsin to central Montana), and the Sheyenne River structure (along the Wisconsin-UP Michigan border, across northern Minnesota and North Dakota, to extreme NE Montana). The Wind River lineament, which extends from southernmost Indiana through southern Wyoming intersects the NE-trending Cheyenne belt (Karlstrom and Houston, 1984) in SE Wyoming. Smaller structures cross all of the major lineaments, and such combinations may be particularly good places to look for kimberlite and lamproite fields — for example, in northeastern South Dakota (fig. 6).

INTEGRATED SEARCHMAPS

Table 2 presents a search matrix that integrates the best of both the Memmi and Pride maps. Memmi was much more successful in focusing exploration in northern Minnesota, but Pride may have had better luck in Wisconsin, plus the latter map highlights larger regions in UP Michigan and SE Wyoming. The bright spot targets in Minnesota may have been isolated because Memmi placed 10 percent interest in occurrences of positive basement flexure axes, which are common in this region (Memmi, 1993). The map by Memmi also isolates the Mid-Continent Rift Zone, which is masked on the map by Pride. However, the margins of the rift probably should be included for their potential as hosts to intrusive activity (e.g., such as that in South Africa — Sykes, 1978), and thus search distances remain sufficient to cover aspects of rift margin geology.

In producing the combined map, we were particularly concerned that the regions of known diamond occurrences and the bright spot anomalies would persist, and we wanted the broad linear structures that cross the northern Great Plains to remain visible. Figure 6 highlights much of the best

Continued on Page 8

Technical Note

Continued from Page 7

of both figures 4 and 5. The prospective regions in UP Michigan and SE Wyoming are plainly evident, as are nearby localities. The bright spot anomalies are subdued in gray scale intensity, but they still are present in central and northern Wisconsin, and in northern Minnesota and southern Ontario. Similar anomalies also are present in southwestern Minnesota, northwestern Iowa, and central Montana.

TABLE 2
INTEGRATED DIAMOND EXPLORATION SEARCH MATRIX

Attribute	Distance(*)	Interest(*)
basement age	72km	23%
lithospheric thickness	60	13
diamond-bearing kimberlite	60	15
kimberlite or lamproite	52	10
alluvial diamonds	64	10
basement fault or lineament	16	10
basement flexure axes	20	10
carbonatite	80	5
cryptoexplosion structure	40	4
		100%

(*) See Table I for explanation of Distance and Interest.

DISCUSSION

SearchMap combines user-friendliness with algorithms to enhance creativity and increase productivity. Users weight input layers interactively until they are satisfied with the result, focusing ever more closely on what their experience tells them is most reasonable. SearchMap software can be applied to data sets from postage stamp to continent in size, and utility is limited only by the imagination of the user, from trace element distributions and mineralization models, to city and regional planning, to agriculture and the military.

Anyone can create SearchMaps, but experienced investigators likely will produce the most useful maps. Applications may be as routine as finding a pathway of minimum slope through rugged terrain, to as challenging as searching for diamonds and gold. Experienced professionals may produce several SearchMaps, each useful for its purpose. SearchMap procedures force users to organize their thoughts, and the technology enables archiving of iterations, preserving the "train-of-thought" for future reference. Iterative modifications can be performed until the locations of attributes known in advance to be significant have been verified — in our example, localities containing diamond-bearing intrusions. Within this context, attributes of suspected significance such as occurrences of alluvial diamonds can be integrated with attributes of known significance in the same SearchMap.

Planned improvements in SearchMap methodology include directional filtering in two and three dimensions, and SearchMapping in multidimensional space. We believe that the addition of directional filtering will allow us to account

Continued on Page 9

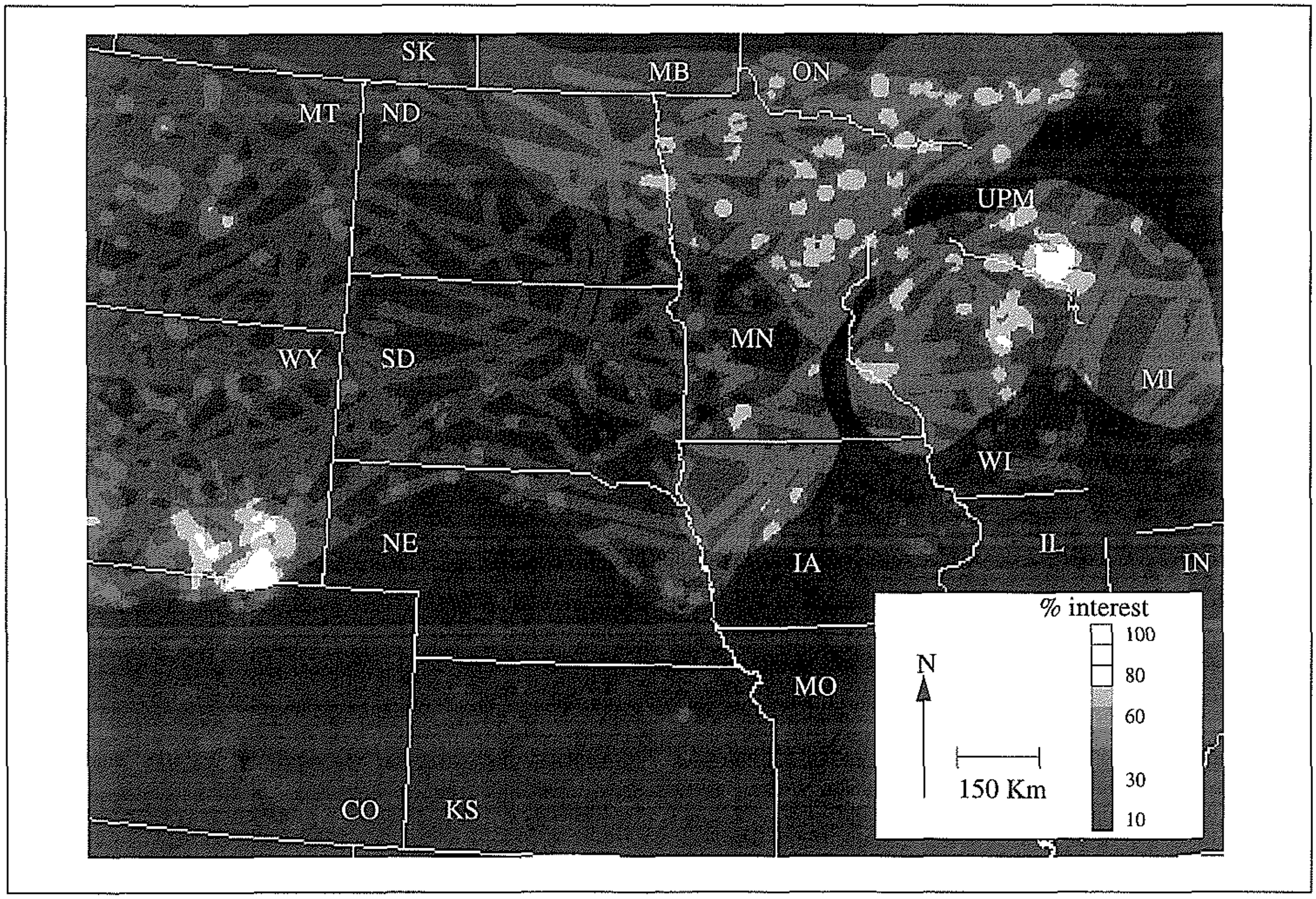

Figure 6. SearchMap based on combined input from Memmi and Pride. Bar scale identifies exploration focus based on the integrated interests of Memmi and Pride.

Technical Note

Continued from Page 8

for ground bias related to (e.g.) lithology, or fluid behavior that may be influenced by lithology and fracture orientation. To date, SearchMaps have been 2D row-column displays, with height (percent interest) as the third dimension. Mapping in multi-dimensional space will allow us to include factors such as color and shade of color, transparency, texture, and time as additional data types. For example, one SearchMap might be represented by height and another by color. Multiple SearchMaps that represent systematic variations in filter characteristics might be stacked, and areas with large values rendered as opaque 3-D objects (isosurfaces).

The ability of the SearchMap software to process changes in parameters in near real-time lends itself directly to animation. Users may wish to display systematic changes in search distance and weight of input layers. Iterations exist as information "frames" that can be added to other such frames to produce an animation product that illuminates suspected mineral occurrences. The animation can be "paused" when known occurrences are revealed in maximum contrast to their surroundings; map patterns of similar character to those that highlight known deposits may be fertile targets for follow-up investigations.

REFERENCES

Cordua, W.S., 1985, Rock Elm structure, Pierce County, Wisconsin: A possible cryptoexplosion structure. Geology, p. 372-374.

Dawson, J.B., 1964, An aid to prospecting for kimberlites. Economic Geology, v. 59, p. 1385-1386.

Gold, D.P., 1984, A diamond exploration philosophy for the 1980s. Earth and Mineral Sciences, The Pennsylvania State Univ. College of Earth and Mineral Sci., v. 53, no. 4, p. 37-42.

Gunn, C.B., 1968, A descriptive catalog of the drift diamonds of the Great Lakes region, North America. Gems and Geology, v. 12, no 10, p. 297-303.

Hearn, B.C., Jr., 1968, Diatremes with kimberlitic affinities in north-central Montana. Science, v. 159, p. 622-625.

Karlstrom, K.E., and Houston, R.S., 1984, The Cheyenne belt: Analysis of a Proterozoic suture in southern Wyoming. Precambrian Research, v. 25, p. 415-446.

Memmi, J.M., 1993, An integrated approach to diamond exploration in the north-central United States. Ph.D. Dissertation, The Ohio State University, Columbus, 223p.

Mitchell, R.H., and Bergman, S.C., 1991, Petrology of Lamproites. New York, Plenum Press, 456p.

Pride, D.E., Memmi, J.M, Loomis, J., and Yagel, R., 1996, SearchMap: Integrating conceptual models with quantitative information in mineral exploration. Geological Society of America Abstracts with Programs, Vol. 28, no. 7, p. 154.

Saunders, D.F., and Hicks, D.E., 1976, Regional geomorphic lineaments on satellite imagery — their origin and application. *in* Podwysocki, M.H., and Earle, J.L. (eds.), Proceedings of the Second International Conference on Basement Tectonics, p. 326-352.

Sims, P.K., Card, K.D., Morey, G.B., and Peterman, Z.E., 1980, The Great Lakes tectonic zone - A major crustal structure in central North America. Geological Society of America Bulletin, Vol. 91, pt. 1, p. 690-698.

Sykes, L.R., 1978, Intraplate seismicity, reactivation of preexisting zones of weakness, alkaline magmatism, and other tectonism postdating continental fragmentation. Reviews of Geophysics and Space Physics, v. 16, no. 4, p. 621-688.

Continued on Page 10

Technical Note

Continued from Page 9

Woolley, A.R., 1987, Alkaline rocks and carbonatites of the world, part 1, North and South America. London, British Museum of Natural History, 216p.

Douglas E. Pride
Department of Geological Sciences
The Ohio State University
125 South Oval Mall
Columbus, OH 43210-1398
E-mail: dougp@geology.ohio-state.edu

John M. Memmi
Apex Technology
519 West Areba Avenue
Hershey, PA 17033-1606

Jeremy Loomis & Roni Yagel
Department of Computer & Information Science
The Ohio State University
2015 Neil Avenue
Columbus, OH 43210-1210

OBITUARY

Helen L. Cannon 1911-1996

Howard McCarthy

Helen Cannon died at her home in Santa Fe, New Mexico on October 20, 1996. Helen was a superb scientist, a pioneer in geobotanical exploration and the effect of the geochemical environment on health, was a bright and tireless worker, and a joy. Helen and I shared an office for two years in building 25 at the Denver Federal Center. During that time, and doing field work together, I came to respect her as a scientist and to value her as a friend.

Helen was born in Wilkinsburg, Pennsylvania on April 29, 1911. Her interest in science began with walks in the Pennsylvania countryside with her father. He encouraged her when she excitededly observed the life in pond or meadow. She was an intelligent young person whose great curiosity led to a lifelong love of the natural world and a desire to understand it.

She attended Cornell University where she was awarded an AB degree in 1932. She did postgraduate work at Northwestern University in 1932-33 and earned an MS degree in geology at the University of Pittsburg in 1934. After a year of postgraduate work at the University of Oklahoma, she joined the geology staff of the Gulf Oil Company in Saginaw, Michigan in 1935. After three years with Gulf, she joined the US Geological Survey in Washington DC and later moved to Denver, Colorado. Her career with the Survey spanned almost 50 years until her retirement in 1989. She was one of only three women geologists in the USGS when she joined, but this did not daunt her.

An opportunity to pursue her interest in geobotany came in 1946, when she proposed that metals taken up by vegetation could indicate the presence of mineral deposits beneath the surface. The broader idea that trace elements in surficial material could be used in mineral exploration was shared by two Survey colleagues, Herb Hawkes and Lyman Huff, and together they formed the first gechemical exploration unit in the United States. Her investigations demonstrated that plants do take up many metals and could be used as guides in prospecting. This application involved collection and chemical analysis of plants for various metals associated with ores. A publication in 1952 on the effect of uranium and vanadium deposits on the vegetation of the Colorado Plateau (Cannon, H.L., Amer. J. Science, v.250, no.10, p.735-770) put geobotanical exploration on a sound scientific footing. This was the first of many publications on the use of geobotany in exploration and resulted in the discovery of uranium deposits in Colorado, New Mexico, and Utah during the "uranium boom" of the 1950's and 1960's. At this time she also observed that certain plants were found only over uranium deposits, and another aspect of geobotanical exploration was born. She found, for example, that the plant *Astragullus pattersoni* required trace amounts of selenium for growth and that this element that was associated with the uranium ores. This led to the reasonable conclusion that mapping the distribution of this plant could be used in exploration for uranium deposits. She also studied the distribution of plant species over other types of ore deposits and the use of "indicator plants" was succesfully applied in exploration (Cannon, H.L., 1957,USGS Bulletin 1030-M, p.399-516).

She also pioneered a third facet of geobotany by recognizing that changes in color or shape of plants was caused by their uptake of various minor and trace elements in soils (Cannon, H.L., 1960, Science, v 132, no 3427, p.591-598). This observation was applied to geochemical exploration by ground observation or by examining colored aerial photographs (which she took) to map areas of possible mineralization. Through this pioneering work she became the recognized authority in the United States, and the world, on geobotanical exploration

In the mid-1960's she began to study the effect of geology and trace elements on health and disease. As her earlier work proved, uranium and vanadium were taken up by plants growing on soils that were enriched in these elements. These results led her to investigate the influence of various trace elements taken up by plants consumed by humans and the effect they had on health and disease (Cannon, H.L. and

Continued on Page 11

Helen Cannon ...

Continued from Page 10

Davidson, D.F., 1957, GSA Special Paper 90, 68 p). She studied the trace element distribution of edible produce in areas where the incidence of cancer and heart disease was high and compared the results with an area of low incidence of these diseases; she found significant differences in element concentrations for plants and soils in the two areas. This led to her association with the American Cancer Society and research on the relation of diet to cancer. All of this pioneering work presaged the idea that the geologic environment can effect the health of humans. She organized and co-chaired the first symposium in the United States on environmental health (Cannon, H.I. and Hopps, H., 1974, National Academy of Sciences, 113 p). as well as other national and international symposia on the relation of the geochemical environment and health.

Honors and awards bestowed on Helen were many. She received the Meritorious Service Award from the Department of the Interior in 1970 and the Distinguished Service Award, the highest award bestowed by the Department, in 1975. She was the first woman to receive membership in American Men of Science. She was a member of the Geological Society of America, serving on the Council and as chair of the Environment and Public Policy Committee. She was a member and served on the Council and various committees of the American Association for the Advancement of Science. She was a member of the Association of Exploration Geochemists and the Society of Environmental Geochemistry. She chaired the subcommittee on the Geochemical Environment in Relation to Health and Disease for the National Research Council.

Helen paved the way for other women in the geosciences by her indomitable spirit and outstanding contributions to science and society. Her life made a difference.

Howard McCarthy
U.S. Geological Survey
Mackay School of Mines
University of Nevada-Reno
Reno, NV 89557-0047

CALENDAR OF EVENTS

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

■May 1-2, 1997, **NORTHCENTRAL GSA SECTION**, Madison, Wisconsin. INFORMATION: Bruce Brown, Wisconsin Geological and Natural History Survey, 3817 Mineral Point Rd., Madison, WI 53705, TEL 608-263—3201, babrown@facstaff.wisc.edu.

■May 17-19, 1997, **Europe's Major Gold Deposits**, Irish Assoc. for Economic Geology and the Inst. of Mining and Metallurgy, Down, No. Ireland. INFORMATION: Kerr Anderson, TEL 353-46-22363, FAX 353-46-22372, navanr@iol.ie and Eibhlin Doyle, TEL 353-1-4785656, FAX 353-1-478-5660, BHP@iol.ie.

■May 19-21, 1997, **Geological Association of Canada—Mineralogical Association of Canada, Ottawa, Canada.** INFORMATION: Geological Survey of Canada, 601 Booth St., Room 757, Ottawa, Canada K1A OE8, Canada, TEL 613-947-7649, FAX 613-947-7650, OTTAWA97@emr.ca.

■May 21-23, 1997, **CORDILLERAN GSA SECTION**, Kailua-Kona, Hawaii. INFORMATION: Fred Mackenzie, Dept. of Oceanography, University of Hawaii-SOEST, 1000 Pope Rd., Honolulu, HI 96822, TEL 808-956-6344, fredm@soest.hawaii.edu.

■May 25-29, 1997, **18th International Geochemical Exploration Symposium**, Jerusalem, Israel. INFORMATION: International Geochemical Exploration Symposium, P.O. Box 50006, Tel Aviv 61500, Israel, TEL 972-3-5140014, FAX 972-3-5175674/660325, iges@mail.gsi.gov.il.

■May 27-30, 1997, **Spring Meeting, American Geophysical Union and American Geochemical Society**, Baltimore, Maryland. INFORMATION: Ronald D. Zwickl (U) , R/E/SE NOAA, 325 Broadway ERL/SEL, Boulder, CO 80303-3328, TEL 303-497-3029, FAX 303-497-3645, rzwickl@sel.noaa.gov

■June 1-5, 1997, **GEOANALYSIS 97**, 3rd Conference on the Analysis of Geological and Environmental Materials, Vail, CO. INFORMATION: Belinda Arbogast, USGS, Denver Federal Center, Box 25046, MS 973, Denver, CO 80225, TEL 303-236-2495, FAX 303-236-3200, geo97@helios.cr.usgs.gov.

■June 2-6, 1997, **7th Annual V.M. Goldschmidt Conference**, Tucson, Arizona. INFORMATION: LeBecca Simmons,

Continued on Page 12

Calendar of Events

Continued from Page 11

Goldschmidt Conference, Lunar and Planetary Institute, 3600 Bay Area Boulevard, Houston TX 77058-1113, USA, TEL 281-486-2158, FAX 281-486-2160, simmons@lpi.jsc.nasa.gov

■June 15-18, 1997, **South American Symposium on Isotope Geology**, Sao Paolo, Brazil. INFORMATION: M. Basei/W. Teixerira, Instituto de Geociencias, USP, Rua do Lago 562, 05508-900 Sao Paolo, SP, Brazil, TEL 55-11-818-3994, FAX 55-11-818-3993, baseimas@usp.br.

■June 15-21, 1997, **Eleventh International Clay Conference**, Ottawa, Ontario. INFORMATION: Jeanne Percival, Geological Survey of Canada, 601 Booth St.,Ottawa, Ontario K1A 0E8, Canada, FAX 613-943-1287, ICC97@gsc.emr.ca.

■June 23-25, 1997, **4th International Conference on the Biogeochemistry of Trace Metals,** Berkeley, Calif. INFORMATION: I.K. Iskandar, US Army Cold Regions, Res. & Eng. Lab, 72 Lyme Rd., Hanover, NH 03755, TEL 603-646-4198, FAX 603-646-4561, iskandar@crrel.usace.army.mil

■August 10-15, 1997, **Gordon Research Conference on Inorganic Geochemistry**: Ore Deposits, New Hampton, New Hampshire. INFORMATION: Mark Reed, Dept. of Geological Sciences, University of Oregon, Eugene, OR 97403-1272, TEL 541-346-5587, FAX 541-346-4692, mhreed@oregon.uoregon.edu or Kevin Shelton, Dept. of Geological Sciences, University of Missouri, Columbia, MO 65211, TEL 573-882-6568, FAX 573-882-5458, geosckls@showme.missouri.edu.

■August 11-13, 1997, **4th Biennial Society for Geology Applied to Mineral Deposits,** Turku, Finland. INFORMATION: Congress Office/SGA Meeting 1997, University of Turku, Lemminkaisenkatu 14-18B, FIN-20520 Turku, Finland, TEL 358-21-333-6342, ceson@utu.fi.

■September 1-5, 1997, **Challenges to Chemical Geology, 10th Meeting of the European Geological Societies**, Carlsbad, Czech Republic. INFORMATION: Dr. MartinNovak, Czech Geol. Survey, Geologicka 6, 15200 Prague 5, Czech Republic, TEL 422-581-71-20, FAX 422-581-87-48, Novak@cgu.cz

■October 5-10, 1997, **4th International Symposium on Environmental Geochemistry**, Vail Colorado. INFORMATION: R.C. Severson or L.P. Gough, USGS, Denver Federal Center, Box 25046, MS 973, Denver, CO 80225, TEL 303-235-5514 or 5513, iseg@helios.cr.usgs.gov.

■October, 20-23, 1997, **Annual Meeting of the Geological Society of America**, Salt Lake City, Utah. INFORMATION: TEL 1-800-472-1988, **Error! Reference source not found.**.

■January 27-30, 1998, **Exploration methods '98-Pathways to Discovery**, Vancover, B.C., Canada by Society of Economic Geologists and British Columbia and Yukon Chamber of Mines. INFORMATION: Jack Patterson, British Columbia and Yukon Chamber of Mines, 840 W. Hastings St., Vancover, B.C. V6C 1C8, Canada. TEL. 1-604-681-5328, FAX 1-604-681-2363.

■March 30-April 3, 1998, **9th International Symposium on Water/Rock Interactions**, Taupo, New Zealand. INFORMATION: B.W. Robinson, Wairakei Research Centre, Institute of Geoligical and Nuclear Sciences, Private Bag 2000, Taupo, New Zealand, TEL 64-7-374-8211, FAX 64-7-

■May 18-20,1998, **Geological Association of Canada** (GAC)-**Mineralogical Association of Canada** (MAC), joint annual mtg., Quebec City, Quebec, Canada (QUEBEC '98,Dept. de geologie et de geologique,Pavillon Adrien-Pouliot, Universite Laval,Sainte-Foy, Quebec, G1K 7P4, Canada; TEL: (418) 656-3137; FAX: (418 656-7339;E-mail: quebec1998@ggl.ulaval.ca; field trips and short course: MineralizedPorphyry-Skarn Systems 374-8199, wri-9@cns.cri.nz.

■October 26-29, 1998, **Annual Meeting of the Geological Society of America**, Toronto, Ontario, Canada. INFORMATION: Pierre Robin, Dept. of Geology, 22 Russell St., Toronto, ON M5S 3B1, Canada, TEL 416-978-3022, FAX 416-978-3938.

■October, 25-28, 1999, **Annual Meeting of the Geological Society of America**, Denver, Colo. INFORMATION: TEL 1-800-472-1988, meetings@geosociety.org

■May 15-28, 2000 **Geology and Ore Deposits 2000** - The Great Basin and Beyond, symposium, Geological Society of Nevada, co-sponsors, Nevada Bureau of Mines & Geology and U.S. Geological Survey, Reno/Sparks, Nevada (Geological Society of Nevada, P.O. Box 12021, Reno, Nevada 89510-2021; TEL: (702) 323-3500; FAX: (702) 323-3599)

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

Virginia T. McLemore
New Mexico Bureau of Mines and Mineral Resources
801 Leroy Place
Socorro, NM 87801 USA
TEL: 505-835-5521
FAX: 505-835-6333
e-mail: ginger@gis.nmt.edu

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

Continued on Page 13

New Members

Continued from Page 12

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

Talbot, David K.
Geochemist
British Geological Survey
Keyworth, U.K.

MEMBERS

Bassim, Abdul F.
Section Supervisor
Ministry of Mineral Resources
Jeddah, SAUDI ARABIA

Black, John E.
Chief Geologist
WMC Chile
Santiago, CHILE

Bobrowsky, Peter
Environmental Geologist
BC Geological Survey
Victoria, BC, CANADA

Chase, Robert
President
South Pacific Resources
Vancouver, BC, CANADA

Davis, Kelly M.
Geochemist (Nicaragua)
WMC
Reno, NV, U.S.A.

De Azevedo, Francisco I., Jr.
Project Manager
GAMSA
Mendoza, ARGENTINA

Derriman, Mark
Normandy Exploration
Perth, WA, AUSTRALIA

Diniz, Helio B.
Regional Manager (Geologist)
Unamgen Mineracao e Metalurgia
Luziania, Go, BRAZIL

Dries, Shanta S.
Exploration Geologist
Normandy Murchison
Peth WA, AUSTRALIA

Ferreira E., Eugenio
Project Geologist
RTZ-CRA Min & Expl
Bristol, U.K.

Howell, William, J.S.
Expl Manager SE Asia
Normandy Anglo Asian
Jakarta, INDONESIA

Lorre, Cristelle
Geochemist
LUISMIN
Durango, MEXICO

McMartin, Isabelle
Quaternary Geologist
GSC
Ottawa, ON, CANADA

Novelo, Luis F.
Manager
Minera Penoles De Argentina
San Juan, Argentina

Sangmor, Samuel
Tech Coordinator (Geologist)
Ashanti Goldfields
Accra, GHANA

Smith, David A.
Manager Pacific Exploration
CRA Exploration
Manila, PHILIPPINES

Westerveld, Thomas N.
Assoc Professor
Department of Geology
Fort Lewis College
Durango, CO, U.S.A.

Williams, Richard
CANARC
Paramaribo, SURINAM

STUDENT

Kato, Tetsuya
Queen's University
Kingston, ON, CANADA

Van Bergen, Frank
University of Utrecht
Utrecht, The Netherlands

RECENT PAPERS

This list comprises titles that have appeared in major publications since the compilation in **EXPLORE** Number 95. 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);

Continued on Page 14

New Members

Continued from Page 13

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**.

Ague, J.J. and van Haren, J.L.M., 1996. Assessing metasomatic mass and volume changes using the Bootstrap, with application to deep crustal hydrothermal alteration of marble. EG 91(7): 1169-1182.

Alipour, S., Cohen, D.R., and Dunlop, A.C., 1997. Characteristics of magnetic and non-magnetic lag in the Cobar area, NSW. J. Geochem. Explor. 58(1): 15-28.

Alipour, S., Dunlop, A.C., and Cohen, D.R., 1995. Morphology of lag in the Cobar region, New South Wales. J. Aust. Geol. And Geophy. 16(3): 253-262.

Bheemalingeswara, K., 1995. Geochemical analysis of bulk and non-magnetic components of acid-treated and untreated heavy-mineral concentrates: Implication on gold exploration. Indian Mineral 49(3): 197-200.

Bonham-Carter, G.F., Galley, A.G., and Hall, G.E.M. (Eds.), 1996. Extech I: A Multidisciplinary Approach to Massive Sulphide Research in the Rusty Lake-Snow Lake Greenstone Belts. GSC Bull. 426. 402 p.

Boult, S., 1996. Fluvial metal transport near sources of acid mine-drainage: Relationships of soluble, suspended and deposited metal. Min. Mag. 60(399): 325.

Bourman, R.P., 1995. Towards distinguishing transported and in-situ ferricretes: Data from southern Australia. J. Aust. Geol. and Geophy. 16(3): 231-242.

Brown, J.G. and Favor, B. (Eds.), 1996. Hydrology and Geochemistry of Aquifer and Stream Contamination Related to Acidic Water in Pinal Creek Basin near Globe, Arizona. USGS Water-Supply Paper 2466. 103 p.

Castro-Larragoitia, J., Kramer, U., and Puchett, H., 1997. 200 years of mining activities at La Paz/San Luis Potosi/Mexico - Consequences for environment and geochemical exploration. J. Geochem. Explor. 58(1): 81-91.

Childe, F., 1996. U-Pb geochronology and Nb and Pb isotope characteristices of the Au-Ag-rich Eskay Creek volcanogenic massive sulfide deposit, British Columbia. EG 91(7): 1209-1224.

Clarke, J.D.A. and Chenoweth, L., 1995. Classification, genesis and evolution of ferruginous surface grains. J. Aust. Geol. and Geophy. 16(3): 213-222.

Claver, N. and Chauduri, S., 1995. Clays in Crustal Environments: Isotope Dating and Tracing. Springer-Verlag. 359 p.

Cleland, J.M., Morey, G.B. and McSwiggen, P.L., 1996. Significance of tourmaline-rich rocks in the North Range Group of the Cuyuna Iron Range, East-Central Minnesota. EG 91(7): 1282-1291.

Coplen, T.B., 1996. New guidelines for reporting stable hydrogen, carbon, and oxygen isotope-ratio data. GCA 60(17): 3359.

Crowley, J.K., 1996. Mg- and K-bearing borates and associated evaporites at Eagle Borax Spring, Death Valley, California: A spectroscopic exploration. EG 91(3): 622-635.

Frei, R., *1996. Sulfur in bulk rock and igneous apatite:* Tracing mineralized and barren trends in intrusions. Schweizerische Mineralogische Und Petrographische Mitteilungen 76(1): 57-74.

Gao, Z.L. and Kwak, T.A.P., 1995. Turbidite-hosted gold deposits in the Bendigo-Ballarat and Melbourne zones, Australia. I. Geology, mineralization, stable isotopes, and implications for exploration. Intern. Geol. Rev. 37(10): 910.

Ghaneshwar, P., 1995. Favourable geochemical characteristics and their utility in search of possible sulfide and allied mineralization in Hyderabad granites. Indian Minerals 49(1/2): 45-54.

Continued on Page 15

Recent Papers

Continued from Page 14

Grabezhev, A.I., Korobeynikov, A.D., and Moloshag, V.P., 1996. Gold in Ural porphyry copper-gold deposits. Geochem. Intern. 33(9): 128.

Hasan, S.E., 1996. Geology and Hazardous Waste Management. Prentice Hall. 387 p.

Heinrich, C.A., Walshe, J.L., and Harrold, B.P., 1996. Chemical mass transfer modelling of ore-forming hydrothermal systems: Current practice and problems. Ore Geol. Rev. 10(3-6): 319-338.

Humphris, S.E., Zierenberg, R.A., Mullineaux, L.S., and Thomson, R.E. (Eds.), 1995. Seafloor Hydrothermal Systems: Physical, Chemical, Biological, and Geological Interactions. Am. Geophys. Union Geophy. Mono 91. 466 p.

Huston, D.L., Taylor, B.E., Bleeker, W., and Watanabe, D.H., 1996. Productivity of volcanic-hosted massive sulfide districts: New constraints from the 8^{18}O of quartz phenocrysts in cogenetic felsic rocks. Geology 24(15): 459-474.

Hutchison, C.S., 1996. South-East Asian Oil, Gas, Coal, and Mineral Deposits. Oxford University Press. 265 p.

Kogarko, L.N., 1996. Geochemical models of supergiant apatite and rare metal deposits related to alkaline magmatism. Geochem. Intern. 33(4): 129.

Komninou, A. and Sverjensky, D.A., 1996. Geochemical modeling of the formation of an unconformity-type uranium deposit. EG 91(3): 590-606.

Kramar, U., 1997. Advances in energy-dispersive x-ray fluorescence. J. Geochem. Explor. 58(1): 73-80.

Krarchenko, E.S., 1996. Prospecting criterion for blind carbonate-hosted Pb-Zn ores. Geologiia Rudnykh Mestorozhdenic 38(4): 273-285.

Lapin, A.V., 1996. Differential mobility of components in the supergene zone as the main factor in the formation of carbonatite weathering crust deposits. Geochem. Intern. 33(6): 1-18.

Lawie, D.C. and Ashley, P.M., 1995. Geochemical characterisation of iron-rich regolith materials in the Olary Block of South Australia. J. Aust. Geol. and Geophy. 16(3): 243-252.

Lintern, M.J., Butt, C.R.M., and Scott, K.M., 1997. Gold in vegetation and soil - three case studies from the goldfields of southern Western Australia. J. Geochem. Explor. 58(1): 1-14.

Maier, W.D., Barnes, S.J., DeKlerk, W.J., Teigler, B., and Mitchell, A.A., 1996. Cu/Pd and Cu/Pt of silicate rocks in the Bushveld Complex: Implications for platinum-group element exploration. EG 91(6): 1151-1158.

Marcus, J.J., 1997. Closing BHP's Island Copper Mine: A study in dignity, honor, and pride. EMJ 198(2): 28-34.

Markl, G. and Schumacher, J.C., 1996. Spatial variations in temperature and composition of geisen-forming fluids: an example from the Varican Triberg Granite Complex, Germany. EG 91(3): 576-589.

Matthai, S.K. and Henley, R.W., 1996. Geochemistry and depositional environment of the gold-mineralized Proterozoic Koolpin formation, Pine Creek inlier, northern Australia: A comparison with modern shale sequences. Precambrian Res. 78(4): 211.

Merk, J.W., 1997. Applied statistics in mineral exploration. Min. Eng. 49(2): 78-82.

Mitchell, R.H. (Ed.), 1996. Undersaturated Alkaline Rocks: Mineralogy, Petrogenesis, and Economic Potential. Min. Assoc. Can. Short Course V. 24. 312 p.

Muller, D. and Groves, D.I., 1997. Potassic Igneous Rocks and Associated Gold-Copper Mineralization. Lecture Notes in Earth Sciences 56. Springer-Verlag.

Nair, R.V.G. and Maji, A.K., 1995. Targeting gold prospects by panning and soil sampling from Attapadi Valley, Kerala. Indian Minerals. 49(3): 131.

Continued on Page 16

Recent Papers

Continued from Page 15

Nayak, B.K., Rajeev, S.M., and Sahoo, R.K., 1995. Implications of factor analysis in the geochemistry of Nishikhal manganese deposit, eastern Ghats, Orissa, India. J. Min., Petrol, and Econ. Geol. 90(10): 341-351.

Noller, B.N., Watters, R.A., and Woods, P.H., 1997. The role of biogeochemical processes in minimizing uranium dispersion from a mine site. J. Geochem. Explor 58(1): 37-50.

O'Hara, M.J. and Fry, N., 1996. The highly compatible trace element paradox-fractional crystallization revisited. J. Petrol. 37(4): 859-890.

Parson, L.M., Walker, C.L., and Dixon, D.R. (Eds.), 1995. Hydrothermal Vents and Processes. Geol. Soc. (London). 411 p.

Phillips, G.N., Groves, D.I., and Kerrich, R., 1996. Factors in the formation of the giant Kalgoorlie gold deposit. Ore Geol. Rev. 10(3-6): 295-318.

Ridley, J., Mikueki, E.J., and Groves, D.I., 1996. Archean lode-gold deposits: Fluid flow and chemical evolution in vertically extensive hydrothermal systems. Ore Geol. Rev. 10(3-6): 279-294.

Robertson, D.M., 1995. Interpretation of fabrics in ferruginous lag. J. Aust. Geol. and Geophys 16(3): 263-270.

Robinson, M., Godwin, C.I., and Stanley, C.R., 1996. Geology lithogeochemistry and alteration of the Battle volcanogenic massive sulfide zone, Butte Lake Mining camp, Vancouver Island, British Columbia. EG 91(3): 527-548.

Ryzhenko, B.N., 1996. Hydrothermal ore formation: Realization of Vinogradov's scientific approach. Geochem. Intern. 33(5): 15-29.

Sergeev, N.B., Bugel'skii, Y.Y., and Kuznetsova, O.Y., 1996. Distribution of gold in the oxidation zone of the Ural massive sulfide deposits: Influence of the primary ore compositions and climate. Geologiia Rudnykh Mestorozhdenii 38(4): 285-296.

Solodov, I.N. and Kochkin, B.T., 1996. Influence of geostructural and geochemical factors on the distribution of technogenous sulfite brines in the aquifer enclosing the Bukinai uranium ore body (Kizil Kum). Geologiia Rudnykh Mestorozhdenii 38(1): 87-102.

Stowell, H.H., Lesher, C.M., Green, N.L., Sha, P., Guthrie, G.M., and Sinha, A.K., 1996. Metamorphism and gold mineralization in the Blue Ridge, southernmost Appalachians. EG 91(6): 1115-1144.

Taylor, G., 1997. Educating explorationists in a regolith dominated continent. J. Geochem. Explor. 58(1): 29-36.

Varentsov, I.M., 1996. Manganese Ores of Supergene Zone: Geochemistry of Formation. Klawer Acad. Pub. (Netherlands). 342 p.

Varshal, G.M., et al., 1996. The relationship between the sorption capacity of the carbonaceous material in rocks for noble metals and its structure. Geochem. Intern. 33(7): 139.

Vasilenko, V.B., Zinchuk, N.N., Kuznetsova, L.G., and Serenko, V.P., 1996. Petrochemical model of the Mir kimberlite pipe. Akademiia Nauk SSSR, Sibirskoe Otdelenie, Geologiia I. Geofrizika 37(2): 97.

Veillette, J.J., 1996. Geomorphologie et Geologie du Quaternaire du Temiscaminque, Quebec et Ontario. GSC Bull. 476. 269 p.

Wang, X., Cheng, Z., Lu, Y., Xu, L., and Xie, X., 1997. Nanoscale metals in Earthgas and mobile forms of metals in overburden in wide-spaced regional exploration for giant deposits in overburden terrains. J. Geochem. Explor. 58(1): 63-72.

Weizhou, S., Dezi, W., and Changshi, L., 1995. Isotope geochemical characteristics and material sources of tin-bearing porphyries in south China. Acta Geologica Sinica 69(4): 359.

Xie, X. and Cheng, H., 1997. The suitability of floodplain sediment as a global sampling medium: evidence from China. J. Geochem. Explor. 58(1): 51-62.

THE CRASH COURSE: A TRIBUTE TO HERB HAWKES

In the spring of 1956, I was hired by Kennco Explorations (Canada) Ltd. for a summer job geochemical prospecting at Newcastle, New Brunswick, Canada. I arrived in Newcastle on a Saturday morning to find that Kennco's geochemical consultant - Herb Hawkes - had completed a short course on stream sediment and soil prospecting for the Kennco staff the night before and he would be leaving late Saturday. As a result, the Kennco staff arranged for Herb to give me a 2 hour "crash" course on geochemical prospecting at Kennco's Clearwater Creek property that afternoon. Later I was to conduct field geochemical prospecting for Kennco in the Newcastle area for the rest of the summer.

Herb immediately impressed me as a gentle and patient teacher. He first explained to me the Bloom test (Bloom, 1955). This is an elegant, cold-extraction, field colorimetric test which determined zinc, copper, and lead simultaneously in samples of stream sediments or other media. During his demonstration, Herb wore white tennis shoes and energetically paddled about in Clearwater Creek. He showed me where and how to collect "active" and "Bank" stream sediment samples and the use of a trenching tool for collecting B horizon soil samples at regular intervals along cut lines. Geochemical samples for verification purposes were put into small, round, aluminum pillboxes prior to chemical treatment at base camp.

At the end of the course he gave me two rules for geochemical prospecting. Rule 1: If you demonstrate a geochemical test to a geologist (or manager) it does not work (even though it worked perfectly a few minutes before the visitor's arrival); and Rule 2: When sampling soils at intervals along a cut line, the highest value will be found at the end of the line. As he was leaving I asked him how to treat any "improvements" I might have regarding the methods he had shown me. His sage rely was instant: "Try it, if it works use it and tell no one. Never discuss unproven ideas." Then, with a few words of encouragement for the summer, he was gone.

Herb's 2 hour short course paid off for Kennco. At the time, the company had just completed negative geological, geophysical, and diamond drilling investigations at the Murray Brook Property and was pulling out. Just before pulling out Kennco obtained access to regional stream sediment geochemical maps of New Brunswick made in 1955 by a Selco team leg by Herb Hawkes (Hawkes and others, 1960). At that time, Bloom test values greater than 7.5 ml dithizone (=7.5D) were considered "anomalous." On the regional maps all values in the Murray Brook area were negative (0-2D) with one exception. This was a 5D value on old forestry campsite on a stream flowing into Murray Brook from the north.

Remembering Herb's Rule No. 2, my assistant and I walked north from the Kennco property through thick cedar swamp to the south bank of Murray Brook. We then found ourselves opposite the forestry camp at a point where the Murray Brook was about 8 feet wide and 2 feet deep. Not

Continued on Page 18

The Crash Course . . .

Continued from Page 17

wanting to get our feet wet, we tested the Murray south bank and, much to our surprise, found and recorded duplicate values higher than 5D! We then moved back into the bush, round the swamp, and returned to sample Murray Brook some 200 feet upstream. We obtained a negative sediment result. Closer investigation of the cedar swamp revealed a little creek flowing into Murray Brook from the south. This creek was not marked on our base map.

The Bloom test on sediment samples from this creek near Murray Brook gave values of 10D and a short distance upstream values of 80D were recorded. Utilizing Herb's advice, I established that 80D in sediment was equivalent to 1D in a test tube of water. We then proceeded upstream and the water values went from 1D to 24D and finally back to zero in the sediment. Although there was little sign of it except a small rusty zone, we had located the geochemical anomaly due to the Murray Brook deposit!

Kennco then initiated what would now be called a "disinformation" campaign for several months until the local land situation had been resolved. The company then moved back to explore the deposit in detail (Fleming, 1961; Rennick and others, 1992). The Murray deposit is now one of the first important finds accredited to stream sediment geochemistry (Rose and others, 1979).

References

Bloom, H., 1955. A field method for the determination of ammonium citrate-soluable heavy metals in soil and alluvium, Economic Geology 50, p. 533-541.

Hawkes, H.E., Bloom, H., Riddell, J.E., and others, 1960. Geochemical reconnaissance in eastern Canada: in Symposium de Exploracion Geoquimica, Proc. 20th Geol. Cong., Mexico City, 1956, 3, p. 607-621.

Fleming, H.W., 1961. The Murray Brook deposit, Restigouche County, N.B.: A geochemical-geophysical discovery; CIM Bulletin No. 587, p. 230-235.

Rennick, M.P. and Burton, D.M., 1992. The Murray Brook deposit, Bathurst Camp, New Brunswick; Geological setting and recent developments; Explor. Mining Geol. 1, No. 2, p. 137-142.

Rose, A.W., Hawkes, H., and Webb, J.S., 1979. Geochemistry in mineral exploration, 2ed., Academic Press, p. 7.

John Fortescue
40M, 1315 East Grand Ave.
Escondido, CA 92027

20TH INTERNATIONAL GEOCHEMICAL EXPLORATION SYMPOSIUM, 2001

The Association of Exploration Geochemists is looking for a venue for the 20th IGES. The Association will consider all proposals for hosting this event. Proposals must include the following:

- Location
- Date
- Sponsoring organization
- Meeting title or theme
- Contact person(s)
- Suggested outline for meeting
- Suggested field trips and short courses
- Facilities
- Brief description of the locality

Any interested organizations should submit their proposals to the AEG Business Office

The Association of Exploration Geochemists
P.O. Box 26099
72 Robertson Road
Nepean, ON K2H 9R0
CANADA

4th International Symposium on Environmental Geochemistry

October 5 - 10, 1997 - Vail, Colorado

Organized by
U.S. Geological Survey (USGS)
Association of Exploration Geochemists (AEG)
Society for Environmental Geochemistry and Health (SEGH)
in collaboration with
USGS Center for Environmental Geochemistry and Geophysics (CEGG)
and International Association of Geochemistry and Cosmochemistry (IAGC)

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

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.

Correspondence

Contact persons:

Drs. R. C. Severson or L.P. Gough
U.S. Geological Survey, Federal Center
Box 25046, MS 973
Denver, CO 80225 USA
Phone: 303-236-5514 or 5513
Fax: 303-236-3200
e-mail: iseg@helios.cr.usgs.gov

Please share this information with colleagues.

ASSOCIATION OF EXPLORATION GEOCHEMISTS

SPECIAL BOOKS OFFER 1996/1997

The following books published by ELSEVIER SCIENCE are available from the AEG on a post-paid basis. Members are entitled to a reduction of the normal price.

Author/Title	Non-member Price US$	Member Price US$	
Augustithis, S.S. Atlas of Metamorphic-Metasomatic Textures and Processes	245.75	147.50	________
Bárdossy, G. and Aleva G.J.J. Lateritic Bauxites	234.50	140.70	________
Buchanan, D.L. Platinum-Group Element Exploration	133.25	79.00	________
Butt, C.R.M. and Zeegers, H. Regolith Exploration Geochemistry in Tropical and Subtropical Terrains	258.75	155.00	________
Chapman, N.A. et al. The Poços de Caldas Project: Natural Analogues of Processes in a Radioactive Waste Repository	249.50	149.00	________
Das, H.A., Faanhof, A. and van de Sloot, H.A. Radioanalysis in Geochemistry	167.00	100.00	________
David, M. Handbook of Applied Advances Geostatistical Ore Reserve Estimation	120.75	72.00	________
Didier, J. and Barbarin, B. Enclaves and Granite Petrology	212.00	127.00	________
Govett, G.J.S. Rock Geochemistry in Mineral Exploration	216.25	130.00	________
Gulson, B.L. Lead Isotopes in Mineral Exploration	142.00	85.00	________
Hedenquist, J.W., White, N.C. and Siddely G. Epithermal Gold Mineralization of the Circum-Pacific: Geology, Geochemistry, Origin and Exploration	380.00	228.00	________
Howarth, R.J. Statistics and Data Analysis in Geochemical Prospecting	212.50	127.00	________
Kauranne, L.K., Salminen, R. and Eriksson, K. Regolith Exploration Geochemistry in Arctic and Temperate Terrains	201.25	120.00	________
Laznicka, P. Breccias and Coarse Fragmentites	279.50	167.00	________
Mysen, B.O. Structure and Properties of Silicate Melts	142.00	85.00	________
Naqvi, S.M. Precambrian Continental Crust and its Economic Resources	190.75	114.00	________
Handling Fee	10.00	10.00	________
	Total Payment enclosed		________

Orders must be accompanied by payment. Orders will be shipped by surface mail.
Send orders to AEG, P.O. Box 26099, 72 Robertson Rd., Nepean, Ontario K2H 9RO, Canada. Fax orders (+1) 613-828-9288

Please note that cheques, International Money Orders, UNESCO coupons, InternationalPostal Orders, VISA and MasterCards are acceptable. All payments are in US funds.

For users of VISA or MasterCard, minor variations in billing may reflect currency echange rates at the time of bank posting. Please note that the cheques drawn on overseas banks require an additional US$15.00 to be submitted to reimburse the AEG for bank charges.

Charge ☐ MasterCard ☐ VISA

Credit Card Account number here:

____

Expiration date: ________________________

Signature ________________________

Name ________________________

Address ________________________

____

AEG PUBLICATIONS

The following special volumes are available from the AEG on a post-paid basis (surface mail) to all.
Both member and non-member prices are listed.

Sp. Vol. No.		Description	Member Price	Non-Member Price	
4		Application of Probability Plots in Mineral Exploration (A.J. Sinclair)	US $ 8.00	US $12.00	____
14	★	PROBPLOT, An Interactive Computer Program to Fit Mixtures of Normal (or Log Normal) Distributions with Maximum Likelihood Optimization Procedures (C.R. Stanley). On 3.5" diskette; requires 1 mb hard disk space	US $30.00	US $55.00	____
4+14	★	Combination offer	US $35.00	US $60.00	____
7		Geochemical Exploration 1977 Proceedings of the Denver Geochemical Symposium (ed. J.R. Waterson and P.K. Theobald)	US $20.00	US $40.00	____
10		Gold-81, Precious Metals in the Northern Cordillera (ed. A.A. Levinson)	US $ 7.50	US $18.00	____
11		Exploration Geochemistry Bibliography to January 1981 (complied by H.E. Hawkes)	US $10.00	US $20.00	____
11.1		Exploration Geochemistry Bibliography Supplement 1 to October 1984 (complied by H.E. Hawkes)	US $10.00	US $17.00	____
11.2		Exploration Geochemistry Bibliography Supplement 2 to October 1987 (complied by H.E. Hawkes)	US $10.00	US $17.00	____
—		Digital bibliography - entire AEG bibliography through 1994. A *.dbf file on 3.5" diskette (requires 14 mb hard disk space)	US $10.00	US $20.00	____
12		Writing Geochemical Reports (S.J. Hoffman)	US $ 5.00	US $ 7.00	____
—		Geochemical Exploration 1980 - Hannover (ed. A.W. Rose and H. Gundlach). Hard cover edition	US $35.00	US $50.00	____
—		GEOEXPO/86, Proceedings of an exploration symposium focussing on Cordilleran environments held in Vancouver May 12-14, 1986 (ed. I.L Elliot and B.W. Smee)	US $25.00	US $25.00	____
—		Reviews in Economic Geology Volume 3. Exploration Geochemistry; Design and Interpretation of Soil Syrveys (ed. W.K. Fletcher). This volume was co-sponsored by the SEG	US $20.00	US $25.00	____
—		1992 AEG Membership Listing and Directory of Exploration Geochemical and Environmental Services	US $10.00	US $20.00	____
—		Epithermal Gold Mineralization of the Circum-Pacific; Geology, Geochemistry, Origin and Exploration, Volumes 1 and 2.	US $160.00	US $246.00	____
—		Soils of the World. Colour wall chart. 95 cm x 135 cm in size. Published by Elsevier.	US $22.00	US $28.00	____
SPECIAL 1.		Practical Problems in Exploration Geochemistry, 1987. (A.A. Levinson, P.M.D. Bradshaw and I. Thomson) 269 pp.	US $35.00	US $80.00	____
—		17th IGES Extended Abstracts from "Exploring the Tropics", 15-19 May, 1995, Townsville Australia (for airmail add $20)	US $50.00	US $65.00	____
—		A Global Geochemical Database for Environmental and Resource Management, Recommendations for International Geochemical Mapping, Final Report of IGCP Project 259. (A.G. Darnley A. Bjorkland, B. Bolviken, N. Gustavsson, P.V. Koval, J.A. Plant, A. Steenfeld, M. Tauchid and Xie Xuejing; with contributions by R. Garrett, and G.E.M Hall).	US $20.00	US $20.00	____
—		Geochemistry in Mineral Exploration (second edition, published 1979) (A.W. Rose, H.E. Hawkes, and J.S. Webb) - airmail US$10.00/International $20.00 additional	US $60.00	US $80.00	____
—		Journal of Geochemical Exploration in Subscription Years 1994 and earlier, whole year or part	US $70.00	N/A	____

NOTE: Members may order back issues or volumes for the usual membership fee. The member may elect to receive all issues of that subscription year or just the issue/volume desired (the price is the same). The 1995 subscription year will be "back issued" six months after completion (ca. Oct., 1995).

Notes for Short Courses on Biogeochemical Exploration. Each book comprises 200-250 pages of text, figures, tables, and photos. The content of each is similar, except different aspects are emphasized. All prices quoted are for surface mailing; if airmail is desired please add (US)$15.00

	Description	Member Price	Non-Member Price	
—	Biogeochemical Exploration, Simplified - with emphasis on arid terrains (C.E. Dunn, J.A. Erdman, G.E.M. Hall, and S.C. Smith) Note: this text includes geobotanical aspects in some detail	US $50.00	US $50.00	____
—	Applied Biogeochemical Prospecting in Forested Terrain (C.E. Dunn, G.E.M. Hall, and Scagel) Note: this text includes a 42 page discourse on plants	US $50.00	US $50.00	____
—	Applied Biogeochemistry in Mineral Exploration and Environmental Studies (C.E. Dunn, G.E.M. Hall, R. Scagel, D. Cohen, P. Catt, and M. Lintern)	US $55.00	US $55.00	____

Note: This text is an expansion of the volume 'Applied Biogeochemical Prospecting in Forested Terrain' and includes several case histories from Australia. In Australia the volume can be obtained from Dr. David Cohen, Dept. Geology, Univ. New South Wales, Sydney, AUSTRALIA, for Aus$60.00.

	Member	Non-Member	
Do you need a receipt? Include self-addressed envelope and US $ 2.00, otherwise your cancelled check or bank card statement is your receipt.	US $ 2.00	US $ 2.00	____
Is your check drawn on a bank outside U.S.A. or Canada? If yes, add US $ 15.00.	US $15.00	US $15.00	____
Do you require airmail? If yes, add US $10.00 per volume, unless otherwise noted. (Specify number of volumes)	____ X	US $10.00	____
	TOTAL US $		____

Send Orders to: P.O. Box 26099, 72 Robertson Road, Nepean, Ontario, K2H 9R0, CANADA; FAX: (613) 828-9288

AEG APPLICATION FOR NON-VOTING MEMBERSHIP*

to the Association of Exploration Geochemists

Please complete the section relevant to the class of membership sought and supply your address on this form. Mail the completed application, together with annual dues, to the address below.

MEMBER

I ____________________ wish to apply for election as a Member of the Association of Exploration Geochemists. I am presently employed by:

____________________ as a ____________________.
(employer) (employment title)

I am actively engaged in scientific or technological work related to geochemical exploration and have been so for the past two years. Upon receipt of the Code of Ethics of the Association I will read them and, in the event of being elected a Member, agree to honour and abide by them. Witness my hand this_____day of__________19_____. ____________________
(Signature of applicant)

STUDENT MEMBER

I ____________________ wish to apply for election as a Student Member of the Association of Exploration Geochemists. I am presently engaged as a full-time student at ____________________, where I am taking a course in pure or applied science. I have read the Code of Ethics of the Association and in the event of being elected a Student Member agree to honour and abide by them. Witness my hand this_____day of__________19_____.

____
(Signature of applicant)

Student status must be verified by a Professor of your institution or a Fellow of the Association of Exploration Geochemists. I certify that the applicant is a full-time student at this institution.

____________________ ____________________
(Signature) (Printed Name and Title)

NAME AND ADDRESS

(to be completed by all applicants)

Name: ____________________
Address: ____________________
____
____
____

Telephone:
bus: ____________________
fax: ____________________
home: ____________________
email: ____________________

Annual Dues

All applications must be accompanied by annual dues. Select one or two below:

1	1995 member dues	US$	70	______
2	1995 student member dues		40	______
	If you require a receipt, include a self-addressed envelope and add		2	______
	If your check is not drawn from a U.S.A. or Canadian bank, add		15	______
			TOTAL	______

All payments must be in US funds. Payment by check, International Money Order, UNESCO Coupons, International Postal Orders, VISA and Master Card are acceptable. For users of VISA or Master Card, minor variations in your billing may reflect currency exchange rate fluctuations at time of bank transaction.

If you pay by charge card, please provide the following information: type: Master Card _____ VISA _____

Credit card account number:____________________ Expiration date: ____________________.

Name:____________________Signature:____________________

Please note: Your completed form should be mailed to the Business Office of the Association and will be acknowledged upon receipt. The Admissions Committee reviews all applications and submits recommendations to Council, who will review these recommendations at the next Council Meeting or by correspondence. If no objection is raised the names, addresses and positions of candidates will be listed in the next issue of the Association Newsletter. If after a minimum of 60 days have elapsed following submission of candidate information to the membership no signed letters objecting to candidates admission are received by the Secretary of the Association from any Member, the Candidate shall be deemed elected, subject to the receipt by the Association of payment of required dues. Send completed application, together with annual dues to:

Association of Exploration Geochemists, P.O. Box 26099, 72 Robertson Road, Nepean, Ontario, CANADA K2H 9R0
TEL: (613) 828-0199, FAX: (613) 828-9288, email: aeg@synapse.net

*Application for voting membership requires the sponsorship of three voting members. Request a voting member application from the Association office.

THE ASSOCIATION OF EXPLORATION GEOCHEMISTS

P.O. Box 26099, 72 Robertson Road, Nepean, Ontario K2H 9R0 CANADA
Telephone (613) 828-0199

OFFICERS

January - December 1997

David Garnett, *President*
General Manager
Becquerel Laboratories Pty, Ltd.
PMB 1
Menai, New South Wales
AUSTRALIA 2234
TEL: (612) 9543-2644
FAX: (612) 9543-2655
email: naa@bq.com.au

Peter R. Simpson, *First Vice President*
BGS Honorary Research Associate
British Geological Survey, Kingsley Dunham Centre
Keyworth, Nottingham NG12 5GG
UNITED KINGDOM
TEL: 44 1159 363-532
Fax: 44 602 363 200
email: p.simpson@bgs.ac.uk

Erick F. Weiland, *Second Vice President*
AGRA Earth and Environmental
5531 East Kelso Street
Tucson, AZ 85712
USA
TEL: (602) 296-5940
FAX: (602) 721-7431
email: 74761.614@compuserve.com

Sherman P. Marsh, *Secretary*
U.S. Geological Survey
MS 973, Denver Federal Center
Denver, CO 80225
USA
TEL: (303) 236-5521
FAX: (303) 236-3200
email: smarsh@helios.cr.usgs.gov

Gwendy E.M. Hall, *Treasurer*
Geological Survey of Canada
601 Booth Street, Room 702
Ottawa, ON K1A 0E8
CANADA
TEL: (613) 992-6425
FAX: (613) 996-3726
email: hall@gsc.nrcan.gc.ca

COUNCILLORS

1996-1998
Stephen J. Cook
Gwendy E.M. Hall (ex-officio)
Richard K. Glanzman
J. Thomas Nash
M. Beth McClenaghan
Erick F. Weiland

1997-1999
Robert Clark
William B. Coker (ex officio)
John S. Cone
Stephen J. Day
Shea Clark Smith
Barry W. Smee

Australia 1995-1997
Leigh Bettenay
Nigel Radford
Mark Elliott

Brazil 1995-1997
Marcondes Lima Da Costa

Chile 1996-1998
Chris J. Oates

China 1995-1997
Guangsheng Yan

Europe 1996-1998
Boudewijn de Smeth

Northern Countries 1996-1998
Clemens Reimann

Southeast Asia 1996-1998
Tawsaporn Nuchangong

Southern Africa 1996-1998
Charles Okujeni

UK and Republic of Ireland 1996-1998
Christopher C. Johnson

COMMITTEES

Australian Geoscience Council Representative
Russell D. Birrell

Awards and Medals Committee
Gwendy E. M. Hall, *Chair 1996-1997*
John S. Cone
Robert G. Garrett
Günter Matheis
Barry W. Smee

Bibliography Committee
L. Graham Closs, *Chair*
Robert G. Garrett
Richard K. Glanzman
Eric C. Grunsky
Gwendy E.M. Hall
Peter J. Rogers

Distinguished Lecturer Committee
Graham F. Taylor, *Chair*

Election Official
Ray E. Lett

Environmental Committee
Richard K. Glanzman, *Chair*
Cecil C. Begley
Peter H. Davenport
Gwendy E.M. Hall
Keith Nicholson

EXPLORE
J. Thomas Nash, Editor
Sherman P. Marsh, Editor
Owen P. Lavin, *Business Manager*

Journal of Geochemical Exploration
Eion M. Cameron, *Editor-in-Chief*

Admissions Committee
Lloyd D. James, *Chair*
L. Graham Closs
Jeffrey A. Jaacks

Publicity Committee
Andrew Bourque, *Chair*
Sherman P. Marsh
J. Stevens Zuker
R. Steve Friberg

Regional Councillor Coordinator
David L. Garnett

Short Course Committee
Colin E. Dunn, *Chair*

Student Paper Competition Committee
Ian Robertson, *Chair*
Frederic R. Siegel
Arthur E. Soregaroli
Todd Wakefield

Symposia Committee
Frederic R. Siegel, *Chair*
Gwendy Hall
Eion Cameron
Graham F Taylor
Barry W. Smee

Betty Arseneault, *Business Manager*
P.O. Box 26099, 72 Robertson Road, Nepean, ON K2H 9R0 CANADA, TEL: (613) 828-0199 FAX: (613) 828-9288, e-mail: aeg@synapse.net

LIST OF ADVERTISERS

EXPLORE

Newsletter for The Association of Exploration Geochemists

MS973, P.O. Box 25046, Federal Center, Denver, CO 80225-0046, USA

Please send changes of address to:
Association of Exploration Geochemists
P.O. Box 26099, 72 Robertson Road, Nepean, Ontario, K2H 9R0, Canada · TEL: (613) 828-0199 FAX: (613) 828-9288
e-mail: aeg@synapse.net

NON-PROFIT ORG.
U.S. POSTAGE
PAID
PERMIT NO. 3550
DENVER, CO