



THE ASSOCIATION OF EXPLORATION GEOCHEMISTS

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NEWSLETTER

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The process of incorporation of the Association is nearing completion. You will shortly be receiving a copy of the document of incorporation which will become the Constitution of the Association and will be submitted for approval to the Annual General Meeting in April 1977. This document is based in most essentials upon our current constitution, incorporating minor changes to meet the legal requirements of incorporation. The opportunity has also been taken to make some changes that we hope may benefit the Association. In particular, the regulations regarding admission to Affiliate status have been simplified and should enable potential members in remote areas to more easily join the Association.

A matter of considerable interest to full-time students are negotiations now underway to arrange for them to receive the Journal of Geochemical Exploration at a discounted price. If present plans materialize, it is probable that the scheme will have to be introduced for a trial period in North America before it can be extended to other areas of the world.

This is the fourth -- and final -- Newsletter that will be issued during the 1976-1977 Association year. It is worth recalling that the purpose of a Newsletter is to literally give news to the membership and to maintain contact between them and the executive. The Newsletter is composed largely by the President and the Secretary from material available to them or which they directly solicit. In my first Newsletter as President I made a plea for you to submit material for inclusion in these pages. The response has been less than overwhelming, but a number of people around the world have promised to submit reports of national activities in their own countries (we should see evidence of this in future issues). I will now repeat my appeal to you to contribute to the Association through submitting news from your local area, technical reports, and anything else of geochemical interest. For example, many people in government positions write short accounts of geochemical activities that are published in government annual reports or information circulars and are rarely seen beyond the local area; send us the title and reference (or a few-hundred word summary) for publication in the Newsletter.

The character of the Association depends entirely upon the degree of your participation in its affairs. The most direct influence you can exert is to record your vote for Ordinary Councillors (a ballot sheet for the 1977-1979 election is included in this Newsletter). Remember, The Council is the governing body of the Association and the executive is elected by the Councillors. So take the time to complete your ballot form and return it to the Toronto office of the Association.

The very best wishes for successful exploration geochemistry in 1977.

G.J.S. Govett, President

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THRESHOLD -- FACT OR FICTION ?

The final session of the 6th International Geochemical Exploration Symposium in Australia on the afternoon of 24 August 1976 was devoted to a workshop format to debate the question "Threshold -- Fact or Fiction?". The Chairman for the workshop was Professor G.J.S. Govett who introduced the fourstage-setting speakers -- A.L. Mather, N.L. Marshall, D.H. Mackenzie, and M.A. Chaffee -- and thereafter attempted the dual role of provoking discussion and maintaining order. Useful discussion ranged widely over the problems of interpreting geochemical data, but no clear-cut conclusion regarding the validity of the concept of threshold emerged. Although Professor Govett concluded the session by stating that he believed that the best approach to a consensus was that "...threshold is a real number, derived by any technique, that leads the geochemist to believe that he can recognize an anomalous sample that he hopes is indicative of mineralisation", there were many shaking heads of dissent in the audience.

To preserve informality and to encourage a free discussion, no record of the proceedings was taken. However, an edited version of the formal presentations is given below.

Please be advised that the following remarks and presentations by the workshop participants have not necessarily been prepared or edited to the standards of scientific journal presentations but are included to keep the AEG members informed of current thoughts and ideas.

ANALYTICAL STATISTICS by A.L. MATHER (Geochemical & Mineralogical Laboratories Pty. Ltd.)

The threshold of any element may be defined as that concentration which, if exceeded, may be considered significant in terms of mineralisation. Numerous methods have been devised to arrive at this value by statistical and other methods. However, before data can be treated statistically to provide a valid threshold one must examine carefully the means by which the data has been obtained and also critically examine the material collected in the geochemical survey.

The principal objective of geochemical surveys is to detect and determine metal transported either physically or chemically from a mineralised area. Ideally the geochemical sample should be analysed in such a way that metal derived from the mineralised rock is selectively extracted and determined while the same metal derived from unmineralised rock is at least only partially extracted. However, in many geochemical surveys being conducted at the present time, the composition of soils or sediments is not taken into consideration. The material, after perhaps being screened through 80 mesh, is digested more often than not in concentrated perchloric acid at 190 degrees Centigrade prior to analysis by atomic absorption. This attack breaks down most of the silicates and dissolves most of the oxide minerals leaving only a few refractory minerals unattacked. Thus total or near total metal values are obtained for subsequent data processing and determination of threshold.

Let us look at the composition of stream sediment samples more closely. Metal from both mineralised and non-mineralised rock may be transported

- (a) as grains of unweathered sulphides or other ore minerals
- (b) as grains of oxidised sulphides or altered ore minerals
- (c) coprecipitated from solution with iron or manganese hydrous oxides
- (d) adsorbed onto clays
- (e) adsorbed or combined with organic matter or organo-clay complexes
- (f) within grains of rock forming minerals
- (g) within weathering products of rock forming minerals

(a) and (b) are components directly related to mineralisation while (c) (d) and (e) may be derived from both mineralised and unmineralised rock; (f) and (g) are components not related to mineralisation.

Thus, we may have in all geochemical soil and sediments samples a mineralised component, a non-mineralised component and an intermediate component in which the mineralised and non-mineralised components may contribute. The relative dominance of these various components will vary according to the climatic and geological environment.

In an arid environment with occasional sheetwash conditions dispersion will be essentially physical with the main anomalous component being secondary minerals such as malachite, smithsonite and cerussite or even gossan fragments. The non-mineralised or background component is largely related to the metal content of the country rock.

Most of you are aware of the distribution of the elements in the various rock types, but to illustrate the problems inherent in total extraction of (f) and (g) I have selected a few rock types and minerals particularly enriched in certain elements.

<u>Metal/element</u>	<u>Rock type or mineral</u>	<u>Average or max. content ppm</u>
Arsenic	Shales	Av 13
	Haematite	Max 500
	Phosphorites	Max 150
Barium	Plagioclase	Max 5000
	Shale	Av 580
	Limestones	Av 100

Beryllium	Magnetite	Max 7
	Neph. Syenite	Max 220
	Granites	Max 20
Copper	Magnetite	Max 400
	Basalt	Av 87
	Shales	Av 45
Nickel	Serpentine	Max 10,000
	Magnetite	Max 5,000
Lead	Plagioclase	Max 100
	Magnetite	Max 500
	Shales	Av 20
Tin	Sphene	Max 10%
	Biotite	Max 5,000
	Magnetite	Max 500
Uranium	Zircon	Max 10,000
	Apatite	Max 5,00
	Sphene	Max 3,000
Zinc	Magnetite	Max 4,000

You will no doubt recognise some of the rocks or minerals encountered in surveys that have contributed to high background and have made the determination of threshold difficult. Obviously these are not the day-to-day metal values encountered in routine surveys but they do emphasise the problem of high background capable of masking low anomalies. Magnetite, as you will note, can have a high metal content and heterogeneous distribution of this and other heavy minerals in the stream sediments would cause large fluctuations in the background values in sediments from such areas.

At the other end of the climatic spectrum a wet environment with a topography of medium relief would undoubtedly produce stream sediments where chemical dispersion would be dominant. Metal would be absorbed and precipitated in the intermediate component. In the analysis of this type of stream sediment, it has been a long established practice to use cold extraction methods which not only are convenient on-the-spot analytical techniques but commonly selectively extract part of the mineralised component to the virtual exclusion of the non-mineralised material. With this type of selective extraction background is very low and the contrast is considerably greater than if total extraction had been carried out. Selective extraction then, has been adopted by many many exploration groups - particularly in wet climatic conditions - and they have enjoyed considerable success. This, however, is not the case with surveys in arid areas in Australia where, in the past, attempts to use standard cold extraction methods have generally met with failure. Consequently, in most surveys in these areas, to my knowledge, high metal extraction techniques (i.e. perchloric or aqua regia) are currently used in the analysis of these samples.

Consider a hypothetical case in an arid area where a supergene layer of base metal carbonates overlies sulphides, and a small portion of these carbonates have been physically comminuted and dispersed into a large drainage basin. Although the primary mineralisation may be large, there is no leaching (unlike in a wet environment) to allow transfer of appreciable amounts of metal to the drainage; and the limited exposure of mineralisation is insufficient to supply significant amounts of metal to the drainage. In these circumstances, a non-mineralised component of moderate metal content can completely mask values contributed by these detrital grains of base metal carbonates. In other words, values of say 10 or 20 ppm Cu contributed by malachite grains could be completely obscured by a copper background of 50 ppm Cu. Certainly a variation of 20 ppm over and above a threshold of 50 ppm would not normally be recognised as significantly anomalous; if an anomaly of 20 ppm could be identified as such it would be important.

Some time ago we decided to look more closely at this problem from the basic premise that most minerals have dissimilar solubilities and that these solubilities vary with type of acid, strength of acid, temperature of digestion and period of digestion. Initial tests of samples from wet and dry areas have shown extraction curves of many shapes and inflections. These initial digestions have produced curves with peak extraction of metal after certain periods of digestion suggesting the metal is being released from specific compounds. Other metals such as Fe and Mn are being determined simultaneously affording information concerning hydrous oxide association.

With these fundamental data we hope to be able to recognise the presence of the mineral component by the shape of the solution curves, the extractant used, the temperature of extraction and by the associated curves of other elements determined at the same time. With more certainty of the nature of the base metal association in the sediment more emphasis will be placed on interelement ratios such as base metal, iron and manganese ratios rather than relating base metals (and other pathfinder elements) to a very variable -80 mesh component representing a load of a stream also of variable mineral composition.

Other applications where selective extraction has been or could receive attention are:-

- 1) The selective extraction of nickel sulphides from serpentinites. Here sulphide nickel values of only a few ppm can be detected against a non-mineralised component of several thousand ppm.
- 2) Partially selective extraction of tin as cassiterite from a matrix containing tin in biotite and other rock minerals. Here samples are heated with ammonium iodide and the free cassiterite rather than the tin in lattice positions within the biotite, reacts to form tin iodide which is separated by sublimation.
- 3) Mercury compounds can be selectively and progressively volatilised each fraction representing the vapour, and liquid phases, and various compounds of mercury can be identified and determined. Here the more stable compounds of mercury can be selectively separated from the more volatile forms and these values can provide a dispersion pattern more closely related to mineralisation.

4) This approach may also be used for uranium. For routine analysis of geochemical samples optimum extraction of uraninite of secondary uranium minerals to the exclusion of uranium-bearing resistate minerals is readily obtained.

SELECTIVE EXTRACTION THEN IS A MEANS OF BEING ABLE TO EMPHASISE THE MINERAL COMPONENT OF GEOCHEMICAL SAMPLES TO THE EXCLUSION IN PART, AT LEAST, OF THE NON-MINERALISED COMPONENT. IN SO DOING ONE CAN REDUCE AND SMOOTH OUT THE BACKGROUND VALUES AND CONSIDERABLY INCREASE THE CONTRAST BETWEEN THRESHOLD AND ANOMALY.

Investigations along these lines have been actively pursued by Professor Rose and his colleagues at Pennsylvania State University. At this symposium Dr. von Moort of the University of Tasmania has demonstrated the selective and sequential extraction of base metals in the various components of soils. I hope his approach to the problem and his preliminary findings will be recognised as a considerable step towards the adoption of more meaningful analysis and, in its turn, enable threshold values to be calculated on a more rational basis.

Looking to the future I can see that the laboratory geochemist will be required to develop many more techniques to provide the exploration geochemist with data that has, at least, been selectively treated to provide values more related to mineralisation and to take the word threshold from the position of fiction to that of fact.

EMPIRICAL ASSESSMENT OF ANOMALIES IN TROPICAL TERRAIN by D.H. MACKENZIE
(C.R.A. Exploration Pty. Ltd.)

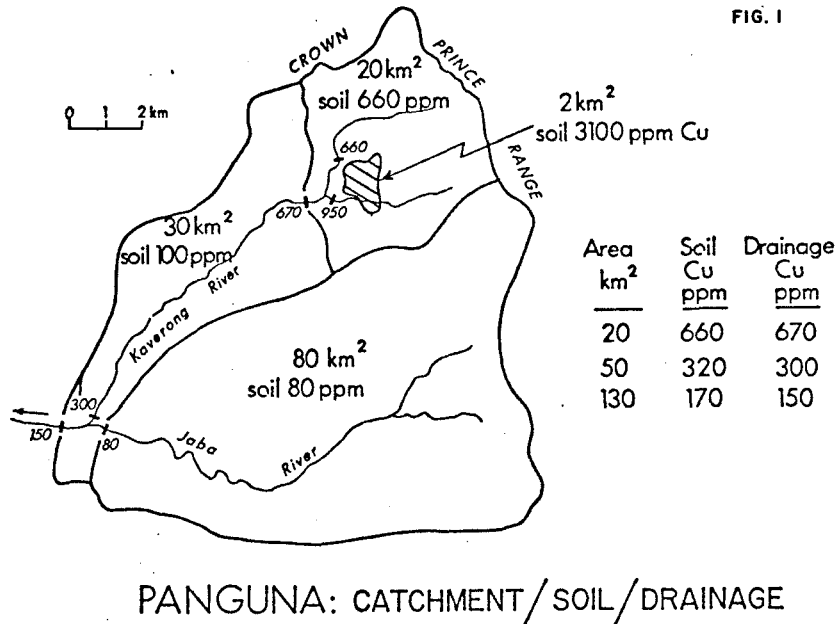
Among the terms which from long usage come rather glibly off the tongues of most of us who use geochemistry in exploration are words like "threshold" - the subject of today's workshop - "drainage train", "anomaly", "background" and so forth. The aim of this presentation is to demonstrate empirically that the experience of CRA with drainage sampling in tropical terrains is that the drainage value for any catchment approximates to the average soil value of that catchment.

As a consequence, the position of a soil anomaly within a catchment is immaterial and drainage train length is thus less important than size of catchment area in relation to the size of target. The corollary is that threshold ceases to be a significance.

First I wish to briefly present credentials for these statements. CRAE first used geochemistry to search for low grade disseminated copper deposits along the East Queensland seaboard in 1960. Many areas from Cairns in the north to Maryborough in the south - a distance of 1200 Km - were explored. In 1964 interest swung northwards to New Guinea and its adjacent island groups, especially the Solomon Island chain. In later years geochemically-based exploration for porphyry copper deposits was carried out in New Britain, New Ireland and north and east coastal areas of New Guinea and Papua, the New Hebrides and part of the New Guinea mainland well into the 1970's. The evidence presented today is a summation of much of this extended ore search programme in which mine porphyry deposits or occurrences were tested by diamond drilling. One deposit, Panguna, is now an operating profitable mine.

My remarks, therefore, refer to field interpretation of geochemical exploration results as used in porphyry copper search in dissected terrains such as P.N.G., the Solomon Islands or North Queensland. All values are for the -80 mesh fraction. The first two examples chosen are the Panguna deposit on Bougainville in the Solomon chain and subeconomic porphyry copper occurrence at Kulu River in New Britain.

The first example - and the best because ample reliable data are available - is the Panguna copper deposit (Figure 1, below).



High soil levels of about 1000 ppm Cu from the halo in the headwaters contribute strongly to the value of 660 ppm in the drainage immediately upstream and North West from the Panguna body. A drainage contribution from the orebody soils marginally raises the values to 670 ppm below the junction with the stream draining the deposit. A value of 300 ppm 12 km downstream is diluted by the contribution of 80 ppm from the Jaba River (approximate background for the basement volcanic rocks); the value of 150 ppm below the Jaba confluence is still outstanding at a distance of 14 km below the orebody where the catchment area is no less than 130 km². A weak anomaly can be recognised and signs of mineralised float have been recorded in the Jaba River 28 km downstream.

This drainage train is a classic one for Papua-New Guinea. However, the relationship of soil and drainage values to catchment area is even more instructive. Sufficient work has been done around Panguna to obtain

average soil values for the various catchments and relate these to drainage values. Soils over the orebody average 5000 ppm Cu over 1.2 Km² and there is about 0.8 km² of ash cover at 200 ppm Cu. Small creeks draining directly off the orebody gave drainage values of 3000 - 6000 ppm Cu comparable to the soils they drain. Surrounding the orebody is a halo 18 km² averaging 400 ppm Cu in soils which allows for a considerable amount of ash cover. Therefore, for the total 20 km² catchment the average soil value is 660 ppm. The drainage value from the same area is 670 ppm. This may be summarized:

<u>UPPER KAVERONG CATCHMENT:</u>		<u>SOIL/DRAINAGE RELATIONSHIP</u>	
	km ²	ppm Cu	
Orebody	1.2	5000	} 3080 ppm } } 668 ppm
Ash on orebody	0.8	200	
Remainder incl. ash areas	18.0	400	

∴ Total area 20 km² at average soil 660 ppm Cu

Drainage value at outlet 670 ppm Cu

In the lowest reaches of the Kaverong the drainage value of 300 ppm Cu corresponds to an additional 30 Km² of catchment at 100 ppm soil level for a weighted average total catchment soil value of 320 ppm. Below the Jaba-Kaverong confluence an additional 80 km² at 80 ppm from The upper Jaba catchment gives an average soil value of 170 ppm for 130 km² whereas the drainage value here is 150 ppm.

From these figures we infer that the drainage value is a direct reflection of the average soil value of the catchment. The exercise can be extended to larger areas or smaller orebody expressions, but generally with less confidence on the average soil value to be used.

The second example is from central New Britain. At Kulu River (Figure 2, Page 10) an area 0.4 km² with an average 1700 ppm Cu in soils overlies primary mineralisation of 0.1% Cu grade established by diamond drilling. The anomalous area drains into two catchments. In one catchment 0.2 km² of 1700 ppm and 2.8 km² of 460 ppm in soils gives an average 540 ppm. Extension of this treatment to the larger catchments shows 44 km² averaging 95 ppm in soil with a drainage outlet value of 90 ppm and 70 km² with an estimated 74 ppm in soil subtended by a 60 ppm drainage value. Variations from the calculated figure probably reflect some inaccuracy in estimation of average soil values in the larger catchments but the order of magnitude is right.

At the Moonmera prospect near Rockhampton in Queensland a similar pattern can be demonstrated. (Figure 3, Page 10) An area of 2.6 km² carries soil values above 1000 ppm Cu average 1250 ppm. One tributary has a soil average of 260 ppm and a drainage value of 275 ppm. A second tributary averages 156 ppm for soil and has a drainage value of 132 ppm. A little downstream the total catchment of 21 km² with an average soil value of 184 ppm has a corresponding drainage value of 175 ppm.

These three examples are illustrative of what can be applied to most other porphyry copper situations especially those in tropical terrains.

As a consequence of application of the method, once the size and style of the target being sought has been defined threshold becomes redundant and interest focusses on the excess value of the drainage over background. For example if the target can be defined by the local geological parameters as 1 km² at 3000 ppm Cu, the background in soil is of the order of 100 ppm or 145 in excess of the background will satisfy. Any lower excess value means a smaller or more obscured target or a higher background. The calculation for this and another example is as follows:

CALCULATION OF EXCESS VALUE OF DRAINAGE ANOMALY

1. Target required say 1 km² x 3000 ppm = 3000
 Background say 19 km² x 100 ppm = 1900

$$\frac{4900}{20} = 245 \text{ ppm}$$

Background = 100 ppm
 Anomaly required = 245 ppm
 Excess value over background = 145 ppm for 20 km² catchment
2. Target required say 0.01 km² x 30,000 ppm = 300
 Background say 19.99 km² x 100 ppm = 1999

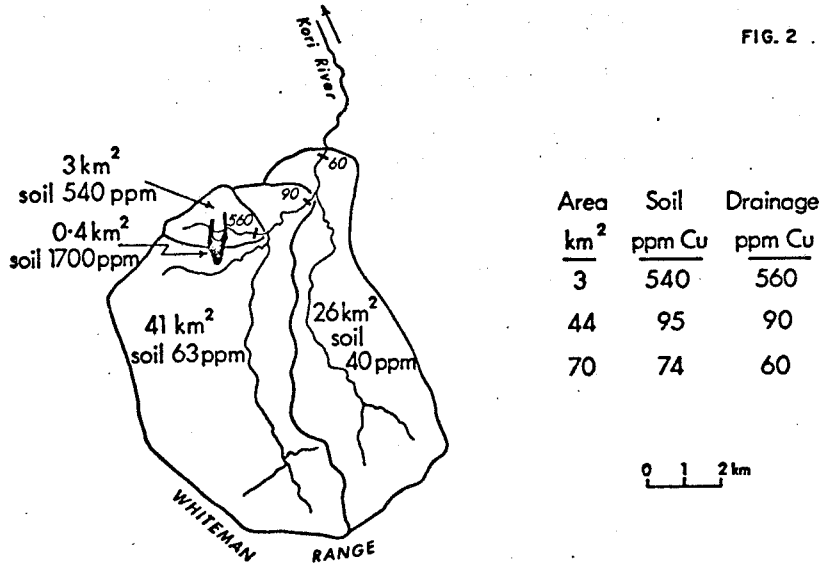
$$\frac{2300}{20} = 115 \text{ ppm}$$

Background = 100 ppm
 Anomaly required = 115 ppm
 Excess value over background = 15 ppm for 20 km² catchment

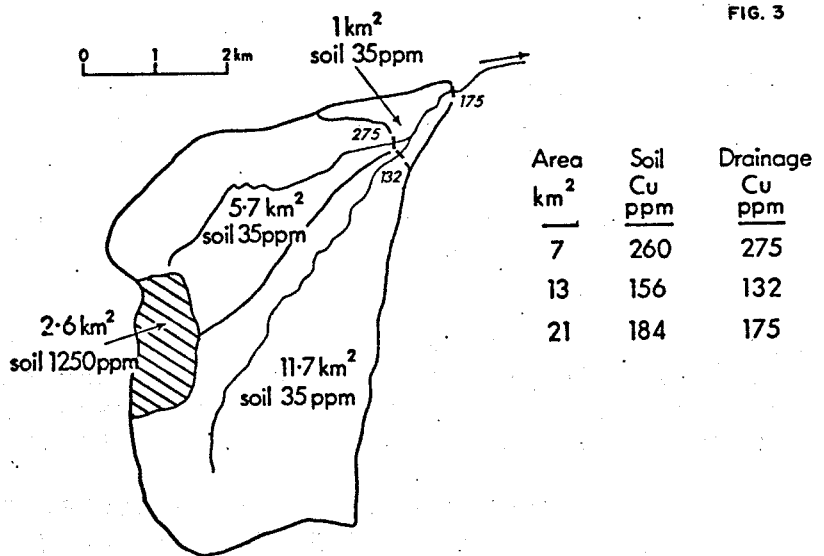
Similarly the hollowed "drainage train" becomes much less significant than the catchment area sampled and the position and area of the anomaly within the catchment. Sampling density must, therefore, relate to catchment area, not intervals along a train.

Although here applied to porphyry copper systems with large surface expressions, there is no reason why this principle should not be applicable to any size of target, provided that transport from soils to streams is mechanical as in the examples quoted.

Many CRAE geologists over many years have contributed to the development of this empirical approach. However, one specific acknowledgement is necessary. It was C.L. Knight who predicted that this approach would work and stimulated its development.



KULU RIVER : CATCHMENT / SOIL / DRAINAGE



MOONMERA: CATCHMENT / SOIL / DRAINAGE

REFINED COMPUTER TECHNIQUES by N.J. MARSHALL (Selco, Australia)

Let me set the scene for the more esoteric techniques by stating the obvious - that there is little need for sophisticated data interpretation when the simple "eyeball" approach leads to easy success, since in the interests of cost-effectiveness geochemical techniques must be efficient.

But within this context of cost-effectiveness, let us ask ourselves whether we are being effective in dismissing a lack of obviously anomalous results from a geochemical survey or even relinquishing an area on this basis when there were compelling geologic and other factors which justified area expenditure, sample collection and analysis in the first place.

At the second A.E.G. Symposium held in Denver in 1968, Prof. Webb stated during a panel discussion on Education of the Exploration Geochemist ".....while the middle stage of data collection has remained simple despite the changing emphasis towards sophisticated instrumental analysis, whether or not the application of geochemical methods improves will depend on the efficiency in the first stage of orientation to establish optimum technique and in the last stage of interpretation. Manifestly, these activities require the services of a specialist....."

These words are increasingly true eight years later, and emphasis on more sophisticated orientation and interpretation must grow as the more obvious targets with surface expressions are depleted as a result of first-pass exploration techniques. In Australia we have perhaps been lulled into a false sense of security by the success of "gossan-bashing" programs, but the gossans must soon run out. In any event, practical sample density logistics leave ample room for gossans to be missed unless targets can be objectively recognized over a larger area of influence and filtered out from background noise.

The fairly recent discovery of the world's richest uranium deposit at Jabiluka, N.T., (Australia) was, I believe, a 'priority 9' ground radiometric anomaly of 2 times background of dimensions less than 100 meters in a target area of 180 square kilometres!

I am sure we all agree that there are many more orebodies without obvious surface manifestations, as well as those with small surface expressions which can easily be missed on any practicable sampling grid. Then there are the numerous teasers which in areas of poor outcrop are difficult to filter out by traditional geologic examination alone.

For the purposes of this discussion, let us assume that:

1. The first pass approach has been done, the samples have been retained and the program was designed in the first place to give multi-element data, having in mind the obvious elements plus others which may be of future use should more sophisticated interpretation be required. That is, the major costs, which are data acquisition, are over.
2. The data were acquired as a continually updated, computer accessible data bank during the surveys so that no tedious data re-organisation, which consumes time and money, is necessary.

3. Proper orientation has been done and obvious pathfinders, cold-extractable techniques, alternative sample types such as pebble coatings etc. considered.
4. The data are reliable.

Thus, in the absence of obvious expressions, we are left with interpreting a complex array of multivariate data, the variables of which probably include:

1. Elements of both contrasting and complementary geochemical character.
2. Spatial data, such as grid coordinates.
3. Lithologic data.
4. Other geologic data apart from lithology - e.g. structure, stratigraphy position, alteration.
5. Geophysical and photogeologic data.

It is worth re-emphasising that once properly organised data are obtained the extra cost of processing these data to extract the maximum of information is small in the overall cost of a survey. In fact, a flexible approach during a geochemical program can save substantial money, if, for example, geostatistical semi-variograms are run to determine optimum grid density to direct future effort. Many grids are over-sampled, and this is inefficient, as is under-sampling, which invokes an undue reliance on luck.

Geochemical data are among the few quantitative and objective measurements we can make in the early stages of exploration, and to treat them in a non-quantitative manner weakens the purpose.

(Here Mr. Marshall described and illustrated the use of three multivariate techniques - moving average and trend surface, regression analysis, and discriminant analysis.)

Naturally, the data must be interpreted by overlaying its spatial distribution with "geology", but I suggest that correctly specified multi-element data may in many cases improve geologic information over visual field examination alone - both are necessary, in fact. This is particularly the case where by "geology" we really mean "lithology", and the area is one of obscured outcrop, or highly weathered outcrop, or monotonous looking rock sequences which may contain geochemical markers and facies not always recognized in the field.

FUTURE TRENDS

The short-coming of many multivariate procedures is that the data are divorced from their geologic position in space. Thus correlations may be weakened or even destroyed by ignoring the locational relationships of values.

On the other hand, the moving average type of approach, or its geostatistical refinements, is intuitively appealing but considers only one element at a time.

Clearly, combinations of moving average type areal analysis with multivariate techniques are worth exploiting.

The geologist interpreting data traditionally overlays various maps and makes a mental synthesis using the human ability to recognize pictorial patterns and their relationships. Thus graphic presentation is desirable and more readily understood than numbers derived by complex manipulation.

However, in dealing with N variables we really need to deal with N -dimensional plots where each measurement is represented by one of N axes. This is not possible to plot for more than 3 variables at once, and the generation of $N(N-1)/2$ plots for pairwise examination is no solution.

The total interactive effect is not necessarily the same as piecewise comparison of individual components. A good analogy is in viewing color film which is made up of three individual spectral bands. Most people see more in one color photograph than by looking at three black and white photographs taken through red, green and blue filters, yet the available information is the same. A chord of music is a cluster of notes struck simultaneously - its sound pattern is instantly recognized, whereas playing the individual notes in random sequence is not the same.

Pattern recognition techniques offer a solution, particularly where combined with a CRT display and inter-active terminal, enabling the investigator to rapidly try various parameters and pre-processing at will. Methods such as eigenvector analysis and non-linear mapping can project multi-dimensional data onto a 2-dimensional plot and one can use either supervised learning or unsupervised learning approaches.

Supervised learning attempts to classify unknowns, such as an area of geochemical results into a class, based on proper selection of a training area of measured geochemical attributes hopefully related to mineralisation.

Unsupervised learning is perhaps more generally applicable if an orientation area is lacking. Here one seeks to graphically display clusters of similar and dissimilar attributes from a multi-element geochemical survey.

Finding the meaning of these clusters once revealed and identifying their geologic significance after taking everything into consideration is of course, the job of the geochemist!

SOME THOUGHTS ON THE SELECTION OF THRESHOLD VALUES AS PRACTICED IN THE
BRANCH OF EXPLORATION RESEARCH OF THE U.S. GEOLOGICAL SURVEY

by M. A. CHAFFEE (U.S. Geological Survey)

Introduction

Before making my comments, I would like to provide you with some information on my background that may help to explain my point of view. I classify myself as a geologist who has been pushed into the numbers game rather than as a mathematician who is learning to identify rocks and minerals. With that issue clarified, I will proceed with my discussion.

Definition of threshold

To begin with, I should define what I mean by "threshold". My definition of the term, in its most simplistic form, is "the lowest anomalous value within the range of values in a group of geochemical analyses." This definition holds for a positive anomaly. For cases where one is considering negative anomalies, the threshold value would be the highest anomalous value. I should add that I can't get complete agreement within my own group on this definition, either. One geologist, for example, argues that because most geochemical exploration analyses are semiquantitative analyses--that is, the reported numbers are considered the best obtainable for the method used but are actually plus and minus one or two reporting intervals--the threshold "value" should actually be a range of values. Most of our group, however, prefer a single value for threshold.

Selection of Threshold Values

It is my feeling that threshold values are probably best selected using a combination approach. The selection should be done using two basic methods: statistical-graphical evaluation and visual evaluation.

Statistical-graphical evaluation--The statistical and graphical approach employs the cold, hard numbers generated in the lab. Geologic or other physical factors measured in the field may be taken into account, but, in my experience, are sometimes ignored. Essentially all of the U.S. Geological Survey's analytical data are now entered into a computer. The computer makes the use of statistical techniques viable, especially for large data sets involving many elements and hundreds or perhaps thousands of samples.

My old standby for picking a first approximation of threshold value is the cumulative frequency versus concentration plot--the probability plot. Many of my research projects have involved what I call "salvage geochemistry." That is, we go into an area that has been drilled out and reconstruct the surface geochemistry before the area is permanently torn up. In such areas I can work with a known and defined mineral deposit anomaly and see just how effective probability plots are. I have found them to be very successful for media such as rock, soils and vegetation, even in areas of relatively complex geology. Some comparisons I have made in these areas also suggest that if I were to pick a single background value as the 50th percentile value, then the threshold is usually not too far from 2 to 3 times that background value. This is an old technique, but it seems to work fairly well.

We are now able to make probability plots routinely using computer graphics. The plot can be displayed on a cathode-ray screen or can be drawn by a bed plotter. For simple cases where there are two or perhaps three statistically distinct analytical populations--a bimodal or trimodal distribution--this plot is sufficient to pick a threshold value at one of the obvious breaks in the curve. For complicated cases, a line based on a least squares fit can be assigned to different segments of each curve in an attempt to define the significant breaks in the curve.

As another means of separating anomalous data from background data, the cathode-ray tube has been used by us on projects involving large data sets to make 3-dimensional perspective maps of analytical data. These maps can be viewed from any angle, an aid in anomaly enhancement. We can vary the lowermost value that is to be plotted and thereby facilitate isolating areas of high concentration. In a real sense, this technique produces a visual, floating threshold.

Visual evaluation--At some point the computer-generated data has to be compared to the real world and we must attempt to find explanations for the chemical variability for each analytical population under consideration. Perhaps the simplest approach is to plot the chemical analyses on a geologic base map and see if the chemical variability can be explained solely on the basis of lithology. Another approach we have used with success in regional reconnaissance sampling is to classify the analyses into, say, three to five concentration ranges and to plot each range on a separate map to see if there is any clustering of analyses of equal or nearly equal concentrations. One can then see if these clusters define a lithologic province or, hopefully, a mineral-rich area.

I am a firm believer in using the multielement approach to separate significant and non-significant anomalies. In this sense, the threshold value of one element can be used to define that of other elements. To cite an example, there are copper anomalies all over the southwestern United States, but few of them seem to be related to porphyry copper deposits. However, where anomalous copper is present in combination with anomalies of elements such as molybdenum, silver, and gold, there is much greater probability that the copper is related to a porphyry deposit. Thus, the spatial coincidence of anomalies can be used to pick threshold values when the threshold value for one of a suite of elements can be found.

This use of spatial coincidence of anomalies has other applications useful in determining what is anomalous. Our group has also experimented with multielement maps and maps based on enrichment factors. For multielement maps, we would simply indicate with a symbol or number, the number of elements, or the specific elements, that were anomalous at each sample site, using some simple technique to determine a first approximation of threshold values. We would then compare the symbols to geologic information and adjust threshold values accordingly. For maps based on enrichment factors, we would generate a factor for each site. For each element at each site a number is created by dividing the reported analytical value by the local background value or some arbitrarily assigned value such as Clarke value. This process is repeated for all elements and then the element quotients can be treated for each sample site to produce the enrichment factor for that site. Hopefully, at this point enough analytical information has been used so that a threshold value can be selected relatively easily.

We have also used multi-media maps where the most important anomalies are those at sites where the same element is anomalous in more than one sample medium, e.g. in (1) -80 mesh stream sediment, (2) oxalic acid leachates of the stream sediment, (3) ashed samples of streambank sod and (4) ashed samples of moss.

Problems

I would like now to mention a couple of problems that we have recognized that can have an important influence in the selection of a threshold value. First, the use of large data sets. If sampling is done over a large, geologically complex area with a large number of samples, then one may find that there is only a unimodal distribution for each element under consideration, regardless of the presence or absence of anomalies related to ore deposits. In effect, the analyses for anomalies related to mineralized rock are simply buried in the total analytical variability of the data set. One data set of ours with about 8000 samples showed this phenomenon, I believe for zinc, in an area containing major base-metal and precious-metal deposits. Thus, for large data sets, one may only have a single population, and no obvious threshold value can be determined.

Another problem that affects the selection of threshold values is found when one is working with a data set containing what is commonly called "censored data". In such a data set, many, perhaps most, of the analytical values are reported as being greater than the upper analytical detection limit or less than the lower analytical limit or "not detected" at the lower analytical limit used. In many cases of censored data, the detection limit for an element may therefore have to be used as the threshold value.

Obviously, when a majority of the samples in a data set have no real concentration values, one must proceed very carefully when using statistical techniques. However, where enough geochemical information is available in an area, it is sometimes possible (and I emphasize the "sometimes") to assign values to samples listed as "greater than", "less than", or "not detected", provided that there are not too many of these values.

Summary

To sum up, the selection of a threshold value is still more an art than a science. A combination of statistical, graphical, and visual approaches is needed to provide the most efficient use of geochemical analyses in the search for mineral deposits.

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RECENT PAPERS ON EXPLORATION GEOCHEMISTRY

These two lists comprise titles that have appeared in major publications since the compilation presented in Newsletter No. 20. Journals routinely covered and abbreviations used are as follows: Economic Geology (EG); Geochimica et Cosmochimica Acta (GCA); The USGS Journal of Research (USGS JR), Professional Papers (USGS Prof Paper), Bulletins (USGS Bull), 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.

- Allen, P.M. et.al. 1976, Geochemistry and relationships to mineralization of some igneous rocks from the Harlech Dome, Wales. Trans IMM 85 B100 - B108
- Anon. 1976, Uranium prospecting today - and what to expect tomorrow. World Mining Pt.1. 29(11) 48-54; Pt.2. 29(12) 50-53.
- Anon. 1976, Geochemical Survey of the Western energy regions, third annual progress report, July 1976, 250p. USGS OFR 76-729
- Ballantyne, S.B. 1976, Geochemical orientation surveys for uranium in southern British Columbia. GSC OFR 341
- Boyle, R.W., 1976, Mineralization processes in Archean greenstone and sedimentary belts. 45 p. GSC Paper 75-15.
- Cameron, E.M. 1976, Geochemical reconnaissance for uranium in Canada: Notes on methodology and interpretation of data. GSC Paper 76-1C 229-236
- Church, B.N. et.al. 1976, The endogenous distribution of minor elements in the Goosly-Owen Lake area of central British Columbia. CIM BULL 69(773) 88-95
- Coker, W.B. 1976, Geochemical follow-up studies, northwestern Manitoba. GSC Paper 76-1C 263-267
- Desborough, G.A. and Leonard, B.F. 1976, Introduction: An issue devoted to platinum-group elements EG 71(7) 1129-1468
- Dyck, W. et. al. 1976. Well water uranium reconnaissance, southwestern Saskatchewan. GSC Paper 76-1C 249-253
- Edmunds, W.M. 1976, Geochemistry of brines in the Coal Measures of Northeast England. Trans IMM 85 B80-81
- Edwards, R.P. 1976, Aspects of trace metal and ore distribution in Cornwall. Trans IMM 85 B83-B90
- Flanagan, F.J. (Comp) 1976, Description and analyses of eight new USGS rock standards. USGS Prof Paper 840, 192 p.

- Goodfellow, W.D. et. al. 1976, Geochemical orientation and reconnaissance surveys for uranium in the central Yukon. GSC Paper 76-1C 237-240
- Glikson, A.Y. 1976, Trace element geochemistry and origin of early Precambrian acid igneous series, Barberton Mountain Land, Transvaal. GCA 40(10) 1261-1280
- Grandclaude, Ph. 1976, Design and use of a geochemical data bank. Computers and Geosciences 2(2) 163-170.
- Hoag, R.B., Jr. and Webber, G.R. 1976, Significance for mineral exploration on sulphate concentrations in groundwater. CIM BULL 69 (776) 86-91
- Hornbrook, E.H.W. and Garrett, R.G. 1976, Regional Geochemical lake sediment survey, East-Central Saskatchewan. 20p. GSC Paper 75-41.
- International Atomic Energy Agency 1976, Nuclear Techniques in geochemistry and geophysics; proceedings of a panel ... organized by the IAEA and held in Vienna, 25-29 November, 1974. 271 p.
- Jacobs, D.C. and Parry, W.T. 1976. A comparison of the geochemistry of biotite from some Basin and Range stocks E.G. 71(6) 1029-1035.
- Jonasson, I.R. 1976, Detailed hydrogeochemistry of two small lakes in the Grenville geological province. 31 p. GSC Paper 76-13
- Jonasson, I.R. and Gleeson, C.F. 1976, On the usefulness of water samples in reconnaissance surveys for uranium in the Yukon territory. GSC Paper 76-1C 241-248
- Jonasson, I.R. and Goodfellow, W.D. 1976, Uranium Reconnaissance Program: Orientation studies in uranium exploration in the Yukon. GSC OFR 388
- Jones, R.C. and Toombs, J.M.C. 1976, Geochemical and geophysical investigations around Garras Mine, Cornwall. Trans IMM 85 B158
- Miesch, A.T., 1976, Sampling designs for geochemical surveys - Syllabus for a short course. 138 p. USGS OFR 76-772
- Maurice, Y.T. 1976, Detailed geochemical investigations for uranium and base metal exploration in the Nonacho Lake area. District of MacKenzie. GSC Paper 76-1C 259-262
- Ridley, K.J.D. et.al. 1976, The variability of chemical analyses as a function of sample heterogeneity, and the implications to the analyses of rock standards. GCA 40(11) 1375-1379
- Rinehart, C.D., 1976, Reconnaissance geochemical survey of gully sediments in part of the Okanagan Range, Okanagan Cty, Washington. 25p. USGS OFR 76-680.

- Rose, A.W. 1976, The effect of cuprous chloride complexes in the origin of Red-Bed copper and related deposits. EG 71 (6) 1036-1048
- Rose, E.R., 1976, A field test for rare-earth elements. 10p. GSC Paper 75-16
- Smee, B.W. and Ballantyne, S.B. 1976, Examination of some Cordilleran uranium occurrences. G.S.C. Paper 76-1C 255-258
- Stanton, R.L. 1976a, Petrochemical studies of ore environment, Broken Hill, New South Wales, Australia: 1-constitution of "banded iron formations". Trans IMM 85 B33-B46
- 1976b, 2-regional metamorphism of banded iron formation and their immediate associates. Trans IMM 85 B118-B131
- 1976c, 3-banded iron formations and sulphide orebodies: constitutional and genetic ties. Trans IMM 85 B118-B131
- 1976d, 4-environmental synthesis. Trans IMM 85 B221-B233.
- Steed, G.M. et.al. 1976, Geochemical and biogeochemical prospecting in the area of the Ogofau gold mines, Dyfed, Wales. Trans IMM 85 B109-B117.
- Swanson, V.E. and Huffman, C. Jr., 1976, Guidelines for sample collecting and analytical methods used in the USGS for determining chemical composition of coal. 11p. USGS CIR 735
- Webber, G.R. 1976, Statistical analysis of lithogeochemical variations in proximity to the Horne Mine, Noranda, Quebec, Quebec Ministère des Richesses Naturelles DPV-424, 40p.
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- Clarke D E, Coker W B and Nichol I, 1976, The relation of lake sediment geochemistry to mineralization in the northwest Ontario region of the Canadian Shield (Discussion and reply): EG 71(5) 952-963.
- Dyck W, Melchat J C and Meilleur G A, 1976, Equipment and procedures for the collection and determination of dissolved gases in natural waters: GSC Paper 75-34 12 p.
- Erdman J A, Shacklette H T and Keith J R, 1976, Elemental composition of native plants and associated soils from major vegetation-type areas in Missouri: USGS Prof Paper 954-C 87 p.
- Govett G J S, Goodfellow W D and Whitehead R E S, 1976, Experimental aqueous dispersion of elements around sulfides: EG 71(5) 925-940.
- Gustavson J B and Neathery T L, 1976, Geochemical prospecting for gold in Alabama: Soc Min Eng Trans 260 177-184.

Jonasson I.R., 1976, Trace metals in snow strata as indicators of silver-arsenide vein mineralization, Camsell River area, District of Mackenzie: GSC Paper 76-1B 71-74.

Koukharsky M. and Mirre J.C., 1976, Mi Vida prospect - a porphyry copper-type deposit in northwestern Argentina: EG 71(5) 849-863.

Miesch A.T. (with 12 others), 1976, Geochemical survey of Missouri - methods of sampling, analysis and statistical reduction of data: USGS Prof. Paper 954-A.

These bibliographic compilations are being prepared for the Newsletter by the Bibliographic Committee --- Dr. H.E. Hawkes, Chairman.

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FROM THE SECRETARY'S OFFICE

This is the first Newsletter of 1977 and Council takes this opportunity to wish all A.E.G. members a successful and prosperous year.

Activity in the Secretary's office has been busy and interesting. Since the last Newsletter considerable progress has been made with the Association records and we are grateful to all those of you who have answered our enquiries and requests promptly and have forwarded 1977 dues in advance.

1977 Membership Subscriptions and the Journal Mailing List

At the end of January Mrs. Filicetti will forward the revised Association membership list to Elsevier containing the names of all individual and Corporate members who have paid their 1977 dues. Elsevier will use this list to make up the mailing list for Volumes 7 and 8 of the Journal of Geochemical Exploration which will include special issues on geochemical exploration for oil and gas and the proceedings of the 6th International Geochemical Exploration Symposium held in Sydney, Australia last August. Regular issues of the Journal will also appear during the year.

The response to the 1977 dues notice enclosed with Newsletter No. 20 last fall has been very gratifying. However, those of you who, for various reasons, have not yet despatched your payments are urged to attend to this matter as soon as possible so that delayed receipts or non-receipts of copies of the Journal and the Newsletter can be avoided. A second copy of the 1977 dues is enclosed for this purpose.

New Officers of the Association

At the Council Meeting held on October 29th, 1976, members of the new Executive, to take office at the next Annual Meeting of the A.E.G. scheduled for late April 1977, were elected.

Dr. R.F. Horsnail of Amax Exploration Inc., Denver, Colorado, will be the Association's eighth President. Dr. Horsnail is well known to all of you and has been very active within the Association in previous years serving terms as Secretary, Treasurer, and Vice-President.

Dr. R.H. Carpenter of the University of Alabama was elected to the position of Vice-President. Dr. Carpenter has served the Association well on Council and has a keen interest in the activities of the Association. In 1977-78 Dr. Bradshaw will serve as First Vice-President and Dr. Carpenter will serve as Second Vice-President.

Dr. F.N. Ward will continue as Treasurer of the Association for another year. The membership will be pleased to learn that Dr. Ward has recovered well from his illness and operation of last August and has expressed his keen desire to continue to serve the Association in his current office. Council expresses its thanks and wishes for continuing good health to Dr. Ward.

Due to pressure of time, J.A. Coope has indicated that he does not wish to continue as Secretary beyond April. He will remain in office until Council names a successor and the membership will be kept advised of developments.

Ordinary Councillors for 1977

Attached to this Newsletter is the Balloting List together with information and instructions to allow the Voting Membership to cast their votes to select Ordinary Councillors for the 1977-1979 period. (Please note that Affiliate Members, Student Members and Corporate Members are not Voting Members of the Association and, consequently, the Balloting List, etc., will not be included in the mailing to these members).

The Voting Membership is urged to complete their ballots as soon as possible and return them to the permanent office by April 1st, 1977. You are reminded that no member can be elected an Officer of the Association without first being elected to Council by the membership as an Ordinary or Regional Councillor.

Annual Meeting 1977

The next Annual Meeting of the Association will be held during the combined Geological Association of Canada, Mineralogical Association of Canada, Society of Economic Geologists, Canadian Geophysical Union Meeting in Vancouver, British Columbia, April 25 - 27, 1977. The location and time of the Annual Meeting has yet to be finalized. The agenda for the Annual Meeting is as follows:-

1. Minutes of the 1976 Annual Meeting
2. Matters Arising
3. President's Report
4. Secretary's Report

5. Treasurer's Report
6. Appointment of Auditors
7. Incorporation of the Association and Adoption of the Constitution and Bylaws
8. Introduction of the 1977-78 Executive
9. Election of Ordinary Councillors
10. Any other Business (A.O.B.)
11. Adjournment

The outgoing President, Professor G.J.S. Govett, will deliver his Address immediately following Adjournment.

Incorporation of the A.E.G.

The Incorporation Documents and the new Constitution and Bylaws of the Association, as approved by Council, were finalized and application made to the Minister of Consumer and Corporate Affairs in Ottawa in mid-January. It is anticipated that copies of the Constitution and Bylaws will be distributed to the Voting Membership in advance of the Annual Meeting following a favourable response and approval from Ottawa.

Membership Requirements - Affiliate and Student Members

Many geoscientists living outside North America have experienced difficulty in locating referees, who are Voting Members of the A.E.G., to support their application for membership in the Association. When he was attending the Australian meeting, Professor Govett indicated to numerous people that he would review the situation to determine if the requirements could be eased to allow these prospective members to become active in the Association.

Following discussion in Council on October 29th, amendments to the bylaws were recommended with respect to the referee support requirements for Affiliate and Student Members, (The other qualification requirements for these classes of membership will remain the same). The amendments, as included in the revised Constitution and Bylaws currently under scrutiny by the Ministry of Consumer and Corporate Affairs, are as follows:-

"The application form of candidates for Affiliate Membership must be signed by two Voting Members or, in the event that there are insufficient Voting Members known to a candidate to support his application for Affiliate Membership, by an equivalent number of geoscientists who are fully accredited members of other recognized learned geoscientific societies. Application forms of candidates for Affiliate Membership endorsed by one or more geoscientists who are not Voting Members

of the Association must be accompanied by a signed letter from the candidate confirming that there are insufficient Voting Members known to him to support his application.

The application form of candidates for Student Membership must be signed by a Professor of his University, or the Principal of his School of Mines or by one Voting Member."

The membership requirements for Voting Members are to remain unchanged.

The amendment of the requirements for Affiliate Membership will allow interested persons all over the world to more easily gain membership in the Association. Involvement in A.E.G. activities by these new members resulting in their introduction to Voting Members, will lead to an important and welcome expansion of the Voting Membership in future years.

"Exploration Geochemistry in the Appalachians" Ed. by G.J.S. Govett

Members will have received their copy of the above titled issue of the Journal of Geochemical Exploration (Vol.6, No.1/2). The official publication date was November 1st, 1976 and, at that time, the names and addresses of all those persons and institutions who had ordered first copies or additional copies of this issue for \$25.00 each through the A.E.G. permanent office were forwarded to Elsevier. (See Newsletter No. 20). Following the receipt of this information, Elsevier mailed out the copies on December 1st, 1976. Copies are still available directly from Elsevier/Excerpta Medica/North Holland, P.O.BOX 211 Amsterdam, The Netherlands, at a price of U.S. \$34.75. The A.E.G. cannot accept further orders.

Proceedings of the Sixth, I.E.G.S.

"Geochemical Exploration 1976", the proceedings of the Sixth International Geochemical Exploration Symposium, Sydney, Australia, will be published in the Journal of Geochemical Exploration in late 1977. The A.E.G. membership will receive their copies of the proceedings as part of their 1977 subscription, but additional copies for university and company office libraries, non-members of the A.E.G. etc. will be available from Elsevier/Excerpta Medica/North Holland, P.O.BOX 211, Amsterdam The Netherlands, at a cost of U.S. \$42.50 each. The volume will be edited by C.E.M. Butt and J.F. Gilfillan and the editors' names should be specified when ordering.

Membership Certificates

To date, the number of members requesting A.E.G. Membership Certificates, is well under the economic minimum of 40 specified in the last Newsletter. A final decision on the matter of these Certificates will be made immediately prior to the 1977 Annual Meeting.

J.A. Coope, Secretary

A N N O U C E M E N T S

1. AGID GEOCHEMICAL WORKSHOP-ZAMBIA, August 1977

A short but intensive course in applied geochemistry is being organised to follow the UNZA-EIZ Conference on the theme "Utilization of Mineral Resources in Developing Countries". The workshop is designed to provide up to fifteen recent geology graduates, drawn from African Countries, with practical training in the use of geochemical methods in mineral exploration. The course will consist of two days of lectures and instruction in basic principles and techniques followed by five days of practical work in a selected field area. The workshop will be concluded with an open day of technical sessions where geochemical case histories will be presented and discussed.

Inquires and requests for registration at the Workshop should be directed to:-

Professor P.G. Cooray,
School of Mines
University of Zambia,
P.O.BOX 2379,
Lusaka
ZAMBIA

2. GEOCHEMICAL EXPLORATION FOR URANIUM AND BASE METALS by Harold Bloom and Nick Saum, Colorado School of Mines, Golden, Colorado.

Offered twice, May 23-27 & June 20-24, 1977.

Purpose and Scope- This program, now in its 17th year, is designed to introduce modern geochemical exploration techniques to geologists, chemists and others interested in trace element geochemistry.

Theory and practical field problems are uniquely combined with the chemical laboratory. Visits are made to nearby mineralized occurrences of (1) uranium, (2) copper, zinc, and lead, and (3) molybdenum where techniques for sampling soils, vegetation, stream waters and sediments are demonstrated.

The theory of sample spacing for use in reconnaissance or follow-up surveys is discussed. The class will analyze stream sediments on site, using field kits. Other samples will be returned to the laboratory for analysis by means of fluorometry, atomic absorption spectrometry or colorimetry. Sampling and analytical errors are evaluated as they affect the interpretation of data. Computer-programmed statistics and graphic methods are used in interpretation.

Other topics reviewed are as follows: primary dispersion and endogenic halos, geochemical mineral suites, secondary dispersion patterns, soil and vegetation sampling criteria, and trace metal partition in stream waters and sediments. Emphasis throughout is placed upon the practical aspects of conducting a geochemical survey.

Course is taught by Prof. Harold Bloom of Colorado School of Mines, and Dr. Nick Saum, consulting geologist, Golden.

Class Schedule- Five days of classes are held, with lectures in the morning from 8:00 to 11:30 a.m. Field study areas are visited in the afternoon. Evening seminars will provide opportunities to discuss the field problems and related topics.

Fees- Each class is limited to 20 people. A registration fee of \$325.00 includes text material, transportation to field area, and refreshments. For further information contact:-

Prof. Harold Bloom,
Department of Geology,
Colorado School of Mines,
Golden, Colorado, 80401
U. S. A.

3. PROSPECTING IN AREAS OF GLACIATED TERRAIN

The third symposium on prospecting in areas of glaciated terrain will be held in Finland from August 15-20, 1977. It is being organised by the Institution of Mining and Metallurgy, London, in cooperation with the Geological Survey of Finland.

Details of papers to be presented, and field visits will be in a second circular, which will be published in March 1977. For more information contact:-

The Secretary,
Institution of Mining and Metallurgy,
44 Portland Place,
London, WIN 4BR, ENGLAND

NEW MEMBERS

Applications for membership in the Association from the following individuals have been recommended for acceptance by the Admissions Committee. The Bylaws provide that if, after a minimum of 60 days have elapsed following the submission of a candidate's name to the voting membership in the newsletter, no signed letters have been received objecting to the admission of the candidate, he will be declared elected.

MEMBER

Brim, R.J.	Geochemist - Projeto Geofisico Brasil Canada; Goiânia, Goiás, Brasil.
Buerger, A.	Exploration Geochemist - Tsumeb Corp.Ltd.; Tsumeb, S.W.Africa. (upgraded from affiliate)

- Chenoweth, L.M. Regional Geochemist - Western Mining Corp.,
Bairnsdale, Vic. Australia.
- Cowart, J.B. Research Geochemist - Dept. of Geology, Florida
State University, Florida, U.S.A.
- Duff, J.R.V. Geoloigst/Geochemist - De Beers Consolidated Mines;
Kimberley, South Africa.
- Friedrich, G.H.W. Professor and Director of 'Institut für Mineralogie
und Lagerstättenlehre der Technischen Hochsdule',
Aachen, West Germany.
- Jackson, R.G. Exploration Geologist - St. Joseph Explorations;
Toronto, Canada.
- Kolbe, P. Geologist - Dept. of Geology and Geophysics,
University of Sydney, N.S.W. Australia.
- Lord, J.R. General Manager - Carpentaria Exploration Co.Pty.Ltd.;
Manila, Philippines.
- Murphy, G.C. Geochemist/geologist - South African Geological
Survey, Pretoria, South Africa.
- Schwartz, M. Geochemist/Geologist - Self-employed.
Hannover, West Germany.
- Soeharto, O Chief of Mineral Chemistry Laboratory, Geological
Survey of Indonesia, Bandung, Indonesia.
- Stephenson, J.F. Exploration Geologist - Manitoba Dept. of Mines
Resources, and Environmental Management;
Winnipeg, Manitoba.
- Williamson, H.C. Geologist/Manager - Asarco Australia Pty.;
Attadale, Australia.

AFFILIATE

- Araujo, E.S. Geochemist - Projeto Geofisico Brasil Canada;
Goiás, Goiânia, Brazil.
- Burlinson, K.G. Geologist - Plympton, Australia.
- Godoi, H. Geochemist - Projeto Geofisico Brasil Canada;
Goiás, Goiânia, Brazil.
- Hobson, B. Lecturer in Applied Geology, Geology Dept.,
Bendigo College; Bendigo, Australia.
- Martin, A.R. Chief Chemist - Commonwealth Aluminium Corp.;
Weipa, N.Q'ld. Australia.

- Ramos, N.N. Geochemist - Projeto Geofisico Brasil Canada; Goiás, Goiânia, Brazil.
- Robertson, D. Project Geologist - Manitoba Mineral Resources; Winnipeg, Manitoba.
- Rodrigues, B. Associate Professor, Department of Geosciences, University of Aveiro; Aveiro, Portugal.
- Rondinelli, D. Geochemist - Projeto Geofisico Brasil Canada; Goiás, Goiânia, Brazil.
- Taufin, P. Geologic Field Asst.-U.S.G.S.; Golden, Colorado. U.S.A.

STUDENTS

- Jannway, G.S. Post-graduate student at the University of Toronto; Toronto, Canada.
- Redman, B.A. Post-graduate student at the University of Melbourne; Carlton, Vic. Australia.

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LOST MEMBERS

Mail addressed to the following members in the cities indicated was returned to the Association office:

- J.A. Criswell, Golden, Colorado, U.S.A.
- M.R. Khalie, Beirut, Lebanon.
- Q.C. Lusty, Carlin, Nevada, U.S.A.
- E.N. Shei, ITC, Kanaalweg 3, Delft, Holland.
- J.R. Hillebrand, Avenida de America 60, Madrid 2, Spain.

Change of address information on these members would be appreciated.

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A N N U A L M E E T I N G

The AEG Annual Meeting will be held in the
Ballroom

of the

HYATT REGENCY HOTEL

Vancouver B.C., Canada

on

Tuesday, April 26, 1977

5:00 P.M.

THE ASSOCIATION OF EXPLORATION GEOCHEMISTS



ELECTION OF ORDINARY COUNCILLORS

Ten Voting Members of the Association have been nominated for Ordinary Councillors for the 1977 - 1979 period. Five incumbent Ordinary Councillors will retire at the upcoming Annual Meeting in April 1977 and a vacancy will be created among those Ordinary Councillors elected for the 1976 - 1978 period by Dr. Carpenter's assumption of the Vice Presidency. Consequently, members are asked to cast six votes by erasing four names of candidates you do not wish to vote for from the Balloting List. The persons whose names are not erased from the Balloting List will receive one vote in the balloting and, in the final tally, the person receiving the least number of votes among those elected will serve to fill the remaining year in Dr. Carpenter's term.

Any Balloting List will be deemed invalid if the number of names not erased therefrom shall be more than six.

Limited information on each candidate is included on the reverse page.

Voting Members should not sign or otherwise identify themselves on the Balloting List. Place the completed form in the small grey envelope marked "AEG Ordinary Councillor Ballot" and seal. Place this grey envelope in the larger white envelope bearing the AEG Permanent office address, seal, stamp and mail to arrive in Toronto not later than April 1st 1977.

CANDIDATES FOR ORDINARY COUNCILLORS

The following information is provided for reference to Voting Members when completing the Balloting Form.

R.C. Armstrong - AEG Member since 1971. Exploration geologist/geochemist with Cominco Ltd., Toronto, Canada.

J.J. Barakso - AEG Member since 1970. President of Min-En Laboratories Ltd., Vancouver, Canada.

A.A. Burgoyne - AEG Member since 1970. Regional Exploration Manager of Western Canada with Union Miniere, Vancouver, Canada

M.A. Chaffee - AEG Member since 1970. Geologist with U.S.G.S., Denver, U.S.A.

L.G. Closs - AEG Member since 1970. Geochemist with Ontario Ministry of Natural Resources, Toronto, Canada.

I.L. Elliott - AEG Member since 1970. Chief geochemist with Falconbridge Nickel Mines, Vancouver, Canada.

J.B. Gustavson - AEG Member since 1974. President of International Oil and Gas, Inc., Memphis, U.S.A.

K.A. Lovstrom - AEG Member since 1973. Assistant Chief Geochemist, with Amax Exploration, Inc., Tucson, U.S.A.

A.W. Rose - AEG Member since 1970. Professor of Geochemistry, at the Pennsylvania State University, U.S.A.

G.R. Webber - AEG Member since 1970. Associate Professor, Dept. of Geological Sciences, McGill University, Montreal, Canada.