EXPLORE

Newsletter for the Association of Exploration Geochemists

NUMBER 105 OCTOBER 1999

PRESIDENT'S MESSAGE

Erick Weiland

Once again I have the opportunity to address each of you. Unsure of what to say that might inspire, I find myself thinking about why I belong to AEG. Granted I started in AEG when I was young and optimistic about the minerals industry. Over the last twenty plus years my optimism has faded some, to what I hope is a more realistic view. Now I work for an engineering firm that provides services to not only the minerals industry but to many other industries as well. However, I find my membership in, and active participation in AEG just as valuable now as it was in 1978. There are many facets to our organization. The Journal provides the basis for the dissemination of technical information which gives each of us a source of valuable lessons and a base from which to move the science of geochemistry forward. **EXPLORE** has been a valuable tool to disseminate information quickly and in a less formal format. **EXPLORE** also allows members to communicate potentially controversial viewpoints and opinions from which productive diseussion may follow. Symposia provide a chance to meet and discuss the latest methodologies with others on both a formal and informal basis with other professionals from all over the world. I find that the friendships developed and the communications that follow, provide a life long opportunity to actively participate in my chosen profession and expand my personal horizons. Short courses and the Distinguished Lecture Series have provided a forum from which AEG has been able to disseminate information to those outside our membership. Over the next few years the AEG web page will increase members benefits and provide a new and exciting forum for many association activities.

During these times of change and turmoil AEG can provide a solid base from which to embrace these changes. As opportunities disappear, new opportunities and challenges will take their place. The association, and the friendships developed by being a member can assist one in finding these new opportunities. No matter which part of the industry you work in, the only known is that changes within the industry will occur and that you will need to be flexible and grow with the changes.

Each of you must decide why you belong to AEG. Each time you evaluate this question, which is usually around the time that dues are paid, remember that beyond the benefits you receive, your participation in the organization also helps to provide a much needed voice to the geochemical profession. Thank you for participating.

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TECHNICAL NOTE

Multimedia Geochemical Survey Results from Archean Greenstone Belts in the Superior Province of East-Central Manitoba

By Mark Fedikow and Erik Nielsen

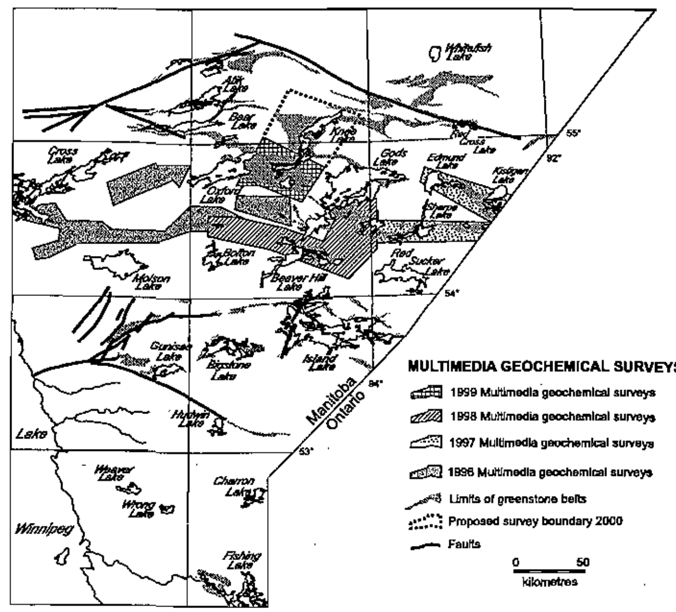

Figure 1. Location of multimedia geochemical surveys in the Superior Province of easy-central Manitoba.

ABSTRACT

A five-year program of helicopter-assisted multimedia geochemical surveys is eurrently underway within the mapped boundaries of Archean greenstone belts in east-

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Information for Contributors to EXPLORE

Scope. This newsletter is the prime means of informal communication among members of the Association of Exploration Geochemists, but has limited distribution to non-members. EXPLORE is the chief source of information on current and future activities sponsored by the Association, and also disseminates technical information of interest to exploration and environmental geochemists and analytical chemists. News notes of members are appropriate. We welcome short- to moderate-length technical articles on geochemical tools for exploration, concepts for finding ore, mineral-related environmental geochemistry, new analytical methods, recent deposit discoveries, or case histories. The goal of this newsletter is communication among exploration geochemists, and to that end we encourage papers on new methods and unconventional ideas that are reasonably documented.

Format. Manuscripts and short communications should be submitted in electronic form to minimize errors and speed production. Files can be transmitted on IBM-compatible 3.5 inch diskettes or attached to email. Most popular text and graphics files can be accommodated. Figures and photos can be transmitted in hard copy (which we will scan) or as high quality digital files. Some issues are published with color pages for special maps and figures which should be planned by early communication with the editors.

Length: Technical communications can be up to approximately 1000 words, but special arrangements may be made for longer papers of special interest. High quality figures, photos, and maps are welcome if they present information effectively.

Quality: Submittals are reviewed and edited for content and style through peer reviews. The intent is to improve clarity, not suppress unconventional ideas. If time permits, the author will be shown changes to material, by FAX or email. Time constraints do not allow author review of galley proof from the printer.

All contributions should be submitted to J. T. Nash by email (tnash@usgs.gov) or by mail (EXPLORE, c/o J.T. Nash, U.S. Geological Survey, Box 25046 MS 973, Denver, CO 80225 USA). Only in rare situations should FAX be sent (303-236-3200).

Information for Advertisers

EXPLORE

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BOOK REVIEW

Encyclopedia of Geochemistry, 1999, edited by C. P. Marshall and R.W. Fairbridge, Kluwer Academic Publishers, Dordrecht, 712 p. US$480 ISBN 0-412-75500-9.

This encyclopedia is one that any geochemist would like to have for quick reference, but probably will not. This hefty volume is the latest in the series edited by Fairbridge over the past 30 years, and an update of a similar title published in 1971. It contains summaries of more than 340 geochemical topics, from acid deposition to zirconium, written by more than 200 leading scientists. The articles, ranging from 300 to several thousand words, are good summaries and provide key references and cross-references to guide further inquiry, if needed. The text and illustrations are cleanly laid out with high quality printing. Academic and research topics, such as isotopes, are covered best, and there is less attention to applied geochemistry topics of prime interest to AEG members. Look in the index of authors cited and you'll find just a few of your exploration heroes. But there is a good summary of geochemical exploration by Art Rose, and parts of many topical summaries include useful information on practical aspects such as ore deposits and element mobility. I commend the editors, the board of associates who guided the compilation, and the many authors for a good job in a short time frame. My major concern is the price tag.

The high cost of this book poses a paradox: is it effective to publish science in a format that few scientists can afford to buy? At US$480 (and discounts appear unlikely), most geochemists and many libraries will be unable justify the purchase. I enjoy good books and especially value those that will be standard references for many years, but there are limits to my pocketbook and my conscience. Although many of us continue to prefer to read our favorite science and literature from printed pages, we will be wondering if this reference might be more attractive on CD-ROM for about $59. The AEG has faced the issue of escalating publication costs for our journal and opted for a new partnership that should make the new journal affordable by more institutions and individuals; there are ways to print at reasonable cost that allows widespread distribution to most parts of the world. But those options will not apply to this encyclopedia, and it probably will be on few desks. Too bad, it is worthy of more use.

JTN

CAMIRO DEEP-PENETRATING GEOCHEMISTRY, PHASE II

By Eion M. Cameron

This project is sponsored by the Canadian Association of Mining Industry Research Organizations (CAMIRO) and is being financially supported by 26 mining companies and commercial laboratories. The companies are based in Australia, Canada, Chile, United Kingdom and the United States.

Phase I of this project was a comprehensive report on methods of detecting ore bodies under thick exotic cover to evaluate:
(a) Mechanisms for the transfer of metals and other indicator elements through thick cover;
(b) Effectiveness of proprietary (e.g., Enzyme Leach, MMI) and non-proprietary selective leaches in measuring weak signals in soils from elements that have migrated from depth;
(c) Electrogeochemistry and hydrogeochemistry as alternatives to selective leaches;
(d) Quality control.

In addition to addressing these issues, the report provided a compilation of case histories supplied by sponsor companies. The principal type of data included in the report were selective leach analyses of soils. Additional data for gases and metals in soil gas showed good correlation. Conclusions were conditionally optimistic: Distinctive geochemical signals can be identified in soils over deeply buried ore deposits and mechanisms exist to explain these signatures. But selective leaches are more demanding in their application than conventional analytical methods, requiring careful quality control and recognition that the responses vary with changing soil compositions. Also, false anomalies are generated, which may not be readily distingnished from those directly related to ore-grade materials.

The report was distributed to the sponsors in April, 1998. These companies identified a need for a second phase project to compare different geochemical methods under carefully controlled conditions and to identify the processes by which both true and false anomalies are formed, hence making the application of these methods more effective.

Phase II started in June, 1999. Samples are being collected from sites where known deposits are buried beneath thick exotic cover. Test areas extend from wet northern to hot arid environments, including the Abitibi belt, southwest United States, Chile and Australia. Soil samples are being collected for analysis by a variety of methods, from strong extractions to weak selective leaches, permitting an evaluation of the their effectiveness for different types of mineralization and cover. Sampling and analyses of soil gas and metals in soil gas will be done at selected sites. The conjunction of varied leach and gas/vapour data will permit a better understanding of the processes causing the formation of anomalies. Where feasible, a three-dimensional view will be obtained. For example, at the Spence copper porphyry deposit, Chile, the availability of capped drill holes permits groundwater sampling, in addition to soil sampling. In the Abitibi Belt, the Ontario Geological Survey will carry out drilling through overburden at a minimum of two sites.

Mary Doherty (BHP) sampling soils over Newmont's Mike copper-gold deposit, near Carlin, Nevada. Ore is covered by 600 feet of post-mineralization rock.

Stew Hamilton (left) and Devin Crandon (both Ontario Geological Survey) preparing to run an SP line over a clay-covered target near Timmins, Ontario.

The project is one of industry-wide, international cooperation. Commercial laboratories are kindly donating analyses: Acme Laboratories, Actlabs, Bondar-Clegg, Chemex, Gedex and XRAL, as are the Chinese Institute of Geophysical and Geochemical Ex-

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Camiro Deep-Penetrating Geochemistry

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ploration and the Geological Survey of Canada. Young geochemists from industry and government are working on the project from sampling, through interpretation, to write up:

Analytical Program: Gwendy Hall, GSC

Abitibi Program: Stew Hamilton (OGS), Beth McClenaghan (GSC).

Southwest United States: Mary Doherty (BHP), David Kelley (WMC), Patrick Highsmith (Chemex).

Chile: Chris Benn (BHP), Matthew Leybourne (GSC), David Seneshen (WMC).

Australia: Dave Esser (Placer-Dome)

Three organizations with special expertise in the detection of gas and metals in soil gas are carrying out field studies at selected sites:

BRGM: Philippe Freyssinet, Hélène Pauwels.

Chinese Institute of Geophysical and Geochemical Exploration: Xie Xuejing and colleagues.

USGS Reno: Howard McCarthy

Laboratories, mining companies and government institutions have been generous in donating their services and the time of their staff. The Ontario Geological Survey, led by Stew Hamilton, are expending close to a half million dollars in complementary studies at the same sites in the Clay Belt. The participation of geochemists with varied experiences and concepts of element migration is particularly important. By meetings at field sites to review data, we hope to stimulate discussion on the processes that may cause the movement of elements over vertical intervals of several hundred meters.

The project will be completed two and a half years after the start date of June, 1999. At that time there will be a final report, plus interim reports as studies on sites are completed. A confidentiality period of two years will apply after results are first released. Other companies are welcome to join the project as sponsors. They may contact Richard Alcock, Research Director, CAMIRO (416-956-5953; ralcock@falconbridge.com) or me at the adress below. Additional funding so gained will be used to extend the analytical program.

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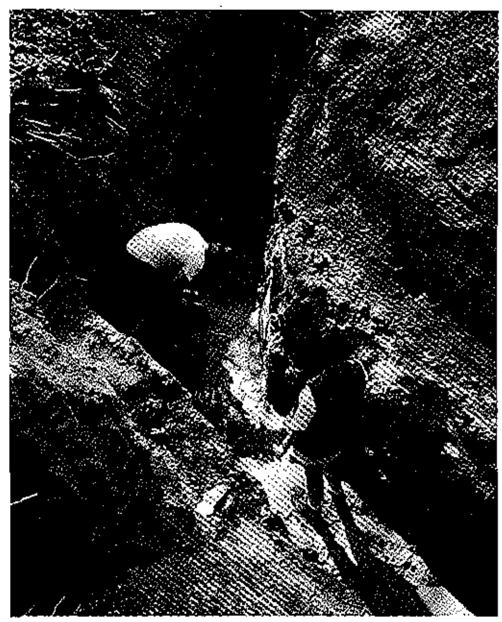
NEWS NOTE

Progress on Diamond Exploration Studies In Glaciated Terrain

Beth McClenaghan and Bruce Kjarsgaard

GSC research scientists Bruce Kjarsgaard and Beth McClenaghan continued their kimberlite/glacial dispersal studies in the Kirkland Lake-Lake Timiskaming kimberlite field of northeastern Ontario, Canada this summer by excavating backhoe trenches into the McLean kimberlite. The kimberlite outcrops along its southern edge and is overlain by up to 3.5 m of till and glaciolacustrine silt at its centre and northern edge. Kimberlite and till samples overlying and down-ice of the kimberlite were collected to determine the mineralogical and geochemical signature of the kimberlite and to document glacial dispersal patterns. This summer, Beth and Bruce also completed a comprehensive biogeochemical survey over the Peddie kimberlite, 7 km to the southeast, which also has a very thin overburden cover. Results of detailed indicator mineral and geochemical studies of the Peddie kimberlite and overlying glacial sediments were released in GSC Open File 3775 in October, 1999. This report can be purchased from the Geological Survey of Canada Bookstore, telephone: (613) 995-4342, Email: gsc_bookstore@gsc.nrcan.gc.ca.



Backhoe trench exposing 3 m of glacial sediments overlying kimberlite. Bruce is washing the kimberlite surface to enable measurement of glacial striations and sampling of rock.

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TECHNICAL NOTE

Salting Solutions

By Don Berkman

All of us, even the most law abiding, are fascinated by crime, and on some days it seems that the newspapers and television report nothing else. The mining industry has a unique criminal activity called 'salting', briefly described as adding high-grade material to an ore sample to create a false impression of the value of a deposit. This description of 'salting solutions' is not a series of recipes for corned beef, but a description of salting practices, and how they may be recognised and prevented.

The newspapers and mining journals have made much of the Busang fraud over the past six months. This may be the world's most successful case of salting, and it draws attention to the question - could a similar scam happen in Australia? The answer is yes - a determined confidence trick has a high chance of success in the short term, based on the inherent greed and ignorance of many speculators in exploration company shares. Over a long term there are ample safeguards built into the Australasian Code for Reporting of Identified Mineral Resources and Ore Reserves (the 'JORC Code'). By following the JORC Code guidelines a competent geologist can apply and audit exploration procedures to ensure that resource and reserve statements are valid.

This newsletter examines some historical frauds in mining and exploration, and describes exploration methods in which samples may be deliberately biased to achieve a scientific objective. Salting may also be accidental, without a deliberate criminal purpose, and this may also be avoided by applying the preventive measures.

SALTING PROCEDURES

Felonious salting is a practice unlimited by race, religion or region - it appears to be an activity of world-wide application and extreme ingenuity. Some examples from widely scattered sites are described below, to illustrate the widespread nature and originality of salting. In the words of Bret Harte:

'The ways of a man with a maid be strange
Yet simple and tame
To the ways of a man with a mine
When buying or selling that same'.

We can supply copies of the journal articles for clients who may wish to examine these and other cases in detail. Preventive measures are described in a later section.

The earliest known salters were **the alchemists of the Middle Ages** who took 'shortcuts' in the search for a method of transmuting base to precious metals. A salting method mentioned in Agricola (1556, p. xxix) involves adding a small piece of silver or gold, hidden in a piece of coal, to a smelting charge, thus producing precious metal from an otherwise barren ore. Agricola had no patience with the 'genuine' alchemists, and considered the tricksters to be 'held in the greatest opprobium'.

Other alchemist's tricks included the use of a crucible with a false bottom, under which gold or silver were hidden; using charcoal that had been soaked in a gold or silver salt; stirring the charge in a crucible with a hollow rod, sealed with wax, which would allow the precious metal salt to escape from the rod when heated; and adding gold or silver dissolved in aqua regia to a smelting charge (Rickard, 1941, p. 42).

Figure 1. 16th century illustration of the divining rod, from Agricola (1556, p. 40). A is the divining rod, and B shows searching for ore veins by trenching, the method favoroed by Agricola.

The divining rod (Figure 1) is another method of mining artifice, again first described by Agricola (1556, pp. 38-41. He comments that 'a miner...understands that a forked stick is of no use to him, for...there are natural indications of veins which he can see for himself without the help of twigs. If Nature or chance should indicate a locality suitable for mining, the miner should dig his trenches there'.

Turning to more recent times, stanniferous veins at the **Lake Superior north shore** tin prospect were sampled by an experienced miner in about 1870, and crude tin was produced by smelting. A glowing report was issued, a company was formed, and sample tin spoons made from the company's ore were sent to the shareholders. Then an engineer was sent to investigate the deposit in the depth of winter, which required a 150-mile trek on snowshoes. The evaluator found that several natural cracks in outcrops had been filled with a mixture of Cornish tin ore and Lake Superior copper ore, cemented by soluble silicates. Unfortunately, the promoters had left their barrel of soluble silicates at the adjacent camp, and the source of the 'ore-forming process' was readily identified (McDermott, 1894-95, p. 121).

In an **African diamond fraud**, the promoter made a critical mistake in taking his wife along as part of an inspection group at a clean-up at the end of a period of exploratory mining. Everything went very well at first - it was a pleasant day, a very tasty lunch was served, the machines all worked properly, and the 'blue ground' looked very promising. At the end of the clean-up eight beautiful diamonds were recovered, to everyone's satisfaction. Unfortunately the wife, who was standing by, said 'Why, Charlie, where are the other two stones?' - and quite ruined the occasion (McDermott, 1894-95, p. 140).

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Salting Solutions

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A **Virginia City** (**Nevada**) mine contained lumps of native silver in the ore. Native silver is not unusual in the Virginia City district, but it is more commonly in a wire, tabular or moss form. In this mine the silver occurred as unusual rounded pellets, like large gold nuggets, which led the investigator to a microscope examination of the lumps. One of the lumps was found to contain an imprint of the letters 'E PLUR'. Any patriotic American would recognise this to be part of the phrase 'E PLURIBUS UNUM' ('one composed of many', the motto of the USA), which appears along the rim of all US silver dollars (Rickard, 1941, p. 42). Obviously the salter had manufactured the ore mineral from silver dollars.

At a **British Columbia** gold mine, the outcrop showed some free gold, and an adit driven to intersect the orebody about 100 feet below the outcrop exposed a lode of similar ore about three feet wide, again showing visible gold. Samples from the ore-body in the adit showed a fairly uniform gold grade, all around 2 oz/ton. The investigator became suspicious, as it seemed unlikely that the owners would wish to sell such a promising deposit, and requested a microscope examination of the samples. The gold was found to be free (unattached to any gangue minerals), a reddish colour, and harder than the usual yellow gold from this area. A bullion assay showed that the gold had a fineness of 916.66, with the remainder silver with a trace of copper — exactly the same composition as English sovereigns (Rickard, 1941, p. 42).

The **Arizona diamond hoax** of 1872 (Liebenberg, 1961) provided an example of salting which was later repeated, several times, at South African prospects. The story begins with two prospectors, in their usual working clothes, depositing a parcel 'of great value' with the Bank of California for safekeeping. On enquiry, the prospectors stated that they had discovered the stones in the Arizona desert, and cupidity took a hand in the story. One of the greatest mining experts of the day was sent to check the claim, blindfolded so that he could not divulge the location, and came away very excited about the promise of the discovery. A company was formed and raised $1.6 million to develop the strike, and the future looked very rosy.

In the midst of this excitement Clarence King, the Director of the US Geological Survey, telegraphed the company that the field was 'fraudulent and plainly salted'. Legal action was brought against the prospectors, and it was found that one of them had purchased a parcel of inferior South African stones in London, for about $12 000, before travelling to the Arizona desert. The legal action concluded with a compromise, by which the leading prospector repaid about half of his share of the proceeds from the project.

Salting of **Madagascar gold deposits** was exposed by Dr Hans Merensky, the doyen of the South African geological fraternity, in 1905 (Liebenberg, 1961). Several vendors held title to claims covering an unusual 'auriferous' agglomerate lying over a thermal spring, which was postulated as the source of the gold, and very large adjacent alluvial deposits. One group of 14 claims had been tested by pitting, and stated to contain 25 million tons of the agglomerate, at an average grade of 10 ounces of gold per ton. The Johannesburg Stock Exchange buzzed with excitement, and the price of the shares in the several companies formed to exploit the claims rose rapidly. In all this excitement several of the leading South African mining houses, including Anglo American and Rothchild, hurriedly sent a total of 21 experts to inspect this new field, chartering a steamship to get them there.

On site Merensky found a band of gneiss (the vendors 'agglomerate') exposed on the side of a limestone ridge, which he concluded could not contain payable gold values. Nevertheless, he sampled the barren gneiss at the end of the first day's examination. The next day he crushed and panned the samples, and was astonished to find a large amount of gold in every sample. Repeat samples were then taken, from the same sites as the original set, but crushing and panning these did not disclose any gold. With the aid of a hand lens he noted that the copious free gold, panned from the first batch of samples was 'not in its natural state', and could not have been a constituent of the gneiss. An examination of the alluvial prospects found only a trace of gold in isolated ravines, at such a low grade that the local people did not work them.

A second group of investigators produced findings that are even more remarkable — samples taken by the leader of the group contained abundant gold, but those collected by his assistant were barren. Several cables were sent to Johannesburg, all stating that the samples had been salted and that the Madagascar rush was based on fraud. The news caused consternation at the Stock Exchange, and the leading

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Salting Solutions

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shares dropped from $100 to $12 overnight, then steadily declined in value and eventually became worthless.

The **Erfdeel fraud** was perhaps the most sensational salting case in South Africa. Drill hole ED5, about 2 kilometres deep was sunk at Erfdeel, about 8 miles from Welkom, to test the Basal (Witwatersrand) Reef by an original and seven further wedged intersections. A stock exchange 'boom' began when core from the second defleetion assayed about 2 ounces per ton. Interest in the project soared when the third deflection was reported to assay 530 ounces of gold to the ton, and the price of the owner company shares quadrupled over five days. As the grade of the first two intersections was much lower, Government authorities became suspicious of this phenomenal assay, and police investigators were called in (Liebenberg, 1961).

The subsequent examination was hampered because whole core had been analysed for the first three reef intersections. The testing combined input from geologists, microscopists and assayers. The pulp from the second deflection was found to contain a small amount of common Witwatersrand gold, but most of the gold in the sample was a 'foreign' copper-gold-silver alloy, present as shavings (Figure 2).

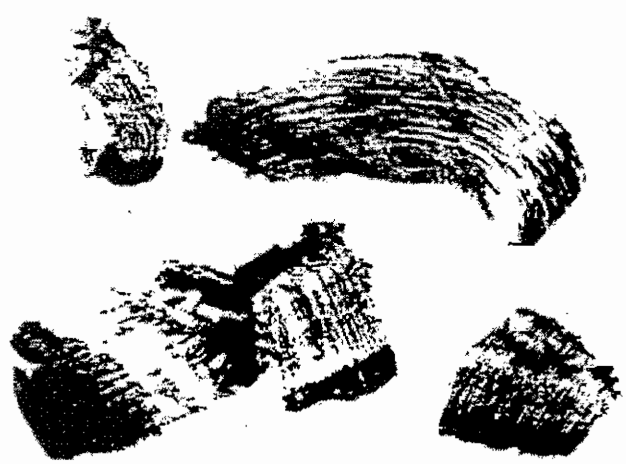

Figure 2. Gold shavings from the sample of the 2nd deflection of the Basal Reef, from Liebenberg (1961, Plate III)

The core-logging geologists were very surprised at the high grade quoted for deflection 3, stating that there was no visible gold in the core and that it looked 'hungry'. The microscopists found that the gold from the very rich material was abnormal as it was a peculiar shape, had unexpected iron oxide coatings, and an abnormally high ratio of coarse to fine particles. The assayers identified an unusually high uranium:gold ratio in the suspect samples.

At an early stage in the police investigation the clothing of the assay staff was examined, and a few grains of quartz and pyrite, and 24 particles of gold, were identified in a pocket of an employee's waistcoat. The clothing from other employees in the assay office was shown to contain minor quartz dust, but no gold particles. Subsequent slitting of the seams of the waistcoat and examination of the cloth disclosed hundreds of fine gold particles, of total weight about 75 milligrams. All of waistcoat gold particles had the iron oxide coatings, the unusually high number of coarse particles and the high uranium:gold ratio of the suspect samples.

The owner of the waistcoat was found guilty of salting the drill hole samples and was sentenced to three years' hard labour and a fine of $12 000.

The **Maungaparerua sulphide prospect**, near Kerikeri in the far north of the North Island of New Zealand, was evaluated by 39 cored drill holes in 1970. Assays of drill hole samples, by Johnson Matthey in London, showed high values for platinum, palladium, gold and silver, in a clay host. Subsequent check assays on splits of the same samples at Johnson Matthey, Impala Platinum in South Africa, at Nippon Steel in Tokyo and at the DSIR laboratory in Wellington showed extreme variability in platinum values, and did not confirm the presence of palladium, gold or silver (Weissberg et al, 1982).

The drill hole samples were then examined by the DSIR, at the leaseholder's request. The investigation was very thorough, and included a geological examination of the site and of the samples, petrological examination of thin and polished sections and of heavy mineral concentrates, and extensive assays. The geological work identified the host as basalt, pervasively hydrothermally altered to a montmorillonite-illite-vermiculite clay assemblage. Alteration products were abundant pyrite and marcasite and traces of sphalerite, chalcopyrite and cinnabar.

Assays of the 'mineralised' samples showed that there was no correlation between platinum, copper or zinc values. Careful heavy mineral separation isolated fine fragments (less than 0.2 millimetres in diameter) of a silvery mineral, eommonly with a curved or hummocky surface on one side and a flat, striated surface on the other (Figure 3). Assays of this material showed that it was at least 99.5% platinum. As there are no naturally occurring platinum minerals of this composition, the DSIR advised the leaseholder that the samples were apparently contaminated, and the leaseholder asked the police to supervise the next part of the investigation.

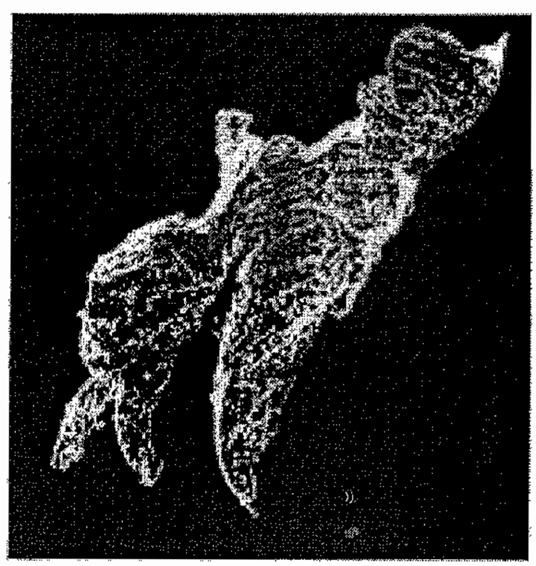

Figure 3. Photomicographs of a platinum particle from drill hole KAA4, Maungaparerua prospect ffrom Weissberg et al. (1982, figure 6).

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Salting Solutions

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The DSIR microscopists obtained a quantity of 21 gauge (0.7 millimetre diameter) platinum thermocouple wire in order to determine if similar particles of pure platinum could be made. Scraping the wire with a knife produced particles, but of an entirely different shape to the particles in the drill hole samples. However, filing the wire, while held in the fingers, produced practically identical fragments of platinum, accompanied by particles of a white, plastic-like material. At this stage, it was realised that particles of similar white material were associated with the platinum fragments in the drill hole samples.

Repeated production of platinum fragments by filing confirmed the association of platinum and fingernail fragments, and the microscopists were able to confidently conclude that the samples had been salted with readily available platinum wire, prepared by filing it into small pieces. The quantity of salting material required to obtain a 10 gram/tonne assay is notably small, this grade being achieved by adding an 11 millimetre length of 21 gauge wire to a one-kilogram sample. The police investigation file has not been closed, but no charges have been laid.

The Bre-X Minerals Ltd **Busang gold prospect**, in Kalimantan, was the subject of the largest scale and most financially successful salting known to date (Mining Business Digest, November 1997, pp. 54-55). At its peak the deposit was stated to contain 71 million ounces of gold, in 889.3 million tonnes of ore at an average grade of 2.48 grams per tonne.

It has been investigated in great detail, including drilling of 'twinned' check holes beside several of the salted holes. Tampering with drill hole samples apparently began with hole 3, in December 1993, after the first two holes produced low gold grades and threatened closure of the project, and continued until March 1997. The salting was apparently managed by Chief Geologist Michael de Guzman, who instructed several employees in the methods used. Salting of hole 3 used shavings of a man-made copper alloy, and purchased alluvial gold was added to the samples from subsequent holes. These employees allegedly systematically salted samples of whole drill core, at the company's Samarinda depot, by adding alluvial gold to the samples during the crushing and grinding preparation stage. Thousands of samples from more than 100 drill holes were salted.

The investigator's interim report states that there are reasonable grounds to believe that large profits were made by the salters by exercising options on Bre-X shares and subsequent sales. Allegedly, the largest sum was generated by Michael de Guzman with $US 4.557 million, with others named in the report being Cesar Pupos with $US 2.163.mil-lion, Jerry Alo with $US 1.239 mil-lion and Bobby Ramirez with $US 378 000.

BIASED SAMPLES

There are some occasions when it is useful to deliberately collect samples of material of higher grade than the average for the country rock. An example is the selective sampling of quartz veins during a regional exploration program, on the basis that the veins are more likely to contain gold values than any other rock type. Another example is the deliberate sampling of iron and manganese oxide coatings on stream floaters, on the assumption that these will have scavenged metals and should highlight anomalous areas. The procedure is crude, and liable to fail in regions of unknown geological setting. However, it may also provide a useful check at the 'last gasp' of an exploration project, when the explorer is checking that a near-surface orebody has not been missed.

These biased samples should be carefully explained in the accompanying report, and the sample material should be clearly described in the 'assay ledger'.

A sampler may, unintentionally, produce samples which contain higher grades than average by taking more of a soft material, or by selecting more of the 'pretty' mineralised material. This is most likely with untrained samplers, particularly those anxious to please a new employer.

Miller et al (1998) suggest that a riffle splitter may collect a disproportionate amount of the heavy fraction from wet drill hole cuttings containing coarse gold, when compared with results from twinned cored holes or rotary holes using a rotary splitter.

An unsubstantiated story from the evaluation of the Bougainville copper deposit provides another example of accidental sample bias. It has been stated that the evaluating team was concerned that the copper values, concentrated in fractures in the country rock, were lost during all forms of

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Salting Solutions

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drilling used to define the ore reserve. A long adit was driven along the course of a horizontal drill hole, for whieh the average assay was 0.8% copper. Bulk sampling of the ore won from the adit showed an average grade of about 1% copper.

ACCIDENTAL SALTING

Valuable minerals may be transferred from a high-grade sample to a following, low-grade sample by crushers or pulverisers that are not thoroughly cleaned after each sample. In a field setting samples may be contaminated by using old cloth sample bags that have not been thoroughly washed, or by attempting to recover samples from split packets or bags.

PREVENTIVE MEASURES

Eternal vigilance is the key to preventing deliberate or accidental salting. Although it is impossible in practice for the supervising geologist to check all of the stages of a large exploration project, safeguards can be built into operating procedures so that fraud or error ean be detected at an early stage.

THESE SAFEGUARDS ARE:

- Develop and distribute a suitable sampling procedure for each project - Roden and Smith (1998) can be consulted as a guide. Then be prepared to spend some time on educating employees and contractors in the standard sampling practice. Explain why you have standard sampling methods, and what may happen if these methods aren't used. You should also check that the standard procedures are being followed during every subsequent field visit.

- Take some samples yourself, alone, carry them yourself, and submit them for assay yourself. (McKinstry, 1948).

- Collect some bulk samples, early in the life of a promising project. It is much more difficult to salt bulk samples

- Use sample numbers out of order in a group of numbers, so that samples from adjacent high-grade material are not prepared for assay in the order the samples were collected. This will allow the detection of any accidental contamination, as the samples are usually prepared in numerical order.

- Visually estimate the grade of all mineralised samples, noting also the quantity of sulphides present. This is reasonably simple to achieve by panning drill hole cuttings and noting the sulphide content.

- Keep all samples, sample records, geological logs and notebooks in a locked, metal box. If felonious salting is suspected, keep this box in a secure place and deliver the samples personally to the assayer.

- Take every 20th sample in duplicate, repeating the sampling procedure on identical raw material. Include blank and standard samples in every batch sent for assay.

- Describe all mineralisation in sufficient detail so that any 'foreign' material added, deliberately or accidentally, ean be recognised.

- Send representative samples of new mineralisation to a petrologist, for a detailed description of the ore and gangue minerals, and their method of association. The petrologist's task may be made easier by submitting core or chip samples with obvious mineralisation, or by preparing high-graded samples by panning drill hole cuttings or sludges.

- Carry out a multi-element analysis on all examples of new mineralisation, so that the metal-pathfinder association can be identified. Most ore deposits can be classified by their elemental association, such as the Cu-Ag-Co-As-Te-Hg pathfinders to gold deposits and the Se-Mo-V associated with sandstone uranium occurrences.

Salting has been part of deposit evaluation for many hundreds of years, and the time-proved methods have been adapted to new fields and improved technology. However, you don't need to make the salter's work easy!

REFERENCES

Agricola, G., 1556. De Re Metallica, translated from the Latin by H C and L H Hoover in 1912 (Dover Publications: New York).

Liebenberg, W. R., 1961. Forensic mineralogy with special reference to the Erfdeel enquiry, Proceedings of the Geological Society of South Africa, Vol. 64, pp. ix-lvii.

McDermott, W., 1894-1895. Mining Reports and Mine Salting, IMM Transactions, Vol. 3, pp. 108-149.

McKinstry, H. E., 1948. Mining Geology, pp. 67-69 (McGraw Hill: New York).

Miller, G. C., Kirk, C. M., Hamilton, G. and Horsburgh, J. R., 1990. Brocks Creek gold deposits, p. 414, in Geology of Australian and Papua New Guinean Mineral Deposits (The Australasian Institute of Mining and Metallurgy: Melbourne).

Rickard, T. A., 1941. Salting, Engineering and Mining Journal, Vol. 142, No. 3, March 1941, pp. 42-44; No. 5, May 1941, pp. 52- 54; No. 6, June 1941, pp. 50-51.

Roden, S. and Smith, T., 1998. Sampling and analysis protocols and their role in mineral exploration and new resource development, pp. 137-141 in AusIMM '98 The Mining Cycle, Publication 2/98 (The Australasian Institute of Mining and Metallurgy: Melbourne).

Weissberg, B. G., Kitt, W., Challis, A. and Wodzicki, A., 1982. Platinum in the Maungaparerua sulphide prospect near Kerikeri, North Auckland, New Zealand, DSIR Chemistry Division Report No. CD 2326.

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RECENT PUBLICATIONS

This list comprises titles that have appeared in major publications since the compilation in **EXPLORE** Number 104. Journals routinely covered and abbreviations used are as follows: Economic Geology (EG); Geochimica et Cosmochimica Acta (GCA); the USGS Circular (USGS Cir); and Open File Report (USGS OFR); Geological Survey of Canada papers (GSC paper) and Open File Report (GSC OFR); Bulletin of the Canadian Institute of Mining and Metallurgy (CIM Bull.); Transactions of Institute of Mining and Metallurgy Section B: applied Earth Sciences (Trans IMM). Publications less frequently cited are identified in full. Compiled by L. Graham Closs, Department of Geology and Geological Engineering, Colorado School Of Mines, Golden, CO 80401-1887, Chairman AEG Bibliography Committee. Please send new references to Dr. Closs, not to **EXPLORE.**

Bendell-Young, L., 1999. Contrasting the sorption of Zn by oxyhydroxides of Mn and Fe, and organic matter along the mineral-poor to mineral-rich fen gradient. Applied Geochem. 14(6): 719-734.

Bonotto, D.M. and Andrews, J.N., 1999. Transfer of radon and parent nuclides ^{238}U and ^{234}U from soils at the Mendip Hills area, England, to the water phase. J. Geochem. Explor. 66(1/2): 255-268.

Brown, T.D., Smith, D.N., Hargis, R.A., Jr., and O'Down, W.J., 1999. Mercury measurement and its control: What we know, have learned, and need to further investigate (Critical Review Summary). Environmental Manager. June: 47-50.

Burenkov, E.K., Golovin, A.A., Morozova, I.A., and Filatov, E.I., 1999. Multi-purpose geochemical mapping (1: 1,000,000) as a basis for integrated assessment of natural resources and ecological problems. J. Geochem. Explor. 66(1/2): 159-172.

Castelo-Branco, M.A., et al., 1999. Potential use of pyrite as an amendment for calcareous soil. J. Geochem. Explor. 66(1/2): 363-367.

Cheng, Q., 1999. Spatial and scaling modeling for geochemical anomaly separation. J. Geochem. Explor. 65(3): 175-194.

Cohen, D.R., Silva-Santisteban, C.M., Rutherford, N.F., Garnett, D.L., and Waldron, H.M., 1999. Comparison of vegetation and stream sediment geochemical patterns in northeastern New South Wales. J. Geochem. Explor. 66(3): 469-489.

da Costa, M.L. and Kern, D.C.,1999. Geochemical signatures of tropical soils with archeological black earth in the Amazon, Brazil. J. Geochem.Explor. 66(1/2): 369-385.

Danielsson, A., Cato, I., Carman, I., and Rahm, L., 1999. Spatial clustering of metals in the sediments of the Skagerrak/Kattegut. Applied Geochem. 14(6): 689-706.

Davy, R., Pirajno, F., Sanders, A.J., and Morris, P.A., 1999. Regolith geochemical mapping as an adjunct to geological mapping and exploration; examplcs from three contiguous Proterozoic basins in Western Australia. J. Geochem.Explor. 66(1/2): 37-53.

Delaney, T.A. and Fletcher, W.K., 1999. Efficiency of cyanidation in gold exploration using soils. J. Geochem. Explor. 66(1/2): 229-239.

Gartz, V.H. and Frimmel, H.E., 1999. Complex Metasomatism of an Archean Placer in the Witwatersrand Basin, South Africa: the Ventersdorp Contact Reef - A Hydrothermal Aquifer? EG 94(5): 689-706.

Gascoyne, M. and Wikberg, P. (eds.), 1999. Geochemistry of the Aspo Hard Rock Laboratory, Sweden. Applied Geochem. 14(7): 817-962.

Guangzhi, T. (ed.), 1996. Geochemistry of Strata-bound Deposits in China. Institute of Geochemistry, Chinese Academy of Sciences. Science Press.

Guangzhi, T. (ed.), 1996. Low-Temperature Geochemistry. Institute of Geochemistry, Chinese Academy of Sciences. Science Press. 202 p.

Continued on Page 11

Recent Papers *Continued from Page 10*

Gzyl, J., 1999. Soil protection in Central and Eastern Europe. J. Geochem. Explor. 66(1/2): 333-337.

Herail, G., Lagos, J., and Vivallo, W., 1999. Gold dispersion in Andean desert environments (Atacama, Chile). J. Geochem. Explor. 66(3): 427-439.

Hoffman, V., Knab, M., and Appel, E., 1999. Magnetic susceptibility mapping of roadside pollution. J, Geochem. Explor. 66(1/2): 313-326.

Holmstrom, H. and Ohlander, B., 1999. Oxygen penetration and subsequent reactions in flooded sulphidic mine tailings: a study at Stekenjokk, northern Sweden. Applied Geochem. 14(6): 747-759.

Horbe, A.M.C. and da Costa, M.L., 1999. Geochemical evolution of a lateritic Sn-Zr-Th-Nb-Y-REE- bearing ore body derived from apogranites: the case of Pitinga, Amazonas, Brazil. J. Geochem. Explor. 66(1/2):339-351.

Kapicka, A., Petrovsky, E., Ustjak, S., and Machackova, K., 1999. Proxy mapping of fly-ash pollution of soils around a coal-burning power plant: a case study in the Czech Republic. J. Geochem. Explor. 66(1/2) 291-297.

Klukanova, A. and Rapant, S., 1999. Impact of mining activities upon the environment of the Slovak Republic: two case studies. J. Geochem.-Explor. 66(1/2): 299-306.

Knight, J.B., Mortonsen, J.K., and Morison, S.R., 1999. Lode and Placer Gold Composition in the Klondike District, Yukon Territory, Canada: Implications for the Nature and Genesis of Klondike Placer and Lode Gold Deposits. EG 94(5): 649-664.

Kontak, D.J, and Jackson, S.J.,. 1999. Documentation of variable trace- and rare-earth element abundances in carbonates from auriferous quartz veins in Meguma Lode gold deposits. Can. Min. 37(2): 469-488.

Koval, P.V., Grebenshchikova, V.I., Lustenberg, E.E., and Henney, P.J., 1999. Database of granites in the Mongol-Okhotsk zone, Mongolia-Siberia, and its use in mineral exploration. J. Geochem. Explor. 66(1/2): 199-210.

Koval, P.V., Kalmychkov, G.V., Gelety, V.F., Leonova, G.A., Medvedev, V.I., and Andrulaitis, L.D., 1999. Correlation of natural and technogenic mercury sources in the Baikal polygon, Russia. J. Geochem Explor. 66(1/2/): 277-289.

Kralik, M., 1999. A rapid procedure for environmental sampling and evaluation of polluted sediments Applied Geochem. 14(6): 807-816.

Kwolek, J.K., 1999. Aspects of geo-legal mitigation of environmental impact from mining and associated waste in the UK. J. Geochem.Explor. 66(1/2): 327-332.

Continued on Page 12

Recent Papers *Continued from Page 11*

Laakgoharju, M., Skarman, C., and Skarman, K., 1999. Multivariate mixing and mass balance (M3)calculations, a new tool for decoding hydrogeochemical information. Applied Geochem. 14(7): 861-871.

Lentz, D.R., 1999. Deformation-induced mass transfer in felsic volcanic rocks hosting the Brunswick No, 6 massive-sulfide deposit, New Brunswick: geochemical effects and petrogenetic implications. Can. Min. 37(2): 489-512.

Lis. J., Pasieczna, A., and Taraskevicius, R., 1999. Total and partial extraction of selected elements in soils of the Poland-Lithuania borderland. J. Geochem.Explor. 66(1/2): 211-217.

Lombard, M., de Bruin, D., and Elsenbrock, J.H., 1999. High-density regional geochemical mapping of soils and stream sediments in South Africa J. Geochem.Explor. 66(1/2): 145-149.

Mahmood, A., Parashar, S., and Srivastava, S., 1999. RADARSAT data applications; radar backscatter of granitic facies, the Zoer pluton, Morocco. J. Geochem.Explor. 66(1/2): 413-420.

Martos, F.S., Bosch, A.P., and Calaforra, J.M., 1999. Hydrogeochemical processes in an arid region of Europe (Alrneria, SE Spain). Applied Geochem. 14(6): 735-745.

McClenaghan, M.B., Kjarsgaard, B.A., Kjarsgaard, I.M., Paulen, R.C., and Stirling, J.A.R., 1999. Mineralogy and geochemistry of the Peddie kimberlite and associated glacial sediments, Lake Timiskaming, Ontario. Geological Survey of Canada, Open File 3775.

McClenaghan, M.B., Kjarsgaard, I.M., Kjarsgaard, B.A., Stirling, J.A.R., Pringle, G., and Berger, B., 1999. Mineralogy and geochemistry of the A4 kimberlite and associated glacial sediments, Kirkland Lake, Ontario. Geological Survey of Canada, Open File 3769.

McClenaghan, M.B., Kjarsgaard, I.M., Stirling, J.A.R., Pringle, G., Kjarsgaard, B.A., and Berger, B., 1999. Mineralogy and geochemistry of the C14 kimberlite and associated glacial sediments, Kirkland Lake, Ontario. Geological Survey of Canada, Open File 3719.

Middleton, G.V., 2000. Data Analysis in the Earth Sciences Using MATLAB. Prentice-Hall. 260 p,

Miko, S., Durn, G., and Prohic, E., 1999. Evaluation of terra rossa geochemical baselines from Croatian karst regions. J. Geochem. Explor. 66(1/2): 173-182.

Moore, D.M. and Reynolds, R.C., Jr., 1997. X-Ray Diffraction and the Identification and Analysis of Clay Minerals. 2 nd Ed. Oxford. 378 p.

Mordberg, L.E., 1999. Geochemical evolution of a Devonian diaspore-crandallite-svanbergite-bearing weathering profile in the Middle Timan, Russia. J. Geochem. Explor. 66(1/2): 353-361.

Mossman, D.J., 1999. Carbonaceous substances in mineral deposits: implications for geochemical exploration. J. Geochem. Explor. 66(1/2): 241-247.

Mossman, D.J., 1999. Mcrobial Processes in Gold Migration and Deposition: Modern Analogues to Ancient Deposits. Geoscienee Canada 26(3): 131-140.

Motuzova, G.V. and Van, N.T.H., 1999. The geochemistry of major and trace elements in the agricultural terrain of South Vietnam. J. Geochem. Explor. 66(1/2): 407-411.

Pasieczna, A. and Lis, J., 1999. Relationship between the geochemistry of soils and the geological basement in the Lower Silesian Coal Basin, SW Poland. J. Geochem. Explor 66(1/2): 219-227.

Pauwels, H. Baubron, J.C., Freyssinet, P., and Chesneau, M., 1999. Sorption of metallic eompounds on activated carbon: applications for concealed deposits in southern Spain. J. Geochem Explor. 66(1/2)115-133.

Piestrzynski, A. and Sawlowicz, Z., 1999. Exploration for Au and PGE in the Polish Zechstein copper deposits (Kupferschiefer). J. Geochem. Explor. 66(1/2): 17-25.

Pwa, A. and van Moort, J.C., 1999. Geochemieal exploration using acid soluble residues of rocks from volancic-hosted massive sulphide deposits, Rosebery area, western Tasmania. J. Geochem. Explor. 66(1/2):55-69.

Continued on Page 20

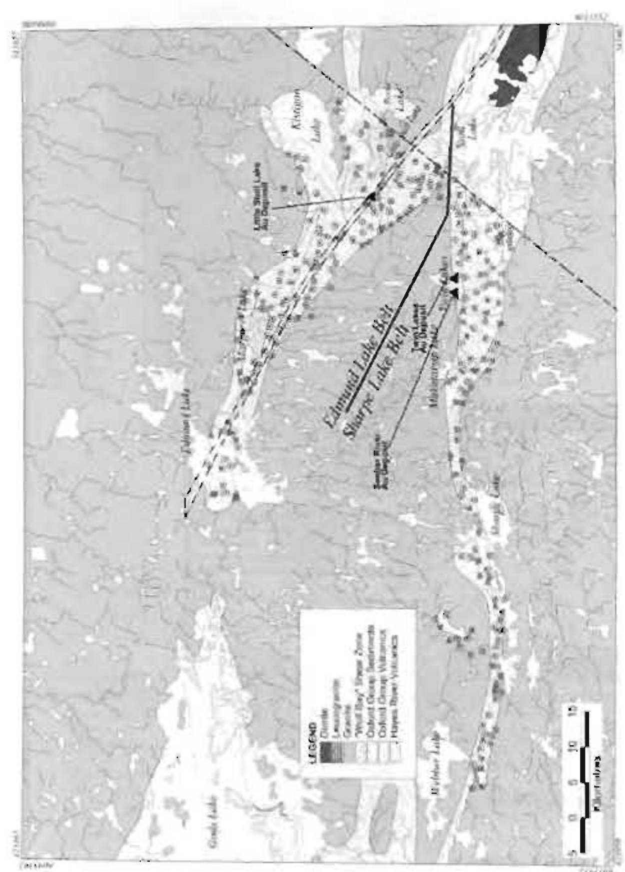

Figure 2. Distribution of sample sites in the 1997 multimedia geochemical survey area.

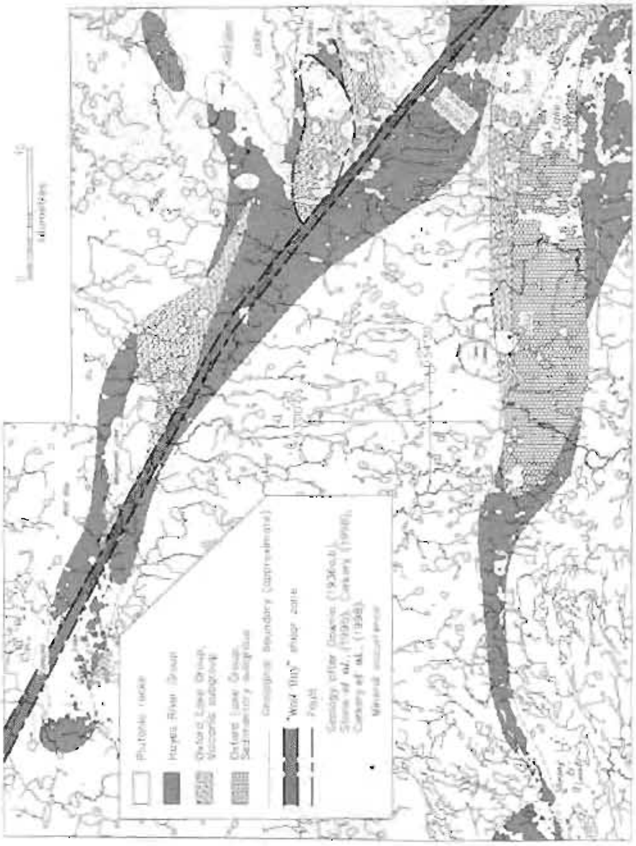

Figure 3. Simplified regional geology and mineral deposits in the 1997 multimedia geochemical survey area.

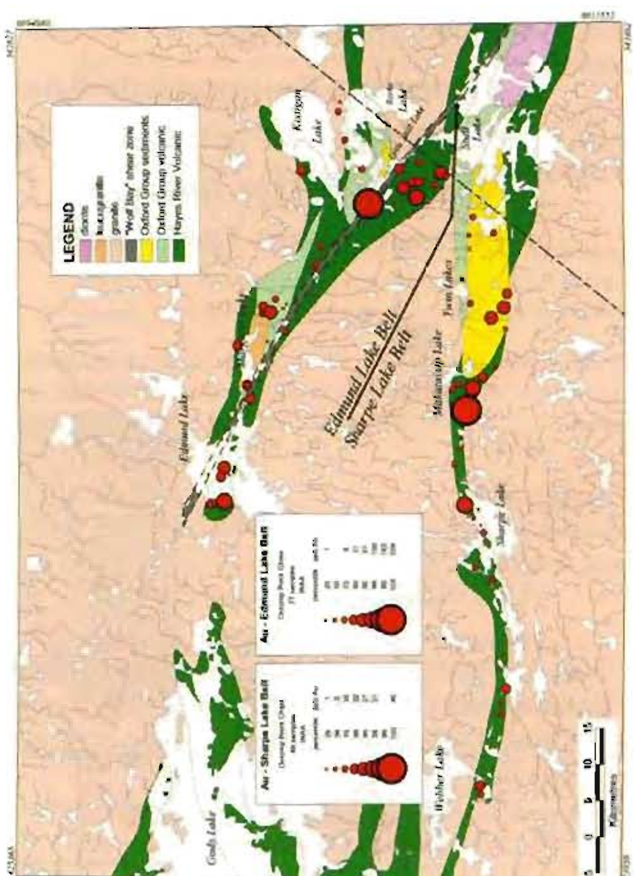

Figure 4. Percentile bubble plot for Au in outcrop rock chips..

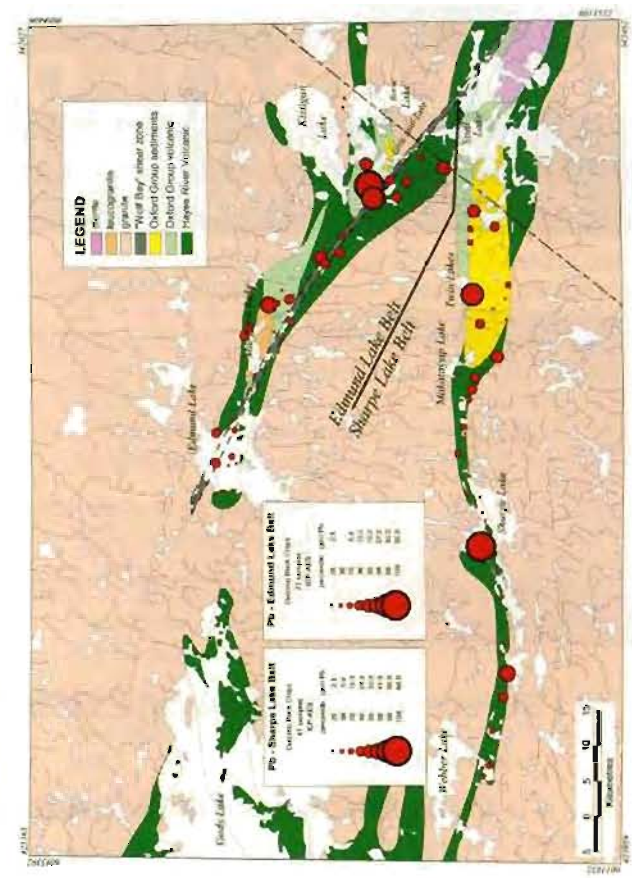

Figure 5. Percentile bubble plot for Pb in outcrop rock chips.

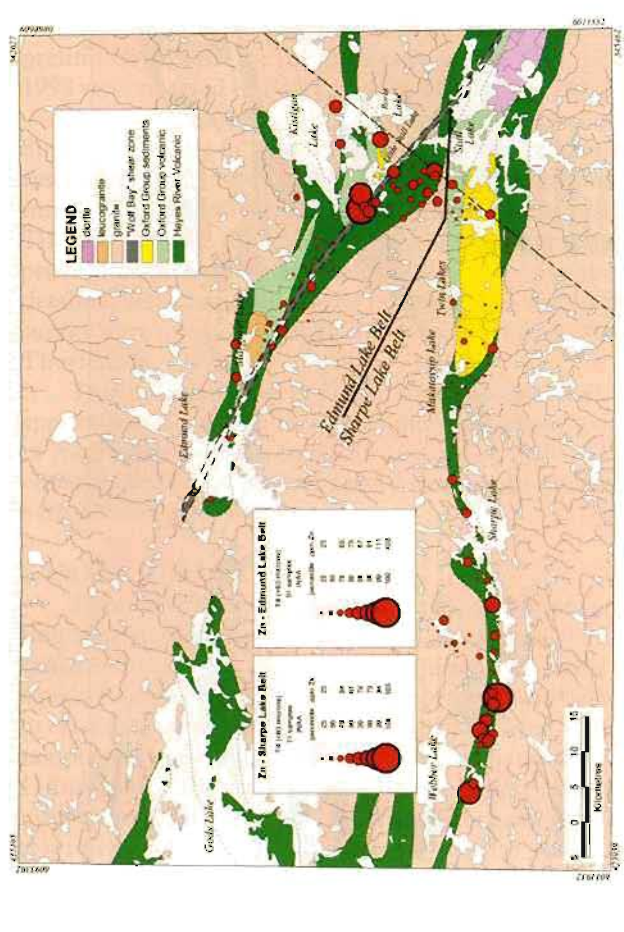

Figure 6. Percentile bubble plot for Zn in the <63 micron size fraction of till.

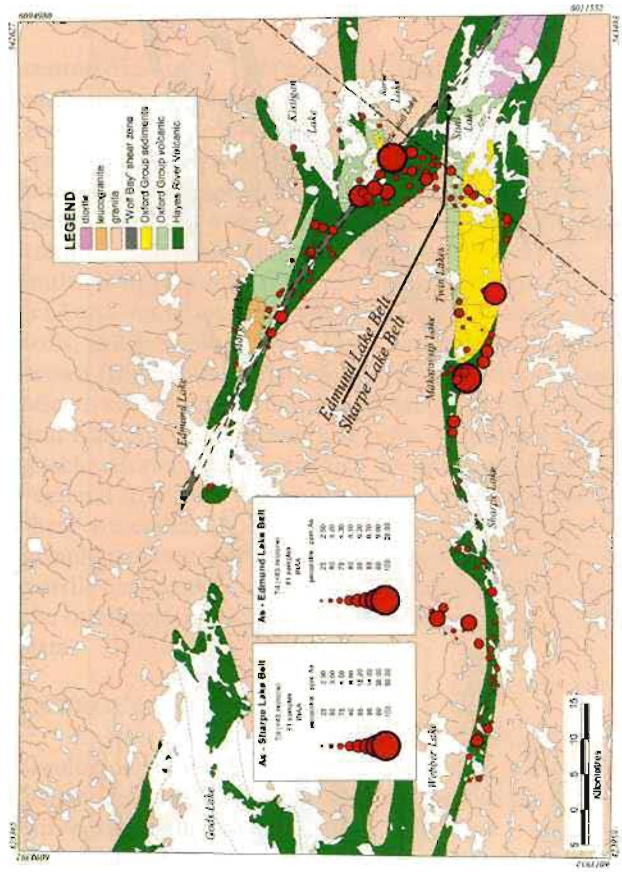

Figure 7. Percentile bubble plot for As in the <63 micron size fraction of till.

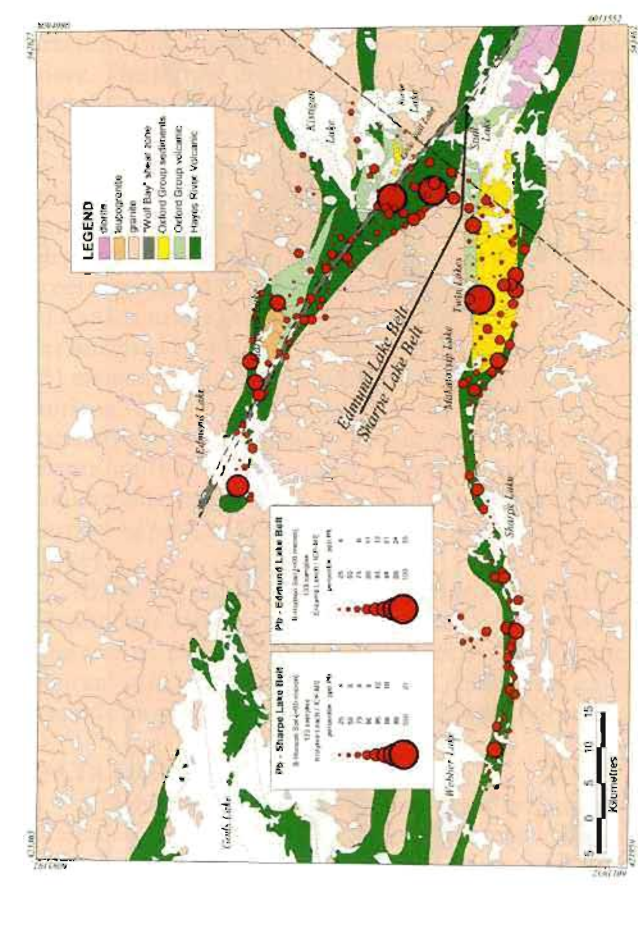

Figure 8. Percentile bubble plot for Pb in b-horizon soil.

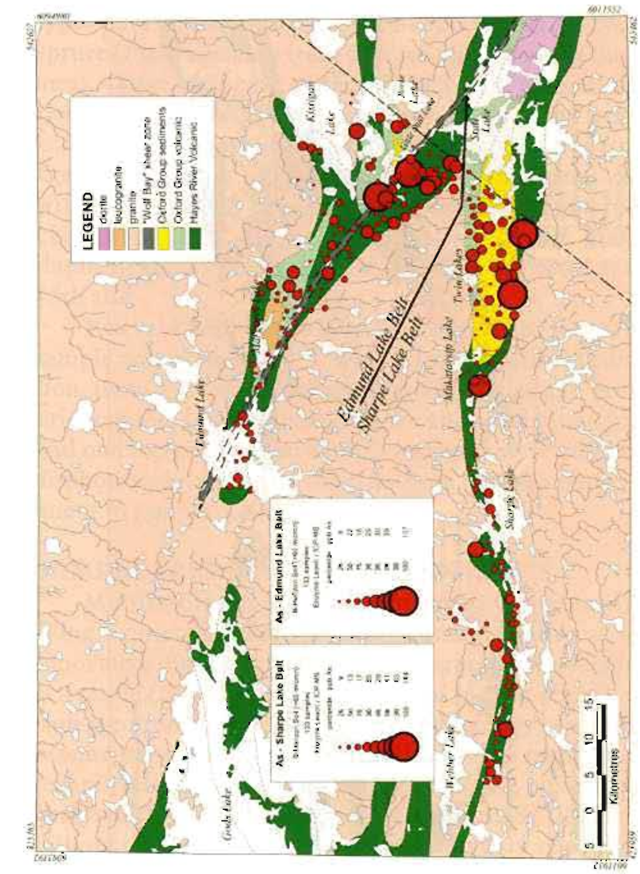

Figure 9. Percentile bubble plot for As in b-horizon soil.

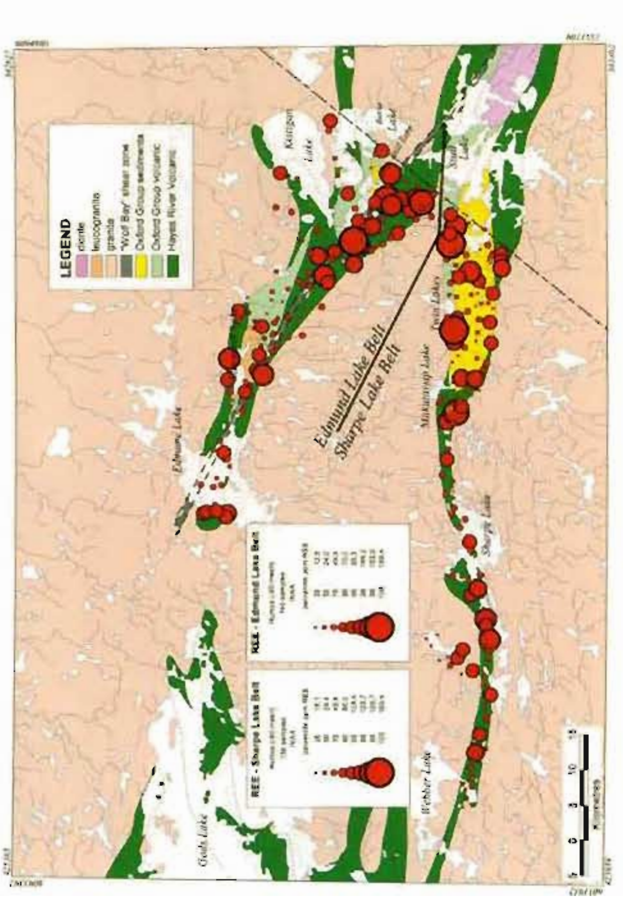

Figure 10. Percentile bubble plot for total rare earth elements (TREE) in humus.

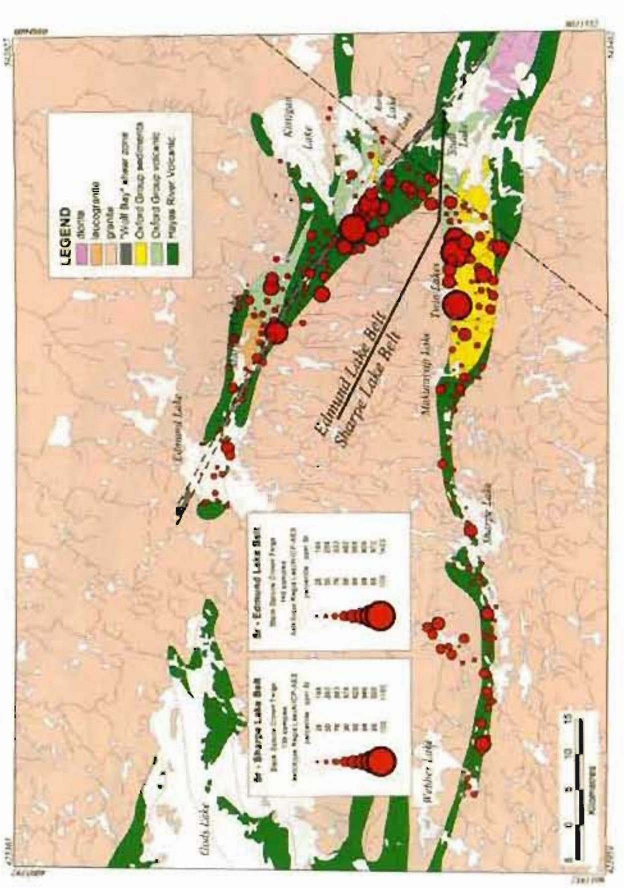

Figure 11. Percentile bubble plot for Sr in ashed black spruce crown twigs.

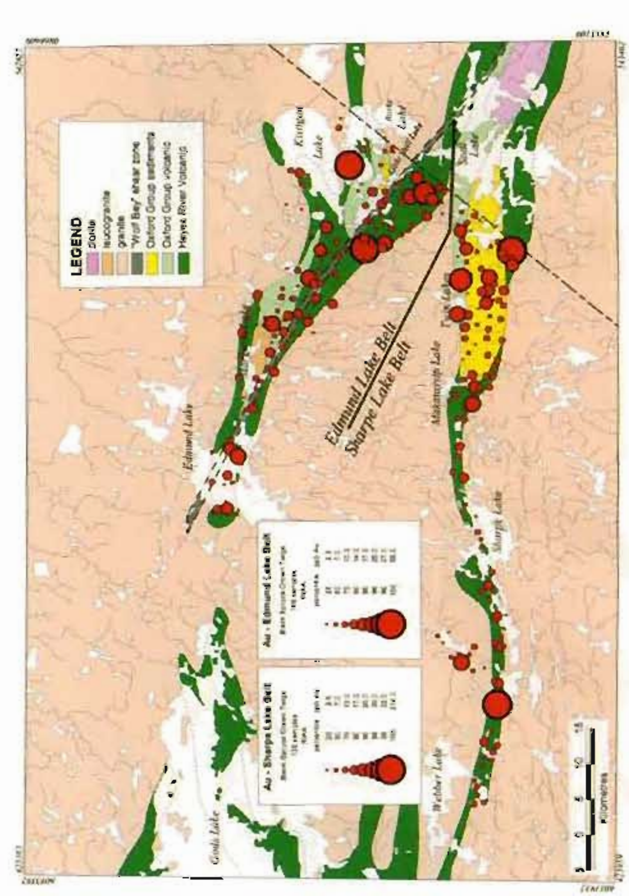

Figure 12. Percentile bubble plot for Au in ashed black spruce crown twigs.

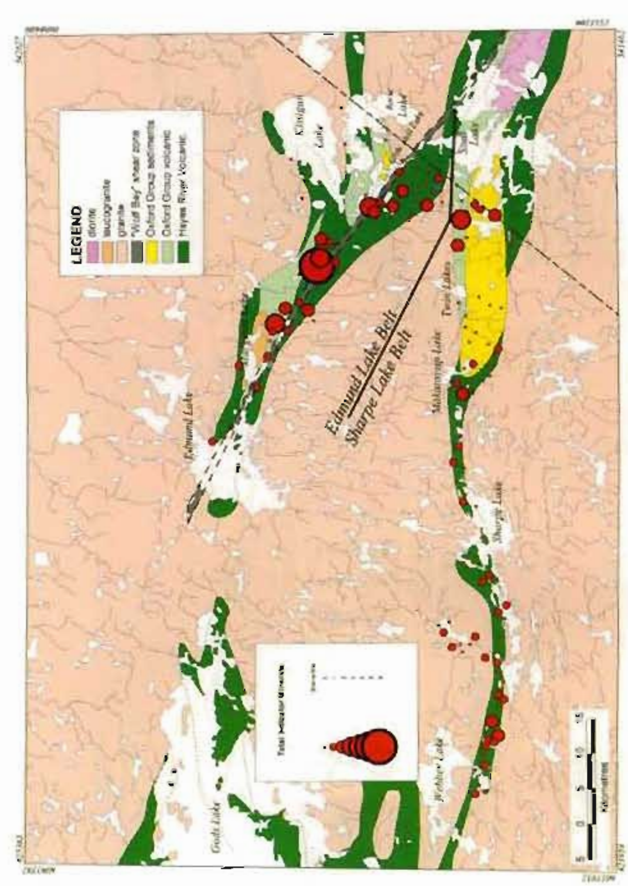

Figure 13. Percentile bubble plot for total kimberlite indicator minerals.

Mutilmedia Geochemical Survey Results

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central Manitoba. This project is designed to develop a multielement geochemical database for integration with geological and geophysical information applicable to the search for base and precious metal mineralization. Indicator mineral surveys for kimberlite, magmatic sulphide and metamorphosed massive sulphide deposits are also being conducted in these belts. Results from 1998 survey multielement geochemical responses in outcrop rock chips, <63 and <2 micron size fractions of till, a- and b-horizon soils, and ashed samples of black spruce (Picea mariana) crown twigs, collected on approximately 1 km centers, effectively delineate known gold deposits in the Sharpe Lake and Edmund Lake greenstone belts. Additional multimedia geochemical anomalies are also documented along the regional structures and stratigraphic sequences that host these mineralized zones. Multimedia analysis ensures good sample representivity throughout the survey areas despite hostile overburden conditions and increases confidence in the interpretation of selective extraction (enzyme leach^{SM}) data.

INTRODUCTION

In 1996 the Manitoba Department of Energy and Mines, Geological Services Branch initiated a five-year program of helicopter- and fixed-wing-assisted multimedia geochemical surveys, designed to assist in the definition of exploration targets and the assessment of mineral resource potential in greenstone belts of the northern Superior Province in Manitoba (Figure 1).

This initiative has been called Operation Superior and preliminary results for the areas surveyed in 1996, 1997 and 1998 were released in Fedikow et al. (1997a, b; 1998; 1999).

A complimentary project, initiated by the Geological Survey of Canada in 1996, geochemically and mineralogically assessed the mineral resource potential of the predominantly intrusive geological terrane separating the greenstone belts. Till samples were collected on a 40 km sample spacing to provide a regional framework for interpretation of the more detailed, belt-scale multimedia program. The results of this survey were released as Open File Report OF97-3 (Matile and Thorleifson, 1997).

This note describes the multimedia geochemical approach to the assessment of residual exploration potential in Archean greenstone belts and presents some of the results obtained from the Edmund Lake-Sharpe Lake greenstone belts surveyed in 1997.

SAMPLE COLLECTION

Samples of rock, till, b-horizon soil, humus and vegetation were systematically collected on approximately 1 km centres or as dictated by access to landing sites, using a float equipped helicopter (Figure 2). The procedure at each site is to establish, by hand augering, the location from which a till sample was to be collected. A pit was then hand dug and an 11 litre pail of till and a 1/2 kg till sample were collected for kimberlite mineral identification and geochemical analysis, respectively. A b-horizon soil sample was also collected from the pit. Humus samples were collected some distance from the pit to avoid particulate contamination. Three sample types were collected from vigorous and representative black spruce (*Picea mariana*) trees that are ubiquitous in the survey areas. Outer scaly bark at chest height on the trunk of the tree and crown twigs from the upper 45 cm of the tree were collected. A 1 cm thick wafer was cut from the tree trunk for age determination by tree ring counts so that metal variation with tree age could be assessed. Representative outcrop rock chip samples (fist size pieces) were also collected. Field duplicate pairs for each sample type were collected at every 15th site.

Relevant field observations were recorded for each sample type at each site. These included sediment composition, texture, geomorphology, as well as striae and drumlin orientations, vegetation abundance and speciation, drainage and outcrop abundance. Sample locations were plotted on airphotos while viewing the sites from the helicopter subsequent to sample collection.

SAMPLE PREPARATION AND ANALYSIS

Multimedia samples collected at each site are analyzed using a variety of state-of-the-art instrumentation as well as innovative digestion techniques. Instrumental neutron activation (INA), inductively coupled plasma-atomic emission spectrometry (ICP-AES) and inductively coupled plasma-mass spectrometry (ICP-MS) are the main analytical techniques. Outcrop rock chips are crushed, pulverized and analysed by INA (35 elements) and ICP-AES (31 elements). Silicate whole rock analysis is undertaken on selected lithologies. Till samples were prepared to obtain the <2 micron (clay) fraction by following standard procedures of centrifuging and decanting, and the <63 micron (silt + clay) fraction was obtained by dry sieving on a 63μm stainless steel sieve. The former is analysed by ICP-AES for 31 elements and the latter by INA for 35 elements. B-horizon soil samples are analysed using the enzyme leach^{SM} selective extraction (Clark et al., 1990; Clark, 1993, 1995) with an ICP-MS analysis for 60 elements. The -80 mesh fraction of humus samples is analysed by INA (35 elements) and ICP-AES (31 elements). Outer scaly bark and crown twigs of black spruce trees were ashed in the laboratories of the Geological Survey of Canada under the supervision of Dr. Colin Dunn. Ashes are analysed by a combination of INA (35 elements) and ICP (31 elements). Hg was analysed in outcrop rock chip, till, b-horizon soil and humus samples using a flow injection mercury system designed by Perkin Elmer Ltd. Measurements of pH and conductivity, converted to H+ and specific conductance respectively, were made on deionised water slurries of rock, b-horizon soil and humus samples for this survey.

Diamond potential for the Superior Province in Manitoba is asscssed by kimberlite indicator mineral surveys. Eleven litre pails of till collected at each sampling site were concentrated, mineralogically picked and microprobed to provide mineral chemistry for classification purposes.

DATA DISPLAY

Geochemical data for all sample types is routinely presented in open file reports in table format with site identification and UTM coordinates. These same data are

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Mutilmedia Geochemical Survey Results

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presented as delimited ASCII and EXCEL 4.0 files on a CD-ROM. The variation in concentration of the various elements throughout the survey areas is initially assessed using percentile interval bubble plots produced using MAPINFO and ARCINFO GIS software, digitized sample locations and analytical data. Greenstone belt boundaries and simplified geology are presented on the percentile bubble plots using a digital version of the 1:1 000 000 bedrock map of the province (Map 79-2) and the 1:250 000 Bedrock Geology Compilation Map Series. The UTM coordinates for sample sites are accurately derived from 1:50 000 topographic maps. For the purpose of this technical note only the percentile bubble plots are presented.

GEOLOGICAL SETTING

Multimedia geochemical and mineralogical surveys were conducted in the Edmund Lake and Sharpe Lake greenstone belts in 1997 (Figure 3). The Edmund Lake belt in Manitoba extends for approximately 60 km from the Manitoba-Ontario border northwest to Edmund Lake. The Sharpe Lake belt trends east-west from the provincial boundary and was sampled as far west as the south shore of Webber Lake, a distance of approximately 90 km.

The Edmund supracrustal belt forms a west-thinning, east-plunging homocline flanked by tonalite and granite terranes to the north and south. Lithologically the belt is characterized by pillowed and massive basalt flows of the Hayes River Group. The Wolf Bay Shear Zone (WBSZ) transects the greenstone belt and hosts gold mineralization at Little Stull Lake. These 5 Au zones are developed within an 8 km long portion of the WBSZ and contain 750 000 tonnes grading 9.3 g/tonne Au.

The Sharpe Lake belt comprises Hayes River Group felsic to mafic volcanic rocks with interbedded slate, quartzite and iron formation, and Oxford Group sedimentary rocks including conglomerate, arkose, greywacke, slate, quartzite, chert and garnetiferous schist. The Twin Lakes and Seeber River Au deposits occur within a 3.5 km portion of the east-trending, 30 km long, Monument Bay Shear Zone (MBSZ) which transects the belt. The Twin Lakes Au deposits contain reserves of 2.45 million tonnes grading 2.5 g/tonne in the "A" Zone and 472,000 tonnes grading 14.3 g/tonne in the "B" Zone. The Seeber River Au deposit is hosted by silicified and sericitized felsic volcanic rocks with arsenopyrite and pyrite and consists of a large, low grade mineralized zone (0.46 to 2.24 g/tonne Au over true widths of 4.0 to 52.0 m) with localized higher grade (5.9 to 16.4 g/tonne Au over 3.0 to 6.7 m) intersections. The deposit contains 590,000 tonnes grading 9 g/tonne Au.

RESULTS FROM THE 1997 SURVEY

Percentile bubble plots depicting selected results for each of the sample media are presented in Figures 4 through 13. The Au mineralized zones at Little Stull Lake and along the MBSZ in the Twin Lakes area are marked by single and multiple sample, high to moderate contrast, geochemical responses for most sample media.

The rock chip geochemical signature for Au (Figure 4) does not indicate the presence of the Twin Lakes Au deposits, although outcrop exposure (and hence rock chip samples) from this area is limited. Significant Au responses are documented west of these deposits along the MBSZ in an area of no known Au mineralization. The Pb signature (Figure 5) identifies the known Au zones and also highlights other prospective areas.

Till geochemical results for Zn and As (Figures 6 and 7) delineate the Little Stull Lake deposits whereas extensive wetlands and peat cover in the area of the Twin Lakes Au zones precluded till sampling in that area. High As-in-till contents occur west of the Twin Lakes deposits. Where till and outcrop rock chip samples were not obtainable due to overburden cover the enzyme leach analysis of b-horizon soils has proven to be an effective geochemical tool in hostile terrane. The Pb (Figure 8) and As (Figure 9) results identify the known Au zones in both belts and identify other anomalous areas for follow up. These include the faulted southern and southwest margins of the Sharpe Lake and Edmund Lake belts, respectively.

Total rare earth element contents of humus (Figure 10) delineate the Little Stull Lake and Twin Lakes Au zones as well as the area of the MBSZ north of Monument Bay in the Sharpe Lake belt. This particular geochemical response is somewhat unusual. However, the faults that characterize greenstone belt margins in the Superior Province of Manitoba are hypothesized to be hydrothermal pathways for residual fluid migration accompanying pegmatite emplace-

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Mutilmedia Geochemical Survey Results

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ment. The rare earth element humus signatures and the Sr response for ashed samples of black spruce crown twigs (Figure 11) are interpreted to be indications of this hydrothermal process. These two sample types are particularly effective in identifying the Au mineralized structures as well as other anomalous responses away from known mineralization. The MBSZ and associated Au deposits are characterized by elevated Au contents in ashed crown twigs (Figure 12).

Total kimberlite indicator minerals for the 1997 survey area (Figure 13) depicts an anomalous site midway along the WBSZ in the Edmund Lake belt. This response is strongly skewed by the abundance of magnesian ilmenite associated with ultramafic rocks observed at this site.

CONCLUSIONS

This brief description of a small portion of the 1997 multimedia survey results demonstrates the usefulness of this approach in the glaciated terrane of east-central Manitoba where prospective structure and stratigraphy is often mantled by thick, wet and compositionally variable surficial deposits. The collection of a variety of sample types assures representivity throughout the survey area and multimedia anomalies from any particular sample site can be used to prioritize areas for ground follow up. The use of innovative analytical approaches, such as the enzyme leach[SM], offers the opportunity to provide meaningful geochemical data for integration with geological and geophysical databases. Confidence in interpretation of selective extraction results benefits from the coincidence of these results with multimedia anomalies, as well as geophysical conductors and geological observations.

REFERENCES

Clark, J.R. 1993: Enzyme-induced leaching of B-horizon soils for mineral exploration in areas of glacial overburden; Transactions, Institution of Mining & Metallurgy (Sect. B: Applied Earth Science), p. B19-B29.

Clark, J.R. 1995: Method of geochemical prospecting; United States Patent 5,385,827, 20 p.

Clark, J.R., Meier, A.L., and Riddle, G. 1990: Enzyme leaching of surficial geochemical samples for detecting hydromorphic trace-element anomalies associated with precious-metal mineralized bedrock buried beneath glacial overburden in northern Minnesota; in: Gold '90, Society of Mining Engineers, Ch.19, p. 189-207.

Corkery, M.T. 1998: Geology of the Edmund Lake area (53K/11NW); Manitoba Energy and Mines, Geological Services, Preliminary map 1998S-1, 1:20 000.

Corkery, M.T., Skulski, T., Whalen, J.B. and Stone D. 1998: Geology of the Little Stull Lake area (Part of NTS 53K/10 and 5); Manitoba Energy and Mines, Geological Services, Preliminary map 1998S-2, 1:20 000.

Downie, D.L. 1936a: Stull Lake sheet (East half); Canada Department of Mines and Resources, Mines and Geology Branch, Map 452A.

Downie, D.L. 1936b: Stull Lake sheet (West half); Canada Department of Mines and Resources, Mines and Geology Branch, Map 451A.

Fedikow, M.A.F., Nielsen, E., and Conley, G.G. 1997a: Operation Superior: 1996 Multimedia geochemical data from the Max Lake area (NTS 63I/8, 9 and 53L/5, 12); Manitoba Energy and Mines, Geological Services, Open File Report OF97-1, 34 p. and 1 diskette.

Fedikow, M.A.F., Nielsen, E., Conley, G.G., and Matile, G.L.D. 1997b: Operation Superior: Multimedia geochemical survey results from the Echimamish River, Carrot River and Munro Lake greenstone belts, northern Superior Province, Manitoba (NTS 53L and 63I); Manitoba Energy and Mines, Geological Services, Open File Report OF97-2, 1500 p. and 2 diskettes.

Fedikow, M.A.F., Nielsen, E., Conley, G.G., and Matile, G.L.D. 1998: Operation Superior: Multimedia geochemical survey results from the Edmund Lake and Sharpe Lake greenstone belts, northern Superior Province, Manitoba (NTS 53K); Manitoba Energy and Mines, Geological Services, Open File Report OF98-5, 403 p. and 1 CD-ROM.

Fedikow, M.A.F., Nielsen, E., Conley, G.G., and Lenton, P.G. 1999: Operation Superior: Multimedia geochemical survey results from the Webber Lake, Knife Lake, Goose Lake and Echimamish River greenstone belts, northern Superior Province, Manitoba (NTS 53L and 53K); Manitoba Energy and Mines, Geological Services, Open File Report OF99-8, 400 p. and 1 CD-ROM.

Matile, G.L.D. and Thorleifson, L.H. 1997: Till geochemical and indicator mineral reconnaissance of northeastern Manitoba; Manitoba Energy and Mines, Geological Services, Open File Report OF97-3, 174 p.

Stone, D., Pufahl, P., and Carter, J. 1995: Precambrian geology, Stull Lake area; Ontario Geological Survey, Map P.3353, 1:50 000.

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NEWS OF MEMBERS

Ian D. Pirie formerly General Manager for Inmet in South and Central America based in Santiago, Chile, recently moved to Toronto to assume the role of Director, Corporate Development for Inmet. Ian now resides at 2258 Yates Court, Oakville, Ontario, L6L 5K6. His phone numbers are (416) 860 3955 (work) and (905) 465 2220 (home); or mail: piriei@inmet-toronto.com.

Recent Papers

Continued from Page 12

Radford, N.W. and Burton, P.E., 1999. The geochemistry of transported overburden: the time factor. An example from the Fender deposit, Big Bell, Western Australia. J. Geochem. Explor. 66(1/2): 71-83.

Rapant, S., Raposova, M., Bodis, D., Marsina, K., and Slaninka, I., 1999. Environmental geochemical mapping program in the Slovak Republic. J. Geochem.Explor. 66(1/2): 151-185.

Reiman, C., et al., 1999. Lakewater geochemistry on the western Kola Peninsula, north-west Russia. Applied Geochem. 14(6): 787-805.

Robertson, I.D.M., 1999. Origins and applications of size fractions of soils overlying the Beadley Creek gold deposit, Western Australia. J. Geochem.Explor. 66(1/2): 99-113.

Safronov, N.I., 1985. On the "dispersion halos" of the mineral deposits and their usage in geological exploration. in Shilo, N.A. (ed.) Geochemical and Geophysical Exploration in the Far North East of the USSR. N.I. Safronov Memorial Issue. Magadan: 14-15. (Originally published in Problems of Soviet Geology, 1936 6 (4): 302-322).

Snoek, W., Plimer, I.P., and Reeves, S. 1999. Application of Pb isotope geochemistry to the study of the corrosion products of archaeological artifacts to constrain provenance. J. Geochem. Explor. 66(1/2): 421- 425.

Tardy, Y. and Roquin, C., 1998. Derive des continents Paleoclimats et alterations tropicales. BRGM. 473 p.

Tingley, J.V. and Castor, S.B., 1999. Stream sediment exploration for gold and silver in Nevada - application of an old prospecting method using modern analytical techniques. J. Geochem. Explor, 66(1/2):1-16.

Twardowska, I., Kyziol, J., Goldrath, T., and Avnimelech, Y., 1999. Adsorption of zinc onto peat from peat lands of Poland and Israel. J. Geochem.Explor. 66(1/2): 387-405.

Vice, D.H. and Halleck, P.M., 1999. The effects of soil environment on the ability of surface geochemical surveys to detect underlying hydrocarbon traps. J. Geochem. Explor. 66(3): 457-468.

Viladevall, M., Font, X., and Carmona, J.M., 1999. Multidata set analysis for gold-deposit exploration criteria: application in the Catalonian coastal Ranges (NE Spain). J. Geochem. Explor. 66(1/2): 183-197.

Viladevall, M., Font, X., and Navarro, A., 1999. Geochemical mercury survey in the Azogue Valley (Betic area, SE Spain). J. Geochem. Explor. 66(1/2): 27-35.

Vogel, J.C., Talma, A.S., Heaton, T.H.E., and Kronfeld, J., 1999. Evaluating the rate of migration of an uranium deposition front within the Uitenhag Aquifer. J. Geochem. Explor. 66(1/2): 269-276.

Wang, X., Xie, X., Cheng, Z., and Liu, D., 1999. Delineation of regional geochemical anomalies penetrating through thick cover in concealed terrains - a case history from the Olympic Dam deposit, Australia. J. Geochem. Explor. 66(1/2): 85-97.

Xianrong, L, Junbo, L., Hong, W. and Peihua, Z., 1999. A survey of ionic conductivity of soil and its significance in prospecting for ore deposits concealed under thick overburden. J. Geochem. Explor. 66(1/2): 307-311.

Xie, X., Wang, X., Xu, L., Kremenetsky, A.A., and Cheneau, M.,. 1999. Orientation study of strategic deep penetration geochemical methods in the central Kyzylkum desert terrain, Uzbekistan. J. Geochem Explor. 66(1/2): 135-143.

Yanako, N.E., Ashery, D., and Kronfeld, J., 1999. Gamma-ray analysis of the sediments overlying the Helez and Kochav oil fields, Israel. J. Geochem.Explor. 66(1/2): 249-254.

Yang, S.X. and Blum, N., 1999. Arsenic as an indicator element for gold exploration in the region of Xiangxi Au-Sb-W deposit, NW Hunan, PR China. J. Geochem. Explor. 66(3): 441-456.

CALENDAR OF EVENTS

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

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

■ November 2-4, 1999, 2nd Asia Pacific Symposium on Environmental Geochemistry, Seoul, Korea. INFORMATION: Prof. Hyo-Taek Chon, School of Civil, Urban and Geosystem Egineering, College of Engineering, Seoul National University, Seoul 151-742, Korea. TEL: +82-(0)2-880-7225/7236. Fax: +82-(0)2-871-7892/8938. Email: chon@plaza,snu.ac.kr.

■ November 3-5, 1999, International Symposium on Geochemical and Mineralogical Tracers in Mining Exploration ORSTOM, Santiago, Chilè. INFORMATION: Department of Geology, University of Chilè. ORSTOM, Casilla 53390, Correo Central Santiago 1, Chile. Tel +562.2363464, Fax +562.2363463. E-mail: orstom@netline.cl.

■ December 5-9, 1999, American Water Resources Association 1999 Annual Conference, Seattle, Washington. INFORMATION: American Water Resources Information, Attn: 1999 AWRA Annual Water Resources Conference (Seattle), 950 Herndon Parkway, Suite 300, Herndon, VA 20170-5531, phone (703) 904-1225, fax 703-904-1228, awrahq@aol.com, www.awra.org.

■ December 13-17, 1999. AGU Fall Meeting, San Francisco, CA. INFORMATION: AGU Meeting Department, 2000

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Exploration Geochemistry for the New Millennium

A joint *Association of Exploration Geochemists, Australian Institute of Geoscientists* and the *GSA Specialist Group for Applied Geochemistry* one day conference.

Novotel Langley Hotel, Perth, Western Australia

5th November 1999

PRELIMINARY PROGRAM

Introduction & Overview ***Leigh Bettenay, Homestake***
ICP-MS: where is it going next? ***John Watling, UWA***
4D Regolith Studies - the way of the future? (aspects of regolith and geochemistry of the Yandal Greenstone Belt, Yilgarn Craton, WA) ***Ravi Anand et al, CSIRO & GCM***
Don't Forget the Biological Part of the Regolith ***Bob Gilkes, UWA***
Target Generation in Areas of Transported Overburden Using Innovative Partial Digestion Techniques & Multi-element Analyses of Soil & Maglag Samples ***Craig Rugless, PathFinder***
Title of paper to be advised ***David Grey, CSIRO***
MMI in Sweden - case history ***John Karajas, Consultant***
Element Ratios in Ni Sulphide Exploration, ***Nigel Brand*** (in publication only)
Recognition of Wallrock Alteration in Sediment-hosted Mesothermal Gold Deposits: examples from Central Victoria ***Dennis Arne, WA School of Mines***
VMS Potential Determined via Sub-volcanic Intrusions in Precambrian Rocks : key geochemical signatures ***Susan Vearncombe, Vearncombe & Associates***
Neural Processing - Providing New Answers When You Need Them Most ***Mark Noppe and John Graindorge, Snowdens***
Interpretation and visualisation of soil and rock chip geochemistry, Sepon Project, Laos ***Paul Agnew, Rio Tinto Exploration***
Regolith Mapping: is it really necessary? ***Simon Bolster, Consultant***

For further information contact:
The Convenor; Graham Jeffress: phone, 08 9424 3500: email, gjeffress@auroragold.com.au
or
Jocelyn Thomson, AIG, phone, 08 9266 3996; facsimile, 08 9226 3997; email, aigwa@aig.asn.au

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Calendar of Events *Continued from Page 20*

Florida Ave., NW, Washington, DC 20009, TEL: 202-462-6900. FAX: 202-328-0566. E-mail: meetings@kosmos.agu.org.

■ March 6-9, 2000, Annual meeting of Society for Mining, Metallurgy, and Exploration (SME), Salt Lake City, Utah. INFORMATION: Shaffer Parkway, P. O. Box 625002, Littleton, Colo., 80162-5002, 303-973-9550. E-mail: smenet@aol.com.

■ March 13-15, 2000, Northeastern GSA Sectional Meeting, New Brunswick New Jersey. INFORMATION: Robert E. Sheridan, E-mail: rsheridn@worldnet.att.net.

■ March 23-24, 2000, Southeastern GSA Sectional Meeting, Charleston, South Carolina. INFORMATION: Michael P. Katuna, E-mail: kautnam@cofc.edu.

■ April 3-4, 2000, South-central GSA Sectional Meeting, Fayetteville, Arkansas. INFORMATION: Doy L. Zachry, Jr.. e-mail: dzachry@comp.uark.edu.

■ April 16-19, 2000, 8th International Symposium on Experimental Mineralogy, Petrology and Geochemistry (EMPG VIII), Bergmano, Italy. INFORMATION: EMGG VIII Organizing Committee, Dipartmento Scienze della Terra, Universita di Milano, Via Botticelli 23, 20133 Milano, Italy. WWW:http://imiucca.csi.unimi.it/~spoli/empg.html.

■ April 17-18, 2000, Rocky Mountain GSA Sectional Meeting, Missoula, Montana. INFORMATION: Donald W. Hyndman, e-mail: dhyndman@selway.umt.edu.

■ April 24-28, 2000, 5th International Symposium on Environmental Geochemistry, Cape Town, South Africa. INFORMATION: 5ISEG, Department of Geological Sciences, University of Cape Town, Private Bag, Rondebosch, 7701, South Africa, FAX 27-21-650-3783. Email: 5iseg@geoglogy.uct.ac.za.

■ April 27-29, 2000, Cordilleran GSA Sectional Meeting, Vancouver, British Columbia. INFORMATION: Peter S. Mustard, pmustard@sfu.ca.

■ May 12-14, 2000, Europe's major base metal deposits, Galway, Ireland. INFORMATION: Leo Fusciardi, Irish Association for Economic Geology, Minorco Services Ireland, Ltd., Killoran, Moyne, Thurles, Co., Tipperary, Ireland, +353.504.54369. FAX: +353.504.45344, e-mail: lfusciardi@minorco.ie.

■ May 15-18, 2000, Geology and ore deposits 2000: The Great Basin and beyond, Reno/Sparks, Nevada, USA. INFORMATION: Geological Society of Nevada. 702-323-3500, ax 702-323-3599, e-mail: gsnsymp@nbmg.unr.edu.

■ May 21-24, 2000, ICARD 2000, 5th International Conference on Acid Rock Drainage, Denver, Colo. INFORMATION: SME, PO Box 625002, Littleton, Colo. 80162-5002. E-mail: davis@smenet.org.

■ May 30-June 2, 2000, International Symposium on Environmental Issues and Waste Management in Energy and Mineral Production (SWEMP 2000), Calgary, Canada. INFORMATION: Raj Singhal, P.O. Box 68002, Crowfoot Postal Out-let, 28 Crowfoot Terrace N.W., Calgary, AB, T3G 1Y0, Canada, phone (403) 241-9460, fax 403- 241-9460.

■ May 31, June 3, 2000, AGU Spring Meeting, San Francisco, CA. INFORMATION: AGU Meeting Department, 2000 Florida Ave., NW, Washington, DC 20009, TEL: 202-462-6900. FAX: 202-328-0566. E-mail: meetings@kosmos.agu.org.

■ August 6-17, 2000, 31st International Geological Congress, Rio de Janeiro, Brazil. INFORMATION: Secretariat Bureau, Casa Brazil 2000, Av. Pasteur, 404 Urca, Rio de Janeiro-RJ-Brazil, CEP 22.290-240, phone 55 21 295 5847, fax: 55 21 295 8094. E-mail: 31igc@31igc,org, http: www.31igc.org.

■ August 30-September 1, Geoanalysis 2000: 4th International Conference on the Analysis of Geological and Environmental Materials, Abbaye des Prémontrés, Pont à Mousson, Lorraine, France. INFORMATION: Jean Carignan, CRPG-CNRS, 15 rue Notre Dame de Pauvres, B.P. 20, 54501 Vandeouvre-lès-Nancy cedex, France, phone 33-3-83-59-42-17, fax 33-3-83-51-17-98.

■ September 3-8, 2000, Goldschmidt 2000. Oxford, UK. INFORMATION: P. Beattie, Cambridge Publications, Publications House, PO Box 27, Cambridge, UK CB1 4GL. TEL: 44-1223-333438, FAX: 44-1223-333438, E-mail: gold2000@campublic.co.uk.

■ November 13-16, 2000, Annual Meeting of the Geological Society of America, Reno, Nev. INFORMATION: TEL 1-800-472-1988, meetings@geosociety.org.

■ December 14 - 19, 2000, Pacifichem 2000, Honolulu. INFORMATION: Congress Secretariat, c/o American Chemical Society, 1155 16th St. N.W., Washington, D.C. 20036, fax: 202-872-6128. E-mail:pacifichem@acs.org.

■ December 15-19, 2000. AGU Fall Meeting, San Francisco, CA. INFORMATION: AGU Meeting Department, 2000

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Calendar of Events *Continued from Page 22*

Florida Ave., NW, Washington, DC 20009, TEL: 202-462-6900. FAX: 202-328-0566. E-mail: meetings@kosmos.agu.org.

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NEW MEMBERS

To All Voting Members:
Pursuant to Artiele 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 David B. Smith, Secretary AEG, USGS, Box 25046, MS 973, Denver, CO 80225, USA.

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

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Kelley, David L.
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BHP Minerals
Golden, CO, USA

Melo Jr, Germano
Professor
Federal University
Natal RN, BRAZIL

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Abernathy, Alix
Exploration Geologist
Cyprus Amax Zambia
Lusaka, ZAMBIA

Armstrong, Ken
Project Geologist
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Caron, Serge
Quaternary Geologist/Geochemist
Geos Sciences Inc.
Rouyn-Noranda, PQ, CANADA

Costelloe, Declan
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Golden Star Resources
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Craig, Dunham L.
VP Exploration and Corporate Development
Wheaton River Minerals Ltd
West Vancouver, BC, CANADA

Katchan, George
President/Director
PT Minorco Services Indonesia
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Liu, Linghan
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Inst. of Geophys. and Geochem.
Langfang, Hebei, P.R. CHINA

Macdonald, James A.
Chief Geologist
Billiton International Metals BV
The Hague, THE NETHERLANDS

Nordin, Gary
Chief Consulting Geologist
Eldorado Gold Corp
Vancouver, BC, CANADA

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New Members *Continued from Page 23*

Nowicki, T.E.
Consultant Geochemist
Mineral Services
Pinelands, SOUTH AFRICA

Smyth, Clinton
Consulting Geologist
Minorco
Singapore, MALAYSIA

Wang, Hui
Geochemist
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Woodbury, Michael J.
Exploration Geologist
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Whitbread, Michael
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Laznicka, P. Breccias and Coarse Fragmentites	288.50	173.10
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Naqvi, S.M. Precambrian Continental Crust and its Economic Resources	196.50	117.90

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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.

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

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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)

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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 Upon receipt of 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)

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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.

NEW BRAZIL REGIONAL COUNCILOR

Germano Melo Jr. has been nominated and approved by the AEG Council as new Regional Councilor from Brazil.

Members from Brazil may submit other nominations via the AEG Business Office. If other nominations are presented, an election will be held. If there are no other nominations, in accordance with Section 4.09 of the Bylaws, the lone nominated member, duly qualified, shall be declared to be elected at the next Annual General Meeting.

Paul Taufen
First Vice President
Chair for Regional Councilors

Deadlines for the Next Four Issues of EXPLORE

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

Issue	Publication date	Contributor's Deadline
106	January 2000	November 30, 1999
107	April 2000	February 28, 2000
108	July 2000	May 31, 2000
109	October 2000	August 31, 2000

VOLUNTEERS NEEDED

EDITORIAL STAFF
FOR
EXPLORE MAGAZINE

Several lead Editors and Associate Editors Needed
(*the current staff needs to move on*)

Publication skills not as important as ideas and energy
(*normal computing skills are adequate; on-the-job training*)

Flexible times and locations around the world
(*a few hours a month, connect by Internet*)

Volunteers and suggestions are welcome!

Contact: Paul Taufen <Paul.Taufen@wmc.com.au>
or Tom Nash <tnash@usga.gov>

THE ASSOCIATION OF EXPLORATION GEOCHEMISTS

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January - December 1999

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