



# 3-D Vectoring and Data Integration



Special thanks to Robert Jackson for assembling focus topics for this issue, 3-D Vectoring and Data Integration

# EXPLORE

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## 3D Vectoring and Data Integration

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### Introduction

The full integration of geology, geochemistry, and geophysics in 3D space is creating opportunities to recognize data relationships that are not easily achieved by traditional 2D plans and sections. This is made possible by the use of sophisticated 3D visualization software that has been developed in recent years. Virtually any type of geochemical dispersion, whether primary or secondary, can be better understood by geochemical modeling - the creation of 3D block models of down-hole trace element data.

With respect to exploration, one of the major challenges today is the discovery of blind ore deposits, particularly in mature mining districts. The term 'blind', in this context, is a catch-all phrase that merely implies that an ore deposit does not outcrop and is not easily discovered by conventional prospecting methods. It is not meant to mean that it doesn't have some associated geochemical dispersion feature that can be used to vector toward the position of an ore body. An example of a blind deposit that has an associated upper

## Effective 3D Modelling Solutions Have a Lot to Offer

Heather Ferguson, Client Account Manager, Surpac Software International, 1122 Mainland St., Suite 330, Vancouver, BC, Canada

Exploration geoscientists can identify with the need to centralize data coming from various collection techniques into one 3D visualization environment. With one integrated display the geologist is able to begin to understand the relationships between observations taken at sparse intervals. If exploration companies and earth science departments had no economic constraints to work within, then data could be collected ad infinitum. In reality, the data collection process is expensive; therefore the data needs to be treated accordingly. This is where effective 3D modelling solutions have a lot to offer, especially those that easily accept data from various sources and offer a range of presentation tools.

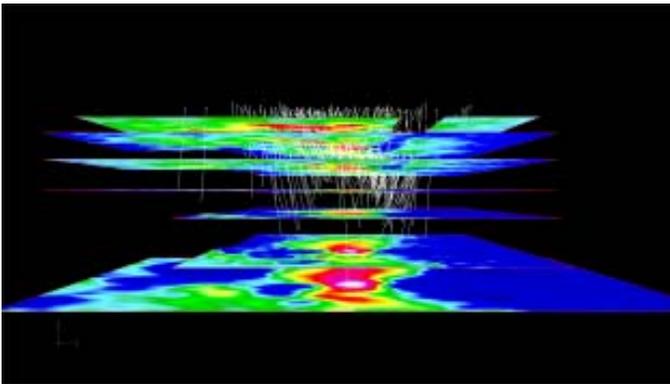


Figure 1: Drill-holes and induced polarisation (IP) chargeability plans at Oyu Tolgoi project in Mongolia. Image courtesy of Ivanhoe Mines Ltd.

Software packages such as Surpac Vision, developed by the Surpac Minex Group, provide applications for collecting, managing, modelling and displaying complex geological datasets. Initial analysis can be as simple as contouring raw sample data from a surface exploration campaign, right through to more sophisticated geostatistical interpolation of drillhole results into a three-dimensional block model (Figure 1). The software package provides links into existing Microsoft Access databases (and other ODBC compliant types) so that visualisation begins immediately upon data collection. The ability to share on-line, 3D visualization sessions with other stakeholders in a project is now a reality with Surpac's Exchange 3D option. The removal of

continued on page 2

Newsletter for the Association of Exploration Geochemists

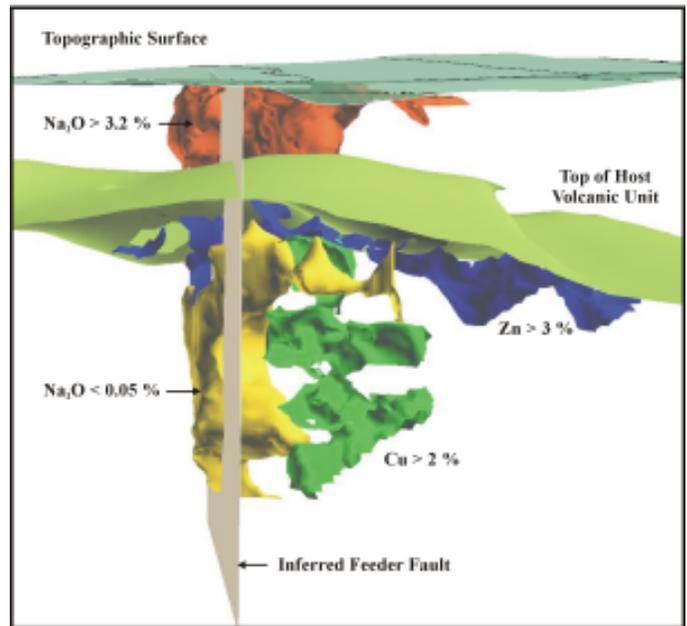


Figure 1: Vertical and lateral zonation in San Nicolas VMS deposit, Zacatecas, Mexico. Note the Na enrichment within post-mineral volcanic tuffs located vertically above a Na depletion zone along an inferred feeder fault that may have controlled the emplacement of the deposit. (Courtesy Teck-Cominco)

continued on page 14

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## Effective 3-D Modelling Solutions...

*continued from Page 1*

inconveniences such as the distance between people who need to communicate ideas, or worries about which data formats are compatible, makes Surpac a valuable addition to the analytical process.

The most basic technique for reconstructing physical surfaces such as topography, faults or geologic contacts can be termed digital terrain modeling (DTM). Triangulation is applied to known coordinate locations (x,y,z points) where the "Z" value can represent elevation or any numerical sample value. There are further options for normalizing data distribution by using grid modeling and interpolation tools which can be utilized to display geochemical concentration levels, induced polarization (IP), magnetic or other geospatial sampling methods (Figure 2). Draping a geochemical signature over a DTM really enhances interpretation. Standard display options include contouring, colour shading, maps, and sections. More modern presentations include 3D image capture, animations and fly-overs. The exploration target is meaningfully reconstructed based on all of the information available.

Compatibility is always a concern, which is why Surpac software accepts data in so many formats; no conversion steps are required. Data centralization can originate from a wide range of sources such as drillhole databases, GIS, CAD, survey instruments and other 3D modelling packages. Drill core samples are displayed in 3D or section view with colour, patterns and text to represent lithology, alteration, assay results, multi-element readings and composite values.

*Continued on Page 3*

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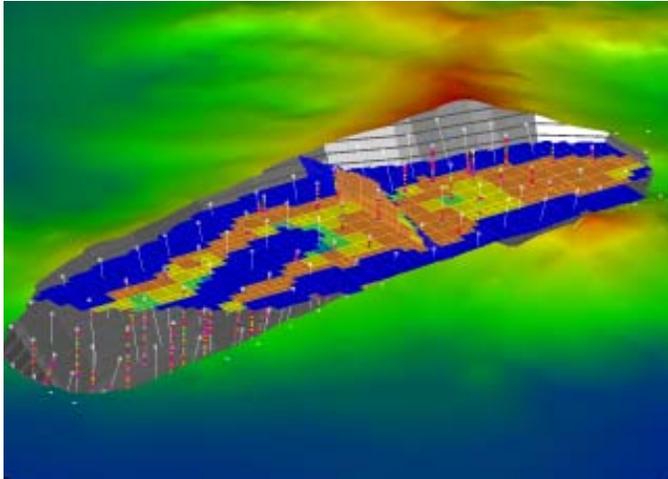
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**Effective 3-D Modelling Solutions...**  
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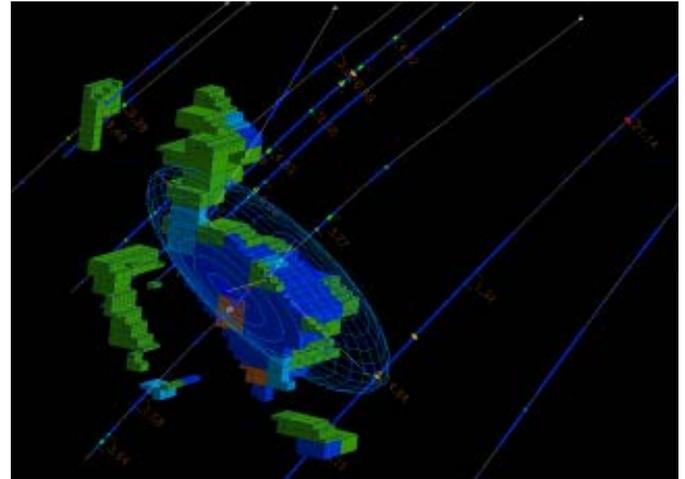


**Figure 2:** The Surpac Vision integrated work space displaying topography, drillhole results, interpreted solid model defining the ore zone, and ore grades by bench as interpolated from the block model and pit design.

Digitising in 3D space, snapping onto drill hole traces whilst panning back within an enclosed area or a mining bench, to give just a few examples. Multiple sections through a collection of data at any orientation can be very revealing.

Block Modeling is essentially a 3D interpolation method for accurately dispersing collected analytical data over a regular, user-defined grid in space. Gridding methods and parameters are user controlled with choices such as kriging or inverse distance. Experimenting with the search ellipse in x,y,z space allows user control over the direction and distance from which collected values will be included in each grid node estimation (Figure 3). Block model cells are filled with attributes which quantify multiple grades, lithologies, or calculated values such as ore/waste equations. With a

block model in hand, accurate volume and grade estimations are easily obtained by running scenarios, such as volume between surfaces, within an enclosed area or on a mining bench, for just a few examples.



**Figure 3:** Experimenting with the search ellipse allows user control over grid node estimations during the Block Modeling process.

A common misconception in the exploration industry is that visualization software is costly. Technology has now developed to a point where this is no longer the case. Surpac supplies "starter" to "deluxe" packages including free trials of the 3D visualization workspace. The convenient Exchange3D package is available for any desktop computer where 3D viewing of spatial data from a number of sources is required. Xplorpac is the exploration geoscientist's tool for complete database management and modelling which includes solid wire-frame modelling for accurate volume calculations. Surpac Vision is the premier package with a complete suite of modular equipment for geological modeling, feasibility studies, open pit and underground mine design as well as mine production planning. Surpac solutions have proven effective at over 800 sites in 85 countries, including 77 universities. Please find more information at [www.surpac.com](http://www.surpac.com).



**TABLE OF CONTENTS**

Focus on: 3-D Vectoring and Data Integration .....	1
Effective 3D Modelling Solutions Have a Lot to Offer .....	1
The Application of Gocad to Geochemical	
Interpretation in Mineral Exploration .....	17
Exploration Three Dimensions .....	18
Interactive 3D Visualization using TECHBASE .....	20
FracSIS Product Suite .....	21
3D Vectoring and Data Integration .....	1
Message from the President .....	4
Important Notice to All AEG Members and	
Comments from Members .....	5
Reader's Forum .....	8
In Memory...Richard F. Horsnail .....	10
AEG Business News .....	11
New Members .....	12
2003 AGM Meeting Notice .....	12
Geochemical Laboratory Updates	
ALS Chemex .....	13
SGS .....	24
AEG Distinguished Lecturer .....	23
Calendar of Events .....	24

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## AEG Presidential Address

Most of you will be aware by now of the plan to change the name of our Association, and the discussion as to what its new name should be. The two principal candidates are “Association of Exploration and Environmental Geochemists” and “Association of Applied Geochemists” although one other name has been suggested – and there is also the possibility that the name will not change. I should be displaying absolute impartiality but I have to say that this last possibility is a remote one at this stage; and that any new change must reflect not only the changes that geochemistry has undergone since 1970, but also the changes that may come in the future. If you wish to see some of the opinions that have been put forward, you can view them in this issue of EXPLORE, and there is still time to add your own to the AEG website.

Although this is not the view of someone who attended it, the 2003 Prospectors and Developers Association Convention in Toronto seems to have passed by in accordance with a familiar pattern, with a great deal of euphoria about how the mining and exploration industries seem to have “finally turned the corner”, and what the implications of this will be for explorationists, followed by the realization that this welcome change, even if it exists, is not being translated into a significant increase in the amount of work in their field. Recent trends in the number of paid-up members of AEG have been inexorably southward, and

it is inevitable that membership will continue to dwindle if we continue to maintain the image of an organization for exploration geochemists and geologists only. And whatever AEG’s members may say during interactions with their professional colleagues, and whatever papers we publish in GEEA or Explore, the deemed mandate of our association, and its attractiveness to the people we hope will join us, will be judged by its name. This is no doubt a principal reason why the recent vote on the proposal to amend the Preamble to the By-Laws to broaden the scope of AEG was so strongly supported.

Are we not an organization of chemists and geologists, whose field of specialization comprises the fusion of these two disciplines to study the distribution of chemical elements and compounds in the natural environment, and the application of the results to solve practical problems? If so, what title would be more appropriate in reflecting the diversity of activities and occupations of all members of our association? It should reflect the interests of the individuals who might be interested in joining the association, and enriching the body of knowledge that AEG has created, without selling out the ideals of the geochemists who founded our association more than 30 years ago, or infringing (or appearing to infringe) the mandate of any other organization.

Amongst the implications of the name change, which will need to be considered, are: a changing of the logo (our current one has serious mining implications and must be changed), and the changing of the banner on the home page of the website: excellent in every respect (does anyone remember who designed it?) except that it includes the old logo and the old name and strongly reflects our old, mining-oriented mandate. Ideally, the name of our Internet domain ([www.aeg.org](http://www.aeg.org)) should also be changed. Having been involved in the recent palaver of transferring the domain to a new host, I would like to put this on the back burner, but we have to do it eventually, unless we can convince browsers that AEG stands for “Accessible to Every Geochemist”. And, we will have to devise a new name for our biennial symposium, which need not necessarily reflect exactly the organization’s new name, but nevertheless, is unlikely with its current name to attract papers from individuals who are not exploration geochemists and are not familiar with our ongoing efforts to broaden our mandate. I anticipate that the upcoming Symposium in Dublin will be the last one that is entitled the International Geochemical Exploration Symposium. And whatever the Perth event in 2005 is titled, will it be the first, or the twenty-second?

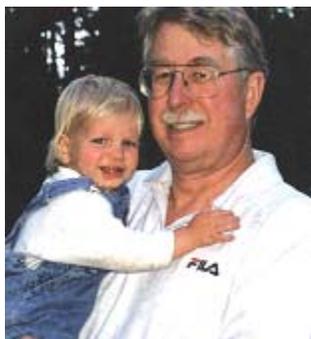
And it is at the AGM of our Association, to be held on the afternoon of Monday September 1<sup>st</sup> as part of the Dublin event, that the name change will be one of the agenda items. We will attempt to agree, via a majority vote, on a new name to be formally submitted to Association Fellows. And our Association will have a new name by the end of the year.

This is the last President’s Piece before the Dublin Symposium, where I hope to meet as many of you as possible. Register now while Euros are still affordable, and please remember to attend the AGM.



### Announcement

## John Steven Cone Memorial Scholarship Fund



A scholarship fund has been established at the Colorado School of Mines in memory of Steve Cone (1941 – 2002) – chemist, trusted advisor, gifted educator and close friend to many in the mining industry. The purpose of the scholarship is to support graduate research in exploration geochemistry and economic geology for students focused on a career in the mining industry.

Donations or inquiries should be directed to:

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## Important Notice to all AEG Members:

The Association of Exploration Geochemists is constituted for the following purposes; to form a united and representative group of persons specializing in the geochemistry of mineral resources; to advance the science of geochemistry especially as it relates to the geochemistry of mineral resources — their exploration, exploitation, and environmental impact; to foster the common scientific interests of geochemists working in these areas; to facilitate the acquisition of professional knowledge and information relevant to the geochemistry of mineral resources, and to promote the interchange thereof amongst its members; to encourage research into dispersion of geochemical species, both natural and anthropogenic, and to use this knowledge for the development of methods for the improved detection and understanding of these dispersion patterns; to advance the status of the profession and to promote and maintain high standards of training and ethics amongst its members.

**It is proposed that the name of the Association be changed from the “Association of Exploration Geochemists” either to the “Association of Exploration and Environmental Geochemists” or to “The Association of Applied Geochemists”.**

*The following are opinions expressed in letters to the editor or on the AEG web site.*

"We strongly endorse the views of Garnett et al. that the AEG should be re-named the *Association of Applied Geochemists (AAG)* for the reasons cited in their letter to *Explore No 118*. We understand that some members are concerned that the proposed new name – *Association of Applied Geochemists* - may be seen to conflict with the *International Association of Geochemistry and Cosmochemistry* which sponsors a journal called *Applied Geochemistry*. We do not see this to be a problem as the stated aims and objectives of the IAGC preclude any claim to the broad field of applied geochemistry. Moreover, as our Association is clearly and visibly identified with our own journal of a distinctly different name, we do not believe that there can be any confusion with the journal *Applied Geochemistry*. We also agree with the arguments of Garnett et al. that the alternative name that has been proposed – *Association of Exploration and Environmental Geochemists* – is entirely inappropriate as a new name for AEG.

**David Cohen, Ken McQueen** (Australia)  
**Mark Fedikow, Chris Gleeson, Terry Mersereau, Art Smith** (Canada)  
**Reijo Salminen** (Finland)  
**Ian Devereux** (New Zealand)  
**Bjorn Bolviken** (Norway)  
**Iftikar Malik** (Pakistan)  
**Pavel Koval** (Russia)  
**David Smith** (USA)

## Change of name for the Association of Exploration Geochemists

The decision to change the name of the Association will have ramifications for many years to come and it is important that we get it right. Of the two names put forward we believe that ‘*Association of Applied Geochemists*’ is by far the best choice. It is non-specific, it is succinct, and it is eminently marketable.

The alternative (Association of Exploration and Environmental Geochemists) fails on all three of these measures. We acknowledge the concern of those who feel that adoption of ‘*Association of Applied Geochemists*’ may cause some confusion, implying links with the Elsevier journal *Applied Geochemistry* which do not exist, but we believe that these concerns are misplaced. *Applied Geochemistry* is supported by the International Association of Geochemistry and Cosmochemistry (IAGC), which has as one of its aims the sponsorship of ‘publications in geochemistry and cosmochemistry of a type not normally covered by existing organizations’.

Clearly this excludes large areas of applied geochemistry. In fact exploration geochemistry is a good example of such a field of interest. We note also that adoption of ‘Association of Exploration and Environmental Geochemists’ could cause problems in that it might be taken as implying some overlap with the interests of the Society of Environmental Geochemistry and Health.

This is a critical time in the life of the Association and we urge all Fellows to give serious thought to the implications

*continued on Page 6*

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## Association Name Change...

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of the change of name. We trust that the majority will come to the conclusion that 'Association of Applied Geochemists' is the preferred choice.

**Colin Dunn, Eric Grunsky, David Lentz** (*Canada*)

**Bryan Smith, Jim Morrison, Richard Carver** (*Australia*)

**Robert Jackson** (*USA*)

**Benedetto De Vivo** (*Italy*)

**Phil Westerhof** (*Holland*)

Dear Editor;

Ever since I have gone through the discussion on the proposed change of name (**EXPLORE** No.118) it has struck me a local proverb which can best be translated as "what is in a name?" Language has become a tricky matter in the hands of professionals. The meaning(s) conveyed by ordinary dictionaries generating a "common understanding" is often quite different. Association of Exploration Geochemists, Association of Exploration and Environmental Geochemists and another proposed as Association of Applied Geochemists cover several shadows of meaning that could be dragged by everyone in its own favour. Name of the Association is not exclusively meant for its members only. It represents what we stand for. We are 'applying' geochemistry in mineral exploration and environmental studies strongly conveying its aspect of 'application'. If we want to attract people from "common understanding" level then the name *Association of Applied Geochemists* will serve the best.

Regards,

**Iftikhar A. Malik** (*Pakistan*)

As a long time member of the Association, I would like to express my personal view on a name change for the Association. I strongly endorse the view of Garnett et al. noted in **EXPLORE** No. 118, that the name of the Association should be changed to **ASSOCIATION OF APPLIED GEOCHEMISTS(AAG)**. Going back to the history of the Association, "it was founded in 1970 to provide an international forum for persons working in the field of applied geochemistry".

The present name, Association of Exploration Geochemists, seemingly appropriate and reflecting well the activities of the Association's members during the 1970s to the 1980s, is too limiting because of the word Exploration. While it can be argued that this term can be used in a broader sense, the general audience perception most probably will limit it to mineral exploration. This is obviously no longer accurate.

I am not in favour of the name **ASSOCIATION OF EXPLORATION AND ENVIRONMENTAL GEOCHEMISTS (AEEG)**, because it narrows to the application of geochemistry seemingly only to exploration and environment. Is this accurate?

To facilitate better participation of the members, I suggest the Association, probably in the next issue of

**EXPLORE**, prepare a ballot (through e-mail etc.) containing four options (boxes): keep the old name (AEG), AEEG, AAG or others.

**Mohamad Tauchid**

Much has already been written on the proposed name change, and I would like to add my comments. If a change is to be made (and there seems ample justification for this), I feel it is important that we choose a name that will encompass as large an audience as possible and one that will stand the test of time. Accordingly I strongly endorse the suggested name of ASSOCIATION OF APPLIED GEOCHEMISTS. This will/should provide an opportunity for anyone involved in applied geochemistry to be a potential member. To single out any one specialty whether it be exploration, analytical, environmental, biogeochemical, hydrochemical, petroleum, coal or whatever is in my view shortsighted and restrictive. The ASSOCIATION needs all the members it can get and therefore the broader the name the better. The name Association of Applied Geochemists is simple, descriptive and all encompassing. Ever onward and good luck.

Respectively submitted;

**John Hansuld**, *Founding member and Past President.*

As a researcher studying the petrogenesis of mineral deposits through to their metallurgical aspects, I feel that the term "*Applied*" is more appropriate in reflecting the diversity of activities/occupations of all members of our association. "Exploration and Environmental" or "Environmental and Exploration" only reflects just two parts of the vast spectrum of research reflected in our journal and the uses they may have in the future; it just seems restrictive, especially as disciplines evolve in the future. With respect to the similarity of AAG with the title of another journal, I only see this as positive, especially considering the popularity of that journal.

**David Lentz**

*Fredericton, NB Canada*

The recent vote on the proposal to amend the Preamble to the By-Laws to broaden the scope of AEG was strongly supported. The vote on the proposed alternative names for the Association was, however, not decisive. During the first two months of 2003 I wrote individually to AEG Fellows for whom I could find an e-mail or postal address (185 in total) to encourage them to become involved in the continuing debate about the name of the Association. This is an issue that is important to all members of AEG and will, I understand, be debated at the AGM in Dublin later this year. The following paragraphs are a slightly modified version of the letter I sent to AEG Fellows which, I hope, will stimulate wider discussion.

The support for a more inclusive Association should be reflected in the name of the Association. For this reason I proposed in a letter to **EXPLORE** No 112 (July, 2001) that

----- continued on Page 7

## Association Name Change...

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the new name should be the *Association of Applied Geochemists*. This is discipline-neutral and, as it is all-inclusive, will not require additional revision in the future. It is also simple and eminently marketable and this is vital as we must work to reverse the decline in membership. The alternative name that has been proposed - Association of Exploration and Environmental Geochemists - I opposed in another letter to **EXPLORE** No 117 (October, 2002) on the grounds that it is too specific and it is exclusive. It is also too long and cumbersome to be readily marketable. There is, of course, the third alternative of simply retaining our original name of the Association of Exploration Geochemists. As a founding member of the AEG I have sympathy with those who support retention of the old name. I also recognise that the world of applied geochemistry has changed since 1970, and that we must acknowledge this in our Association. It is because I also expect the world of applied geochemistry to continue to change in the future that I am so strongly advocating a name - Association of Applied Geochemists - that will readily accommodate these changes.

The January issue of **EXPLORE** No 118 had another letter supporting the name of Association of Applied Geochemists signed by a number of Fellows. The letter also urged all members to become involved in the debate through the Members' section of the web site, or the pages of Explore. I obviously strongly support this plea because when the issue is next raised it must be resolved decisively.

**GJS Govett**  
Australia

I tend to favour the more succinct *Association of Applied Geochemists*, irrespective of potential confusion with the Elsevier publication. This name suggests an even more general scope for our organisation than suggested by "AEEG". The name "AAG" may also prevent potential new members being put off by the inclusion of the "opposition camp" in the name "AEEG" (i.e. environmentalists being necessarily linked to exploration, or the reverse).

**David Cohen**  
Sydney, NSW Australia

The changing of the name of our Association as the scope of our geochemical activities evolved was inevitable and a logical progression. I believe it is necessary. The "geochemistry of mineral resources" represents a wide spectrum of scientific endeavors and as such this diversity must be reflected in the name of our organization and its journal. Neither of these should intentionally target a specific group or area of interest. The Association and its journal should offer as wide a venue as possible for geochemical/scientific expression and hopefully, in so doing, membership in "AEG" would appeal to a wider audience and perhaps attract new members, not to mention significant cross-fertilization of innovative approaches to geochemical issues.

The Association and its journal does not need to become more "academic" but rather strive for balance between academia and applied studies. I believe this balance and the broadest possible appeal to geoscientists and potential members would be reflected by the name "*Association of Applied Geochemists*".

**Mark Fedikow**  
Winnipeg, MB, Canada

I do not think the name change of AEG will increase our Members because of global trend of shrinking geosciences. Speaking of the proposed names, I would like to adhere to a simple name AAG, the *Association of Applied Geochemistry*.

**Wang Mingqi**  
Beijing, P.R. China

Any name could be good for the association; however, we need a name and it could be *AEEG*. A generic name as proposed by Dr. Querol could be also welcome. Please do not forget the essence of the Association, and that any other branch added to our original group will cause it to become stronger. For some of the explorationists, environmentalists is synonymous of trouble; however, we have to adapt our explorations and operations to the global world, and keep this world running and as clean as possible.

**Erme Enriquez**  
Durango, DGO Mexico

I favour "*The Association of Exploration and Environmental Geochemists*" or *AEEG* title that clearly reflects all of the activities and interests of the association. The continued convergence of the geochemical disciplines is inevitable and, with ongoing contributions to the journal, will invariably lead to the cross pollination of new ideas as well as innovative geochemistry.

**Craig Rugless**  
Perth, WA Australia

I think the change in name and broadening to include environmental aspects of mineral deposits is very desirable. We are already covering this scope in the journal, *GEEA*. Looking back at the 1990 report, it is clear that the academic side of AEG has weakened, and we need to consider how to strengthen the profession by strengthening the academic image. One reason for fewer schools teaching exploration geochemistry is a lack of research funding. Does the AEG have the resources to fund university research, as is being done by the Society of Economic Geologists? Without sources of research funding, I doubt that many major universities will hire faculty in this area.

**Arthur W. Rose**  
University Park, PA USA

continued on Page 8

## Association Name Change...

continued from Page 7

I think it is important to communicate the purpose and diversity of the association in the title. I find proposed title *AEEG* long but accurate!

**Julie Graham**

*Perth, W.A. Australia*

We must be consistent with the new scope of our association. I agree with both proposals. With respect to the name, I adhere to *AEEG*.

**Jorge E. López-Rendon**

*Medellín, COLOMBIA*

I suggest a more generic name: *International Association of Geochemists* which it does not speak on the application of the Geochemist, since it can be dedicated to any field, and gives the international character that it has.

**Francisco Querol-Suñe**

*Hermosillo, Sonora Mexico*



## Readers' Forum



**Reply To Article "Theory behind the use of soil pH measurements as an inexpensive guide to buried mineralization, with examples" by Barry Smee in EXPLORE 118, Jan 2003.**

**Alan W. Mann**, *Perth, Western Australia, March 2003.*

*Email: alan@mmigeochem.com*

Some aspects of Barry Smee's recent article (Smee, 2003) on soil pH measurements deserve some comment and reflection; the contents of the first paragraph in particular bear little relationship to the title. One can only wonder why denigration of alternative ideas such as Selective Weak Extractions (SWE) is so important to the promotion of his own. In this paragraph he asserts amongst other things, that "proponents often appear to be associated with companies which offer analytical services whilst studies that reveal the difficulties are from arm's length institutions". On at least three counts this statement can be shown to be at best superficial, and at worst both erroneous and mischievous. He is correct in asserting that debate will be on-going, and has in one sense provided ammunition to ensure that this is a self-fulfilling prophecy.

Firstly, cautionary notes about difficulties have been provided by at least some of "the proponents" of SWE. Mann et al (1995) warned "partial extractions needed to be implemented with due diligence and care" and amplified the comment. The function of orientation surveys to obviate problems (particularly sampling depth) was highlighted in one of the articles quoted by Smee (Mann et al, 1998). In three industry-sponsored (MERIWA) projects in Australia, a large number of case histories were compiled in which Mobile Metal Ion (MMI) digestions were compared to total digestions of soil over various mineralization styles to provide objective comparable data for discussion and comment. Problems with weak acid leaches on carbonate soils were highlighted (Birrell & Mann, 1999) in the Vancouver IGES short course.

Secondly, a number of workers in "arms length institutions" have in fact championed the cause of SWE, and Smee appears to be suffering from the well-known phenomenon - Selective Memory Extraction (SME) in not mentioning some of these. The absence in the bibliography of some of the important articles by Gwendy Hall (e.g. Hall, 1998), as well as producing the bias intended, must be seen as an insult to her, the organization she represents and anyone in the industry interested in SWE. Mark Fedikow, whilst working at the Geological Survey of Manitoba (Fedikow and Ziehlke, 1998; Fedikow, 1999, 2003) realized the importance of sampling for MMI correctly in that province to overcome the problems encountered by Bajc et al (1998) in the neighboring province. CAMIRO has completed two industry-sponsored research studies which have seen the psyche change from (justifiable) skepticism to guarded optimism due to the results obtained. A third

Coming soon in the  
**AEG EXPLORE** newsletter:

Technical articles and letters to the editor are encouraged as submissions for discussion within the newsletter. Each issue of **EXPLORE** contains a series of short discussion papers which provide either an update on a particular geochemical topic, or present current debates about issues of interest. Suggestions for future "Focus" topics may be forwarded to the editor,

Mary Doherty  
(Email: [MaryEDoherty@earthlink.net](mailto:MaryEDoherty@earthlink.net)).

**Issue: Focus topic and Contact:**

121 Environmental Geochemistry Update  
Rob Bowell  
[rbowell@srk.co.uk](mailto:rbowell@srk.co.uk)/[srk003@aol.com](mailto:srk003@aol.com)

**Contributor Deadline** August 31, 2003

**Publication Date:** October 2003

122 Soil Gas Chemistry  
Patrick Highsmith  
[phighsmith@alschemex.com](mailto:phighsmith@alschemex.com)

**Contributor Deadline** November 30, 2003

**Publication Date:** January 2004

123 Update from Universities  
Mary Doherty  
[marydoherty@earthlink.net](mailto:marydoherty@earthlink.net)

**Contributor Deadline** February 29, 2004

**Publication Date:** April 2003

continued on Page 9

## Readers' Forum...

continued from page 8



project to more fully understand mechanisms is under way. In the article by Gray et al (1999) quoted by Barry, the final two lines mention the similarity of results for conventional and partial digestions in the Yilgarn of Western Australia, whilst recognizing the inherent superior anomaly contrast of the latter technique at the sites investigated. No advantage was seen for using SWE at these sites (despite, or perhaps because of samples being taken at "conventional" depths and in one case being drill spoil), but this is a very different conclusion from that drawn from the article by Smee.

Thirdly, SWE have been around a lot longer than either the present day "proponents" or "arm's length institutions". To use the origins of association or incorporation of current practitioners as the reason to malign a long-standing technique (whilst flattering) is ill-advised and extremely dangerous.

The AEG comprises many groups, "arms length institutions", companies (mining and analytical) and consultants to name a few. All have in one way or another some "vested interests" whether they be financial or intellectual. The presumed aim of the AEG to associate (and not dissociate) members requires respect and understanding of others interests, vested interests and the right to make a living. To assert as the article does that objective science is the province of, and is practiced by, only one group is wrong, illogical and capable of great divisiveness. There are some who have recently transferred their employment category. Do they instantly forfeit or gain the intellectual capacity or objectivity? Scientific merit must be judged on just that, merit, not from whence it came. Science has very often progressed along a learning curve from empirical observation, through experimentation to postulation and then theory.

There is an element of "it does not fit my theory therefore it does not exist" in the article, not just in relation to SWE, but also with respect to the (only partly) related phenomenon of vertical migration of ions. Where we are on this learning curve in relation to vertical migration of ions, and SWE is very much a subject for healthy debate. This reply is to assure Barry, and others of like mind that there are a number of scientists, whether they be (presently) categorized as "at arm's length" or not, who are endeavoring to progress this learning curve in the best long-term interests of geochemistry.

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## IN MEMORY

### ***RICHARD F. HORSNAIL***

**Kenneth Lovstrom, Tucson, Arizona**  
*kalovstrom@worldnet.att.net*

The geochemical and minerals exploration community lost an outstanding scientist, dedicated manager and dear friend. Richard F. Horsnail passed away on April 9<sup>th</sup>, 2003 as a result of small cell lung cancer. He was two weeks shy of his 62<sup>nd</sup> birthday. Dick was diagnosed with cancer in January of 2001 with metastasis to the brain and other internal organs. He had a relatively enjoyable two years with the assistance of chemotherapy and radiation, but, as doctors predicted the cancer prevailed this year. During these past two years Dick faced his cancer with strength, courage and humor. He continued to enjoy traveling, writing short stories, memoirs and tending to his antiquity collection. His beloved wife, Gillian, preceded him in death. Dick is survived by his mother Nesta, daughter Joanna and son Alan.

Born in Essex, England on April 25, 1941, Dick received his PhD in 1968 from Imperial College, London studying under Professor John Webb. His thesis involved the study of stream sediments, in North Wales and southwestern England, and the scavenging effect of manganese producing anomalies unrelated to mineralization. In addition to his academic endeavors Dick was an avid soccer and cricket fan, enjoying his love of sport throughout his life.

Dick spent most of his professional career with AMAX Exploration starting in 1968 as Regional Geochemist in British Columbia. His application of geochemistry to minerals exploration quickly expanded to other areas of North America, and eventually worldwide, serving as AMAX Chief Geochemist for a number of years in Denver. Dick's favorite aspect of exploration was field work whether it was sampling mesquites in Arizona, radon sniffing in Wyoming or till sampling in Ontario. Dick's interest and expertise in managing exploration programs led to his position of Manager of International Exploration until his departure from AMAX in 1994. He was an historian, a prolific writer and reader and collector of artifacts. His AMAX reports not only evaluated geology and mineral potential but made for interesting and entertaining reading. He was instrumental in guiding programs for tin-tungsten in southwest England and copper, molybdenum, gold projects in the former Soviet Union to mention a few.



Anyone who knew Dick will always remember his storytelling, sometimes accompanied by a few nips of Glenmorangie or Laphroaig, of travels to some 103 countries. Most of his adventures were rather hair-raising.

Director of International Exploration for Echo Bay Mines from 1995-1996, Dick conducted programs in Mongolia, West Africa and the Philippines. He then joined North Atlantic Natural Resources in Sweden as Senior Exploration Consultant where he was involved with the discovery and development of the Storliden copper-zinc deposit. He continued his association with NANR until his death.

Dick joined the Association of Exploration Geochemists in 1970 and contributed to its early growth and success. He served on many committees, as Councillor and eventually as AEG President in 1977-1978. His contribution to the Association and to exploration geochemistry will always be appreciated.

To all his colleagues, friends and family he will be greatly missed and happily remembered.



# Association of Exploration Geochemists

## ASSOCIATION OF EXPLORATION GEOCHEMISTS BUSINESS

### Secretary's Report, David B. Smith, Secretary, AEG

Since the Association's last Annual General Meeting in November 2002, Council and Executive held two regularly scheduled meetings. The November 2002 meeting and the March 2003 meeting were both conducted by teleconference. Significant issues included:

1. The most recent issue of the **EXPLORE** newsletter can now be downloaded from the public sector of the AEG web site.
2. Council voted to discontinue AEG's membership in the Canadian Council of Geosciences.
3. AEG will provide support in the amount of \$250US to each of five students to assist in their attending the 21<sup>st</sup> International Geochemical Exploration Symposium in Dublin, Ireland.
4. R. Bowell was named as AEG's Second Vice President.
5. Council agreed to place the subject of the new name for the Association on the agenda for the 2003 Annual General Meeting to be held in Dublin, Ireland on September 1, 2003.

### Australian Geoscience Council – David Garnett

The Australian Geoscience Council has vigorously pursued a range of issues of importance to Australian geoscientists over the last year. Submissions have been made to the Prosser Inquiry into Resources Exploration Impediments. This inquiry forms part of the activities of the House of Representatives Standing Committee on Industry and Resources. Considerable effort has been put into the Mineral Exploration Action Agenda aimed at analysing the problems faced by mineral explorers in Australia and suggesting possible solutions to these problems. In addition detailed discussion documents have been developed on the topic of Mapping Australia's Science and Innovation System, National Geoscience Strategy, and on the recently released Higher Education Review.

### Distinguished Lecturer Committee - David Garnett

Clemens Reimann completed his Distinguished Lecture series towards the end of 2002 and was succeeded by our current Distinguished Lecturer, Cliff Stanley. Cliff was in Australia in December 2002 and gave talks at the University of Adelaide, Perth Geochemical Discussion Group, and James Cook University. In February 2003, lectures were given at the University of Western Ontario and Queen's University, with talks planned for the Colorado School of Mines and, later in the year, the Geological Survey of Norway.

### By Laws Committee - David Garnett

The proposed changes to the By Laws have now been completed and have been reviewed by Council prior to their release to members for discussion, comment and ultimately acceptance or rejection. The issue of the new name for the Association is still outstanding and this will need to be resolved before the By Law revisions are complete. Council has agreed that both the By Laws and the new name should be on the table for discussion at the Annual General Meeting in Dublin. The issues of the By Laws and the change of name will eventually be put to a vote by all Fellows as two separate motions.

### New Membership Committee - Robert Jackson

The New Membership Committee has been carrying out a series of brainstorming activities to identify: 1) the issues relating to the decline in our membership numbers over the last 7 years, 2) the opportunities that exist for obtaining new members, and 3) the activities the AEG needs to engage in to add to its membership. The intent of these discussions is to develop an action plan to market the AEG and attract new members. This plan will be presented to Council prior to the IGES in Dublin. The Committee will seek approval, funding, and overall co-ordination of the plan by the AEG Council.

The patterns of increase and decrease in AEG membership over the years suggest that the recent decline is related to a downturn in the mining industry. All regions have been similarly affected as have all areas of subject interest (ie. exploration, environmental, analytical, etc). The major interest of the majority of members remains exploration geochemistry. There has not been a growth in members specifically interested in environmental geochemistry but it is recognized that this is unlikely to take place until a more inclusive name has been selected for the Association that reflects its change in focus.

The major reasons for seeking membership in the AEG are perceived to be: 1) our journal (GEEA), 2) the organization of technical meetings in applied geochemistry, 3) networking opportunities provided by a pool of geoscientists with similar interests, and 4) the opportunities to remain current in applied geochemistry through the Newsletter and the Web site. It is imperative therefore that the AEG seek to strengthen each of these assets to the benefit of its existing members and to attract new members.

The Committee will make specific recommendations as to how to improve the assets of the Association. It will also develop a marketing strategy for increasing the memberships once a new name has been selected by the membership for the Association. The Committee believes that the choice of name is a key factor in being able to effectively market membership in the Association from geoscientists with diverse interests. For the sake of the viability of the Association, each member should give this issue due consideration and indicate their preference when the opportunity presents itself.

## Association Business...

— — — — — continued from Page 11

### Minutes of the Annual General Meeting of the Association of Exploration Geochemists, held by telephone conference on November 20, 2002

#### I. Call to Order, Establishment of Quorum

President Philippe Freyssinet called the meeting to order at 4:10 PM MST. Sixteen Fellows were present, thus exceeding the required number (15) for a quorum.

#### II. May 9, 2001 AGM Minutes

The minutes from the 2001 AGM were published in **EXPLORE**, No. 117 (October 2002). President Freyssinet asked if there were corrections or additions to these minutes, and none were noted. It was moved (N. Radford) and seconded (D. Smith) that the AEG approve these minutes as published. President Freyssinet asked for a vote on this motion and it passed without objection.

#### III. AGM Reports of Executive and Committees

The reports of AEG Executive and Committees for the 2002 AGM were published in **EXPLORE** No. 117 (October 2002). President Freyssinet asked if any additions or corrections should be noted in any of these reports. There were no additions or corrections noted to the published reports.

#### IV. Election Results

The results for the motion to change the Preamble to the By Laws (as published in **EXPLORE** No. 116) were as follows:

*For the change: 102, Against the change: 9*

The results for the motion to change the name of the Association:

*In favor of a name change: 91, Opposed to a name change: 20*

The results of the question regarding the new name of the Association:

*Association of Exploration and Environmental Geochemists: 56, Association of Applied Geochemists: 34*

It was moved (N. Radford) and seconded (G. Hall) that the Association charge D. Garnett, chair of the By Laws Committee, with drafting all proposed changes to the By Laws. These changes will include the change to the Preamble just approved as well as other changes recommended by the By Laws Committee. These changes will be sent to Council for final revision and then submitted to AEG Fellows for a formal vote. The new name of the Association will be put to a vote as a separate item on the ballot. President Freyssinet asked for a vote on this motion and it passed unanimously.

D. Garnett will try to have the revised By Laws submitted to AEG Council for comments in December 2002 with the goal of publishing them for comments from all AEG members in the March 2003 issue of **EXPLORE**.

The new Councilors for 2003-2005 are: Rob Bowell, Chris Oates, Cliff Stanley, David Seneshen, and Alan Kelly.

#### V. Motion to Destroy Ballots

It was moved (D. Smith) and seconded (R. Jackson) that AEG destroy all ballots from the recent election regarding new Councilors and the change to the Preamble of the By Laws. President Freyssinet asked for a vote on this motion and it passed without dissent.

#### VI. Motion to adjourn

It was moved (R. Jackson) and seconded (D. Smith) that the 2002 AGM adjourn. President Freyssinet asked for a vote on the motion and it passed unanimously.

President Freyssinet thanks all participants in the AGM and adjourned the meeting at 4:45 PM (MST).



## New Members...

To All Voting Members:

Pursuant to Article Two of the Association's ByLaw No.1, the 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.

*Members:*

#### **Mark Arundell**

*Consultant Geologist, Belmont, Western Australia.*

#### **Robert L Carpenter**

*District Geologist DIAND, Nunavut, Canada.*

#### **Ray T Fenstermacher**

*Geologist, WL Gore and Assocs, Elkton, MD, USA.*

#### **Giovanni Funaioli**

*Consulting Geologist, Castiglione, Italy.*

#### **Neil O'Brien**

*Senior Geologist, Teck Cominco, Guadalajara, Mexico.*

*Student Members*

#### **Katherine A Robertson**

*Student, University of Texas at Dallas, USA.*

**Jamil A Sader**, *Student, University of Texas at Dallas, USA.*

**Announcing**  
**Association of Exploration Geochemists**  
**Annual General Meeting, 2003**  
**AGM 2003 Meeting**  
**September 1, 2003**  
**Dublin, Ireland**  
**21<sup>st</sup> IGES Meeting**

## Geochemical Laboratory

Updates... *continued from Issue 119*



**ALS Chemex**

**Patrick Highsmith, Chief Geochemist,**

*ALS Chemex Labs*

*Email: [patrick.highsmith@alschemex.com](mailto:patrick.highsmith@alschemex.com)*

*“There is nothing new in the world except the history you do not know.”*

— Harry S. Truman, U.S. President, 1952.

Gold mining and assaying have a long history. There is much to remember, but none of the problems we encounter are new. Sampling and assaying of coarse gold is such an old problem. How much have we learned and how well do we remember? Our training has made us all aware of the pitfalls of sampling for gold; many of the procedures in modern assay labs are based on the classic writings of Gy (1954, 1956, and 1967), Pitard (1993), and Clifton *et al* (1969). However, since memories are short and technical best practices are constantly evolving, it is worthwhile to review the options for handling coarse gold at ALS Chemex.

There is no disputing one trend that has emerged from the recent price cycle: gold explorers are seeking grade more than tons. While miners have always preferred rich ores to lean ones, the emphasis on high-grade may steer geologists to certain preferred deposit types. This shift has implications for the geoscientist and his assay lab – as high-grade gold deposits become the focus, the specter of the “nugget effect” can’t be far behind. Exciting exploration targets in the news today include low sulfidation epithermal and Archean lode gold deposits. These types of deposits are well known for the presence of sometimes-spectacular coarse gold.

One can examine a current Schedule of Services from ALS Chemex and note details that are relevant to the inhomogeneity of gold ores. First, under Sample Preparation there is a constant emphasis on the particle size of the samples. Second, there are multiple options for crushing, splitting, pulverizing, screening, and even “washing” of prep equipment. Finally, under Precious Metals Analysis there are myriad procedures employing different sample aliquots, ranges of detection, and the Screen Fire Assay procedure figures prominently. Many of these procedures have changed little in the last two or three decades, so a strong classical knowledge of sample prep and assay procedures is still a necessity.

Consider a few options and progressive steps towards the optimum assay protocol. All ALS Chemex facilities offer multiple sample preparation options. It is true that there is often a local standard for sample preparation. In Australasia, small rock and drill samples (< 4 kg) are often crushed and pulverized in one step using the large bowl LM-5 mill or equivalent. In South America and North America, a crush and split protocol using jaw crushers and bowl pulverizers is more common. In many ALS Chemex prep labs, both options or combinations thereof are available. One of the first steps to enhance treatment of inhomogeneous materials is to collect a larger sub-sample. Importantly, this includes sampling at the drill rig. We offer several options to achieve

this goal in sample prep while taking care not to introduce bias. If we crush larger field samples to at least -2 mm (10 mesh), we can normally take representative splits consistent with Pierre Gy’s guidelines. The client can select how much material to split and pulverize based on the practicalities of available equipment and the dictates of the geology and gold habit. This incremental step of preparing extra large pulps is usually available for modest incremental charges.

Even the splitting procedures have not escaped the scrutiny of the experts and conscientious lab managers. As Pitard (1993) demonstrated, the choice of a riffle splitter is not without consequences; he formulated a prescription for minimum slot widths that prudent lab managers do not ignore. Rotary splitters offer a better solution than riffle splitters, but with penalties in speed and cost. These pieces of equipment only achieve representative splits when properly used. So it is essential that the prep lab staff is properly trained and educated about the importance of splitting.

The efficacy of these changes to crushing, splitting, and pulverizing protocols is dependent on certain matrix issues. The more knowledge you have about the occurrence of gold on your project, the better we are able to address the specifics in the sample prep regimen. For instance, sometimes the gold or electrum itself is relatively fine grained but it tends to occur in clumps or aggregates, millimeters in diameter, exhibiting a sparse particle effect. Proper crushing breaks up these clumps and distributes the fine grained electrum more evenly.

When coarse gold is observed in some samples, it may be wise to separate them before submission to the lab. Relatively narrow zones that are known to contain high grade coarse gold may warrant isolation in the lab to ensure there is no carryover into lower grade wallrocks. You are not always able to visually identify high grade zones, but where possible it allows us to focus that extra measure of care (washing all prep equipment with clean rock, screen metalics assays, etc.) on the obviously spectacular samples. These sorts of special high grade intercepts will ultimately drive the economics of any high-grade project, so the extra effort is usually well worth it.

Of course, the analytical method is the final arbiter of assay values. Often, the careful geoscientist opts for a 50-gram or 2 assay-ton fire assay. The benefit relative to the 30-gram fusion is obvious, but consider the argument that the multiples of sample aliquot gained at the field sampling and prep stages may have greater impact. A 1,000-gram pulp is a factor of four larger than the standard North American pulp of 250-grams, but a 50-gram fire assay is only 1.67 times larger than the standard 30-gram fire assay.

The cyanide bottle roll is an attractive option for testing large volume samples where the gold is known to be free. Coarse gold may require prolonged leaching in cyanide, but ALS Chemex is well prepared to offer modifications such as the LeachWELL™ cyanide accelerant or hybrid methods combining fire assay and cyanide leach.

*continued on page 24*

## 3D Vectoring and Data Integration...

*continued from Page 1*

level expression is the San Nicolas VMS deposit in Zacatecas, Mexico (Figure 1- see Page 1).

However, following the various geochemical signals observed above or lateral to an ore deposit back to the actual location of the deposit is challenging. Success relies heavily on the full integration of all available data to identify the most promising drill targets. Advances in 3D visualization software now make this possible on a routine basis. Surface data of all types can be displayed, depending on the nature of the information, as color-coded symbols, color-fill contoured images, or bit maps draped on topography. The subsurface geologic information can be represented as 3D surfaces or volumes. Down-hole geochemistry can be gridded to create 3D block models. From these, actual 3D shapes or grade-shells can be created – essentially a 3D contour. And finally, the products of geophysical inversion modeling software can also be displayed as 3D shapes. This type of data integration can take place at virtually any scale. Where the depth (*z*) dimension is very much smaller than the horizontal *x* and *y* dimensions, the vertical scale can be exaggerated so that data relationships can be identified and explored easily using pattern recognition techniques.

This same capability is equally suited to addressing environmental issues related to geochemical dispersion. Cause and effect relationships can be explored effectively as can changes in contamination effects over time.

This article focuses on how 3D visualization of geochemistry can be used effectively in mineral exploration and environmental studies. All illustrations in this article were created in GoCAD 3D visualization software. The author would like to thank Teck-Cominco Ltd. and Dr. Robert Ginn for giving permission to present some 3D illustrations relating to, respectively, the San Nicolas massive sulphide deposit and the Timginn orogenic vein system. Brief descriptions of various types of 3D visualization software and their capabilities are presented elsewhere in this **EXPLORE** issue.

### Geochemical Modeling

Geochemical modeling is a term used, in this context, to describe the process of interpolating concentration values at points in 3D space based on the analyses of samples collected from drill holes or profiles. The result is a 3D block model for each element with interpolated values assigned to each cell of the model. Geochemical modeling will always produce a result. The task at the outset is to grid the data in a manner that produces a geologically meaningful result.

First, some clean-up of the data is generally needed. Relative accuracy shifts resulting from the use of multiple labs or analytical methods need to be leveled to the degree possible. Alternatively, the data should be segregated into separate databases, particularly in the case when data are a mix of both partial and total digestion methods. Zeros and special characters indicating analyses less than the detection limit should be removed. Some pre-modeling down-hole

compositing may be required to remove the effects of variable sample intervals or lengths.

Second, some kind of data normalization is generally needed prior to modeling. This could be as simple as a log transformation to create more symmetrical statistical populations. Generally, this symmetry lends itself better to color imaging if the populations are highly skewed. However, it may also be that certain elements are strongly dependent on another variable such that their absolute abundance does not reflect the dispersion feature of interest. This is often the case with whole rock data where issues of closure can obscure zonation relationships unless the data are normalized using mass balance equations. In situations where trace element abundance is controlled by some other factor such as grain size, organic content, or the relative amount of Fe and Mn in the sample, element ratios or regression residuals may help normalize the data.

Third, appropriate gridding parameters need to be selected. The grid cell size, which determines the level of detail that can be displayed, must take into account data density, overall model dimensions, and computer graphics capability. There are many gridding methods to choose from, each producing a different result and appropriate to a specific set of conditions. For example, ordinary kriging is commonly used for models at the deposit scale where the deposit itself is a relatively homogeneous feature to be interpolated based on the drill results. Precise information on the strike, dip, and plunge of the mineralization can be used to guide the interpolation process. However, on a larger scale, the shape of dispersion features can be quite complex and not conform to any one preferred orientation. In this situation, usually an inverse distance squared algorithm is a more effective interpolation method. The dimensions and orientation of the search ellipse used to interpolate a value at a grid node are also critical parameters affecting the outcome.

Finally, it is essential to establish some geologic context against which the geochemical model can be judged to reflect known geologic features. Without a level of confidence in the validity of the model, it is difficult to attach geologic significance to observed relationships.

### Exploring Geochemical Models

The advantage of interpolated 3D block model representations of down-hole or profile geochemical data is the ease with which data relationships can be displayed, explored, understood, and communicated. This applies at virtually any scale that may be of interest.

The most common display feature of 3D visualization software is that of colour-fill, contoured cross-sections, long-sections, and level plans. As the section or plan panel is moved through the model, the display changes depending on the contents of the grid cells intersected by the panel. Multiple sections can be displayed at one time. This is useful to create type sections in areas of geologic interest and then to cycle through different elements in this fixed view of the geochemical system. Sectional views are also excellent ways to look at the relationship of geochemical patterns in the subsurface to that of data draped on the topographic surface.

*continued on Page 15*

## 3D Vectoring and Data Integration...

*continued from Page 14*

However, as importantly, 3D grade shells can be created for different concentrations and for different elements (Figure 1). These 3D contours allow for the display of a geochemical shape representing a particular concentration. Displaying these in relation to one another or to other data is a powerful means of exploring zonation relationships.

Block models also allow for the display of geochemistry along particular surfaces, such as the surface topography, a lithologic contact, or a structure. Interpolated concentrations at nodes intersected by the surfaces are displayed as a colour-filled contour map on the surface. This is particularly useful when certain geologic surfaces are thought to be important controls on primary or secondary dispersion. If the surface is a lithologic contact, cross-cutting geochemical trends can be identified that are independent of variations in lithologic composition. If it is a fault, then plunge lines may be evident.

The various stratigraphic and structural components of a 3D workspace can often be used to define regions in the block model. These can be used for display purposes or to subset the data. An illustration of this is a display showing the distribution of Zn relative to Cu on the surface of a volume defined by the distribution of sulfide (Figure 2). Another application would be isolating the geochemistry of a particular till unit from other glacial facies and then creating grade shells that are not influenced by data in other stratigraphic units.

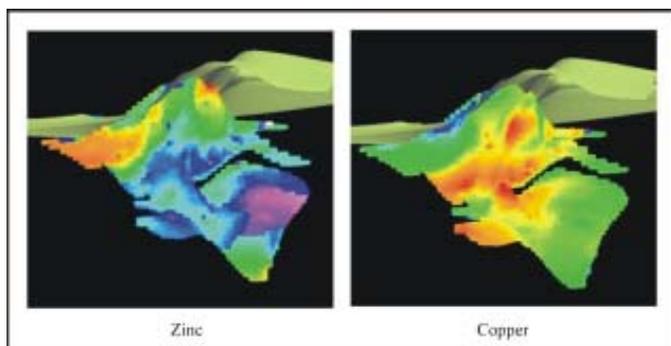


Figure 2: San Nicolas VMS deposit shown as a 3D volume beneath the surface of the host volcanic unit. The coloration on the surface of the 3D volume is the display of Zn and Cu grades. (courtesy Teck-Cominco)

3D visualization software is well suited to on-screen peer reviews that allow for effective communication of ideas and targeting concepts to management and fellow geoscientists without the need of extensive hard-copy maps. The interactive nature of these reviews makes it possible to respond to almost any question with a visual answer provided that the data exist in the model. Some companies or research organizations have taken this interactive approach a step further and employed the use of virtual reality rooms to communicate more effectively amongst the members of multi-disciplinary teams.

Examples are the CIMTEC Virtual Reality Laboratory in Sudbury, Canada and the NewMIC (New Media Innovation Centre) in Vancouver, Canada (Figure 3). Through the use of back-screen projectors and 3D glasses, objects are displayed floating in space before team members. An operator manipulates the display in response to questions and issues that need to be explored to arrive at key team decisions. The cross pollination of ideas and expertise in these situations can be extremely beneficial to an organization.



Figure 3: CIMTEC Virtual Reality Laboratory in Sudbury, Canada. (Photo courtesy of CIMTEK)

### Applications of 3D geochemistry

With respect to mineral exploration, 3D visualization of down-hole geochemical data significantly improves zonation vectoring as a means to discover blind deposits. To begin with, geochemical zonation relationships associated with a particular type of mineral system may not be that well documented or understood. It is only relatively recently that inexpensive analytical methods have provided the kind of detection limits needed to reveal subtle zonation relationships amongst many important pathfinder elements. This has created the opportunity to characterize the geochemistry of known deposits and their environs and to develop a zonation model that can be applied to district-scale exploration.

A good example is zonation in sediment-hosted gold systems of the Carlin type in Nevada. Gold and many other trace elements occur in these systems as sub-micron sized sulfide overgrowths on diagenetic or paragenetically early pyrite. The strong association of As, Sb, Hg, and Tl with Au was useful in the early history of exploration for locating the large system expression of outcropping ore-bodies, with Au being the primary locator of these deposits. These same elements have been less effective in the search for blind deposits due to the regionally extensive nature of anomalies.

*continued on Page 16*



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### 3D Vectoring and Data Integration...

*continued from Page 15*

Similarly, alteration signatures such as decalcification, silicification, argillization, and baritization are often regional in scale.

However, the geochemical characterizations of deposits and whole districts along the Carlin Trend have resulted in the development of a zonation scheme which appears to have broad application to exploration for sediment-hosted gold deposits within Nevada. This model has aspects of both vertical and lateral zonation with respect to the location of ore deposits. Elements not previously thought to exhibit spatial relationships to mineralization include Ag, Bi, Cd, Cu, Mo, Ni, Pb, Se, Te, U, W, and Zn (Heitt *et al*, 2003). Most importantly, an understanding of the upper level expression of individual deposits has led to the development of new criteria for the discovery of blind mineralization beneath the level of shallow drilling common to many known districts, extensively explored only for shallow oxide deposits. Because of the complex interplay between flat-lying stratigraphy and vertical structure, 3D visualization plays an important role in applying the Carlin geochemical model to the search for blind deposits in district-scale exploration.

In VMS exploration, zonation in the vicinity of the San Nicolas deposit (Figures 1, 2) illustrates that the upper level expression of the system in post-mineral tuffs is a zone of anomalously high Na. This effect could have arisen by continued fumarolic activity along ore-controlling feeder structures following the burial of the deposit. One wonders what other vectors would emerge if trace element data were available. Once vectors are recognized, they can be applied to district-scale exploration.

In the case of orogenic vein systems, an example from the Timginn property in the Timmins Camp of Ontario demonstrates how the main structural alignments of Au intercepts can be determined by rotating the data into a view looking down plunge (Figure 4). This can assist in targeting plunge lines between intersecting structures, hopefully controls on higher grade. This system is also zoned on a property scale with respect to trace elements. The gold intercepts are associated with an outer shell of alteration centered on a small unexposed intrusive body. The zoning sequence from the intrusion outward is Pb-Bi-W to As-Mo-Ag, to Au-As-K-Ba-(Ni)-(Mg) where the elements within brackets represent depletions.

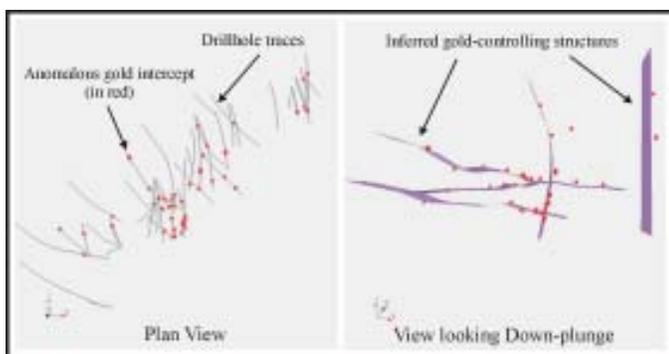


Figure 4: Anomalous Au drill intercepts on the Timginn property, Timmins, Canada. (Courtesy of Dr. Robert Ginn).

Geochemical modeling can also contribute significantly to the understanding and interpretation of surficial geochemistry in such diverse environments as glaciated terrain, the complex weathering and erosional environment of Australia, and covered terrains in arid regions, just to mention a few. Recently, it was applied to characterizing mobile ion dispersion patterns in the 3<sup>rd</sup> dimension beneath a surface soil anomaly. A key factor in effectively interpreting this type of data was to separate out the effects of different types of overburden materials.

Overburden drilling programs in glaciated terrain could benefit from 3D modeling and visualization. When the contacts between different glacial sediment facies can be displayed as solid surfaces, the geochemistry at the base or surface of any unit can be selectively viewed to identify the location and orientation of dispersion fans. Grade shells can be created from individual units to view a dispersion feature in true 3D form.

In weathered terrains, the effects of element remobilization and redistribution can be established where data exist above and below the redox boundary. In Nevada, a change from a wetter climate in the early to mid Miocene to a more arid period resulted in deep oxidation that commonly extends 200-300 m below the preserved mid-Miocene unconformity. Supergene weathering processes at that time redistributed Au and most other elements contained in sulfides. Some elements like Au were redeposited within the oxide zone. Other elements, in particular the chalcophile and siderophile elements, precipitated in the supergene sulfide zone beneath the redox boundary. Understanding the behaviour of elements in response to weathering in this situation is critical to effective interpretation of surface data. Geochemical modeling makes it possible to observe these relationships and use them to advantage to identify drill targets where the upper level expression of deposits has been significantly modified by supergene weathering.

Another application of 3D modeling is the study of contamination plumes from point sources common in environmental geochemistry. In addition to displaying a plume in 3D space, changes in the size and shape of plumes over time can be modeled. Another application would be to visualize the relationship between subsurface contamination and surface measurements in fluid or gaseous seepage zones.

### Conclusions

The full integration of geologic, geochemical, and geophysical data in 3D space opens up many new opportunities in the geosciences. In the dynamic world of 3D, virtually any type of spatial data can be stored and viewed in relation to other data. Periodic data updates are easy to perform. The workspace becomes a vehicle to conceive or test ideas, investigate data relationships, and illustrate concepts. In mineral exploration, it can help identify or refine exploration targets. Such models can also be applied to environmental problems.

Geochemical modeling is an important part of this process. The ability to interpolate element concentration between data points assists in identifying patterns in the data.

*continued on page 17*

## 3D Vectoring and Data Integration

continued from Page 16

However, as with all mathematical interpolations, a result is always obtained. A sound knowledge of the geology and the nature of geochemical zonation associated with ore deposits needs to be applied to the modeling process to ensure a geologically meaningful result.

### References

Heitt, D.G., Dunbar, W.W., Thompson, T.B., and Jackson, R.G., 2003, Geology and geochemistry of the Deep Star Gold Deposit, Carlin Trend, Nevada: Economic Geology, in press.



### Focus on: 3D Vectoring & Data Integration...



### The Application of Gocad to Geochemical Interpretation in Mineral Exploration

**John McGaughey**, Mira Geoscience Ltd., Suite 309, 310 Victoria Avenue, Westmount, Quebec, CANADA H3Z 2M9

Geochemical data are spatially referenced numbers representing chemical properties of sampled rock, soil, or water. These data are interpreted in many ways but in most cases their interpretation involves an analysis of their spatial distribution. Zonation, gradients, and anomalous spikes are interpreted in terms of metallogenetic environment or as direct indicators of mineralisation targets. Typically, spatial modelling is still done simply as 2D map gridding. Interpretation has been facilitated over the last decade or so by GIS techniques allowing visual overlay of geochemistry with supporting geological and geophysical data, as well as more sophisticated “expert system” which enable numerical combinations of multidisciplinary data to be presented in mineralisation favorability maps. Geochemical data comes, however, from a 3D earth. In reconnaissance programs relying purely on surficial sampling, map-based spatial analysis of geochemical data may be sufficient, but as soon as programs progress to borehole sampling, 3D spatial analysis is warranted.

The Gocad technology was created for 3D multi-disciplinary earth modelling. As a property of the earth, geochemical data are easily modelled and visualised within the Gocad environment. Prior to visualisation and interpretation, geochemical data must be interpolated (“gridded”) in 3D. Gocad offers an extremely strong suite of tools for interpolating both continuous variables (e.g. copper concentration) and categorical variables (e.g. metamorphic facies or alteration indices). Interpolation algorithms offered include variography with a full range of modern estimation tools, such as inverse distance and kriging, as well as a suite of simulation tools such as sequential Gaussian simulation. The simulation tools are required for properly modeling and understanding model uncertainty. Carrying out interpolations most effectively requires a 3D geological model as a prerequisite. Data interpolation must recognise lithological or other boundaries within a general geological framework. The interpolation or gridding must recognise faults and respect fault displacement (Figure 1). Gridding or interpolation must be properly bound spatially to volumes or surfaces that are

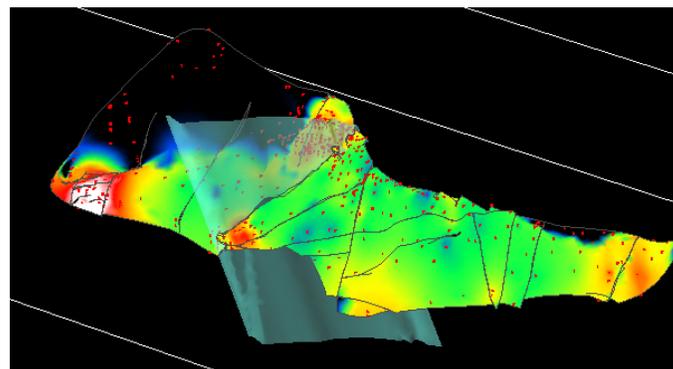


Figure 1. A lithochemical (“whole rock”) element interpolated over a complex, faulted volcanic-stratigraphic horizon as an indicator of mineralization favorability. Data points shown in red. The semi-transparent blue surface is a major fault. The modeled surface is approximately 16km on its long axis. (Courtesy of Noranda-Falconbridge Ltd. Exploration)

interpreted to be the correct domain supporting the geochemical data under analysis. For example, we may want to confine the spatial analysis of an alteration indicator to a specified stratigraphic horizon corresponding to an ancient volcanic event (Figure 2). The interpolator must be able to

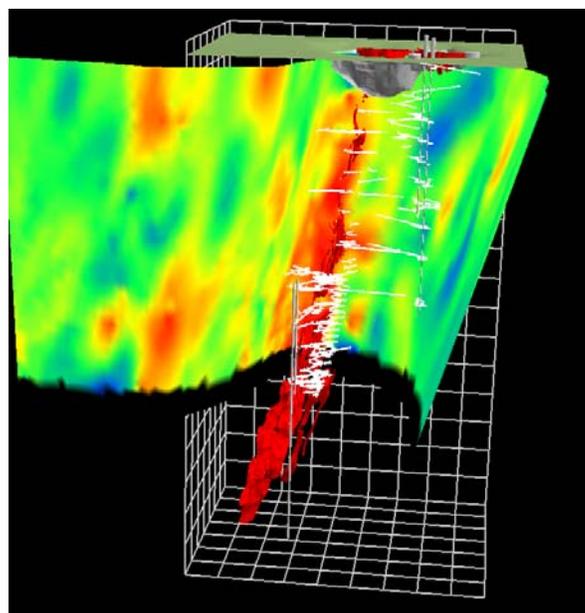


Figure 2. “Ishikawa Index”, an alteration indicator for mineral exploration, modeled on a folded volcanic-stratigraphic surface at the Kidd Creek Mine, Ontario. (Courtesy of Falconbridge Ltd. Kidd Creek Mining Division)

continued on Page 18

# Focus on: 3D Vectoring & Data Integration...

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follow the local folds in the stratigraphy as well as respect fault displacements.

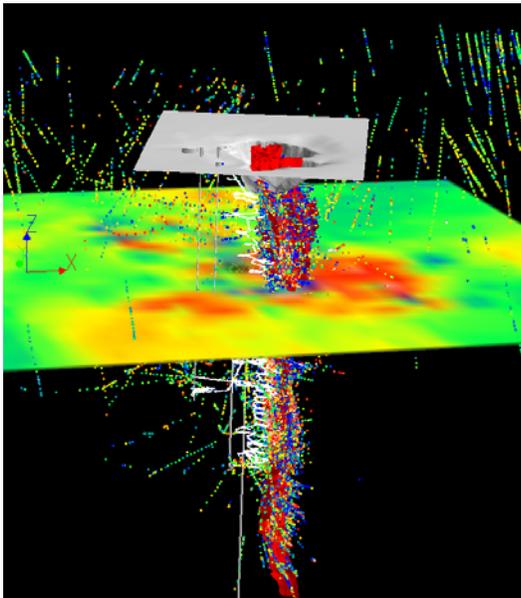


Figure 3. Cu-Zn ratio kriged from whole-rock analysis (data points shown) in 3D and shown at one level through the Kidd Creek Mine, Ontario. (Courtesy of Falconbridge Ltd. Kidd Creek Mining Division)

Finally, the visualisation of the geochemical model must be done within a 3D geological model for effective multidisciplinary interpretation (Figure 3). In other words, effective analysis requires simultaneous access to both a strong surface and volume modeller for the geological framework and a strong property modeller that can act on modelled surfaces or within volumes.

Effective interpretation of modelled geochemical data requires strong query and visualisation tools. Geosoft offers many tools for the query and visualisation of interpolated geochemical data within the proper context of its modelled geological environment. These tools include multi-channel volume rendering, colour and sun-shaded property mappings on complex surfaces, variable transparency, and iso-surface extraction and display. Visualisation is done on systems ranging from laptop computers to high-end immersive visualisation systems in which a multidisciplinary geoscience team can meet together to interpret 3D data in an environment that encourages exploration decision making.

## Exploration in Three Dimensions 3D Visualization When Processing and Interpreting Exploration Datasets

Tracey Minton and Tim Millis, Geosoft Inc.

Computers and software applied to mineral exploration have had a significant impact on the exploration process, particularly over the past 25-30 years. Within data processing, analysis and interpretation environments, technology has improved the ability to manipulate and query data with greater ease and efficiency. Today, 3D visualization technologies are delivering better insight into our data, reducing uncertainty and helping to improve the quality of exploration decisions.

### The Value of Visualization

Visualizing drillhole exploration data in true 3D space is fundamental for any exploration drilling campaign.

Traditionally, exploration data sets have been processed and visualized using one or two-dimensional methods. Two-dimensional cross-sections or maps were produced from spreadsheets to help determine the location, orientation and relationships of data that are really three-dimensional.

While cross-sections and maps do a good job of showing the position of data, they often fail to demonstrate the interaction between surface and subsurface features. For example, the relationship between mineralization, weathering profiles, and their associated geophysical signatures is complex and difficult to process and interpret using a simple plan or section view.

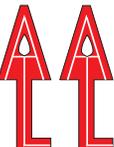
### Working within the 3D Environment:

#### An Exploration Case Study using Geosoft's Oasis montaj

Within the Oasis montaj geospatial data platform, Geosoft data processing and analysis (DPA) software applications provide a range of options for processing and

continued on Page 19

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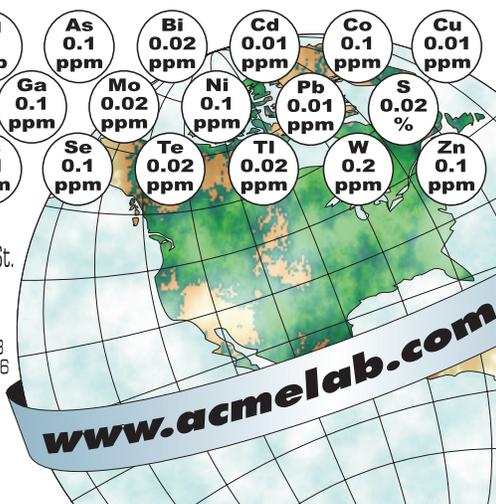
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# Focus on: 3D Vectoring & Data Integration... *continued from page 18*

visualizing related data sets. Survey, location and GIS data can be integrated and processed in a single, one-dimensional spreadsheet database. Two-dimensional line profiles, plans and section views can be created to visualize and interpret data. For 3D viewing, the 3D visualization tool can be used to display drill holes, surface and other data in an integrated, dynamically linked and interactive viewing environment.

The 3D visualization tool is fully integrated with other Geosoft modules, and grids generated in "sectional" views from other software applications such as Interactive IP can be displayed directly into the 3D view in their correct orientations "on-the-fly". Other grids and images (including bitmaps and jpegs) can be opened and easily located in any orthogonal plane that the user desires. The transparency of individual layers (planes) can be controlled, in the 3D viewer, much like a light-table effect. Data such as MapInfo tables and 2D DXF files can be imported directly to the 3D environment and drawn on any surface displayed in the viewer itself. Data in the database are dynamically linked (in real-time) through the cross-section and plan maps to the 3D environment. Dynamic linking is a core feature of the Oasis montaj environment and available in all Geosoft software applications.

The 3D environment, within Oasis montaj, can help us understand some of the relationships between mineralization

and oxidation profiles as illustrated by the following example.

A N-S cross-section (Figure 1) displays the weathering, lithology and gold assays down each individual drillhole in a graphical and text representation (as per the legend). The section also displays an interpretation of where the surfaces of complete (orange) and partial (brown) oxidation intersect the section. From this section view, one can conclude that there is a relationship with some of the mineralization and level of oxidation. It does not tell us how this relates to the drillholes on either side of this section.

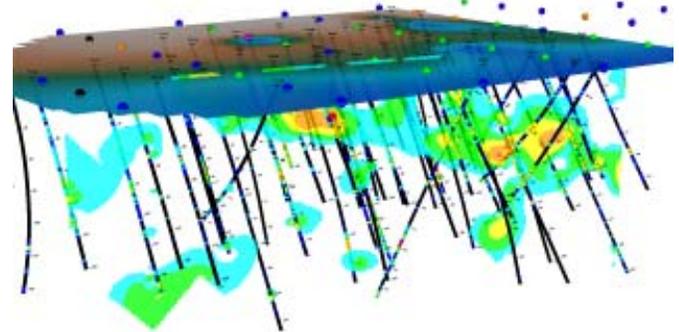


Figure 2. Oasis Montaj 3D view, mineralization with oxidation.

In a 3D view of this same data (Figure 2), a topographic grid is displayed together with surface soil samples (shown as spheres) that are colour-coded according to their gold content. The drill holes are displayed in their true three-dimensional space and include the attributes of up to two different data types along their trace. In this diagram the traces are attributed with gold, which is shown as coloured bands according to the grade distribution shown in the 2D cross-sections. Also, displayed in its true 3D location is a long section with the distribution of gold mineralization shown as a gridded image clipped to gold values greater than 0.1 ppm. This figure illustrates the significant westward plunge of the mineralization and that the mineralization, though not outcropping, has a subtle expression in surface soils

A second 3D view (Figure 3) shows how a number of different exploration techniques can be integrated to help define and interpret the mineralization. The plunge of the gold mineralization can be seen to follow the interface between partial and fresh oxidation (shown as a dark blue surface). The enrichment of the mineralization that was seen in the 2D cross-section can be explained by the intersection of the mineralization with the oxidation interface.

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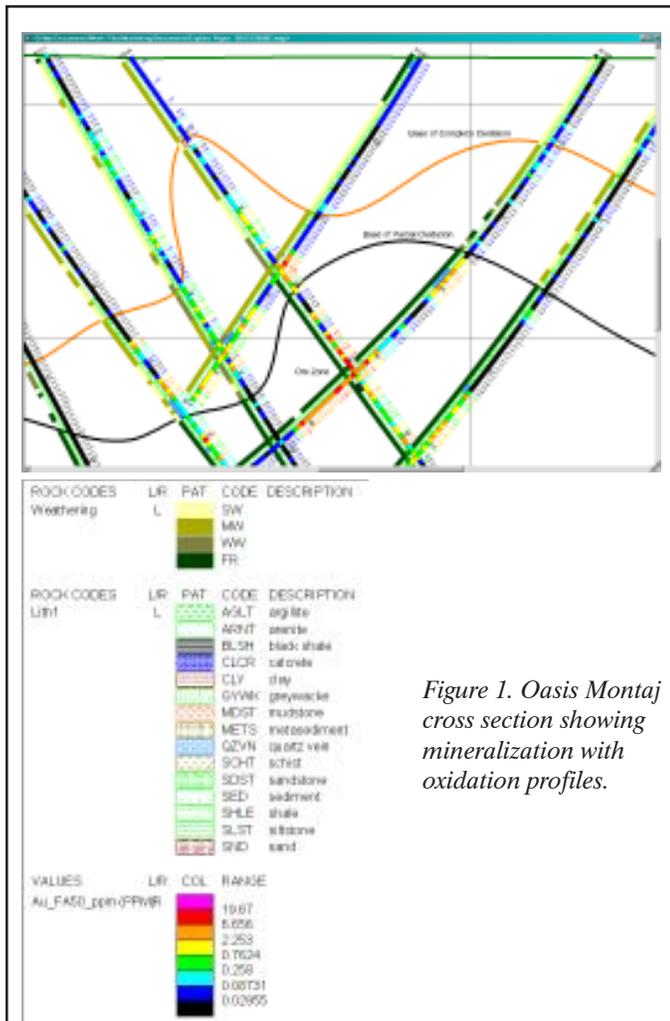


Figure 1. Oasis Montaj cross section showing mineralization with oxidation profiles.



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## Focus on: 3D Vectoring & Data Integration... *continued from page 19*

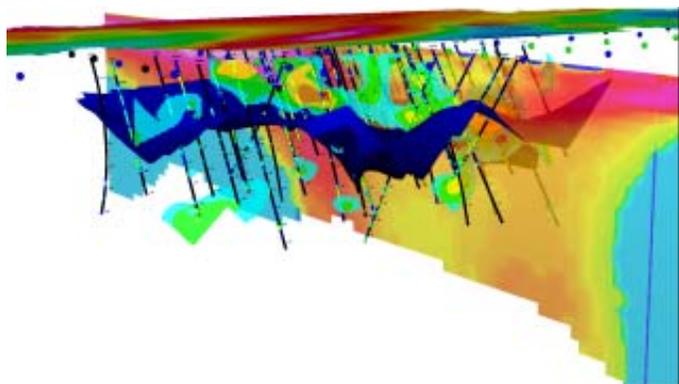


Figure 3. Oasis Montaj 3D-View.

### Interactive 3D Visualization using TECHBASE

Susan Hall, Ph.D., Manager of Technical Support  
 TECHBASE International, 134 S. Union Blvd., Suite 640,  
 Lakewood, CO 80228, USA 303-980-5300  
 www.TECHBASE.com

TECHBASE International has been writing software for 20 years, focusing initially on the rigorous statistical and modeling tools required in the mining industry. Only recently have 3D visualization tools been added to the software, and they have proven highly successful in discerning regional and deposit-scale geochemical trends.

TECHBASE stores data in a database designed for use with geochemical and engineering data. These data can then be analyzed using simple statistics (scatter plots, histograms and the like) or multivariate statistical tools (Factor analysis, Principal Component Analysis, Regression etc). Surface data can be modeled into “cell tables” using Kriging, Inverse Distance, Triangulation or Minimum Curvature Algorithms. Down-hole data require slightly different treatment. Raw data are usually plotted on down-hole projections of drill holes for first pass visualization. Typically borehole information is then composited to regular intervals, within geologic or other pertinent units, or onto benches using TECHBASE compositing tools to better withstand the rigors of 3D modeling. Modeled into a block table, results can then be projected into a 3D model. At different stages in this

The diagram also includes an image, generated by an EM software package, located along its survey traverse. The apparent increase in signal along the mineralization is an effect of the level of oxidation, rather than the mineralization itself. The magnetic grid draped over the topographic surface appears to relate to a crosscutting structure in the mineralization, which is depicted by a break in the gold mineralization and a valley in the partial-fresh oxidation surface.

### Conclusion

This example demonstrates the value of visualizing data in 3D, and illustrates how data integrity can be maintained by dynamically linking to the original data in 1D space and 2D sections.

process, TECHBASE graphics tools can help to visualize your data, and combine raw geochemistry with cultural, geologic or spatial data.

Combining geochemical results with other surface information can be a very useful tool during sample design and data analysis. Figure 1 shows surface geology draped onto modeled topography illustrating that any surface data including images, geology, geochemistry and land ownership can be plotted along with topography using the TECHBASE Insight3D program. Using TECHBASE filtering tools, slices of regional geology can also be projected in 3D facilitating

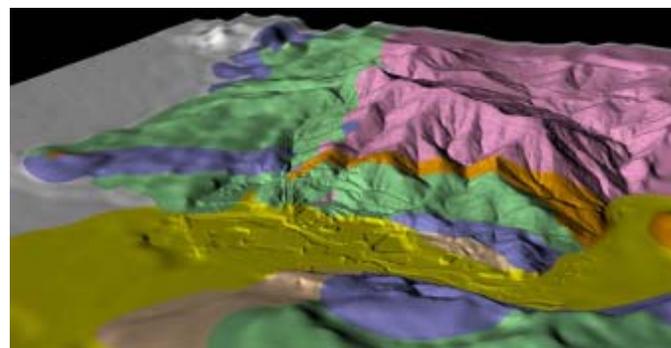


Figure 1: Geology draped over a 3D model of regional topography helps visualize regional trends in an industrial mineral deposit. Note the mined benches, which are visible in the foreground.

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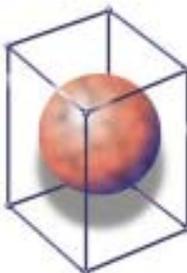
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## Focus on: 3D Vectoring & Data Integration... continued from page 20



regional correlation and interpretation (Figure 2). This combined approach to the visualization of geochemical and geologic results can be very useful when factoring in cultural,

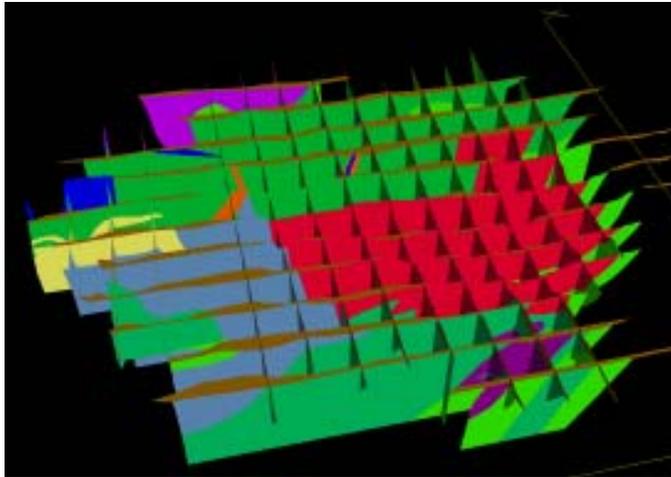


Figure 2 Slices of geology projected in 3D shows project geologic trends through integration of numerous cross sections using the TECHBASE Insight 3D program.

topographic, weathering or other quantifiable data to help explain results.

Once your project has progressed to the phase where drilling and underground modeling has defined the economic character of a deposit, it is often useful to view these blocks in 3D. TECHBASE's filtering capabilities allow you to plot an infinite variety of data. In Figure 3, we have plotted blocks that have a high precious metal concentration and positive economic value. Any modeled value, including

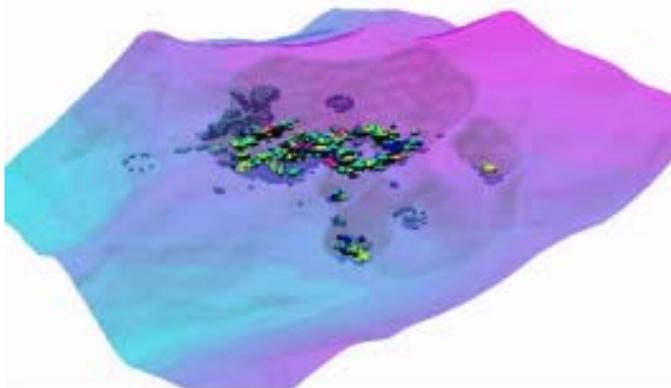


Figure 3 Color-coded blocks with a positive economic plotted with the topography of an ultimate pit. Adding translucency to the surface allows you to rapidly identify mineralized areas that will not be mined given the economic conditions you assign to your model.

geochemical concentration, can be plotted as a 3D block. Blocks are then color-coded based on value – hot colors having a higher metal concentration and concomitant economic value. Blocks that do not have a positive value at a given metal price were filtered out of this view. Finally the

topographic expression of an ultimate pit, calculated using the TECHBASE openpit module, is superimposed on the block model. Combining this information has proven an excellent tool to help you quickly identify pods of mineralization that might be missed with a set of given mining and economic parameters.

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## FracSIS Product Suite

Robin Swindell, *Technical Writer, Fractal Technologies,*  
57 Havelock St, West Perth, WA 6005;  
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Fractal Technologies' FracSIS Product Suite is a complete spatial data integration platform that brings disparate data from existing geoscientific software packages together, so all users in your organisation can access it, regardless of where it came from. FracSIS value-adds to your data, complementing existing mine planning and exploration packages – not replacing them. The FracSIS Product Suite is designed to be used at all levels in an exploration or mining organisation. Everyone benefits from an easy to use system that allows them to visualise an entire project's data in a unified 3D visualisation environment – they don't even need to know how to use the software from which the data originated.

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*continued on page 22*



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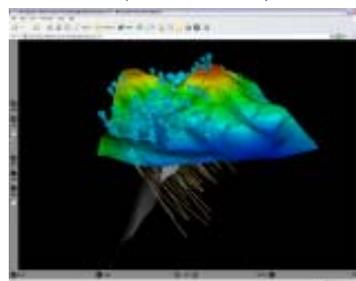
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- Vulcan
- Whittle

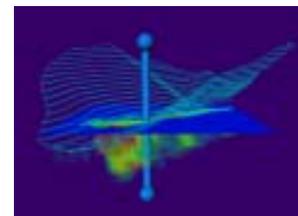
The FracSIS Product Suite also ships with a comprehensive global coordinate system knowledge base. There is no need to create duplicate information or to perform complex calculations to use data in multiple coordinate systems. FracSIS converts coordinate information automatically – so users can view and manipulate data regardless of its coordinate system. You can even create your own coordinate systems for local grids. This allows users to assign relevant coordinate system information to their datasets. The advantage of tagging objects with a coordinate system means that data stored in disparate coordinate systems may be viewed in a common coordinate system or re-projected on the fly into an entirely new coordinate system.

### 3D Visualisation

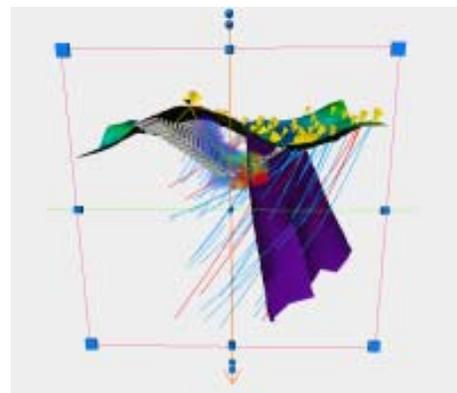
Users can visualise common data in ways unique to their requirements, without ever modifying the data in the database (Figures 1-3). For example, you can visualise



*Figure 1: Publish scenes to the web to collaborate with others and communicate results.*



*Figure 2: View block model data as a semi-transparent volume.*



*Figure 3: See where drill-holes intersect with ore-bodies, faults and other geological features.*

*continued on Page 23*

## Focus on: 3D Vectoring & Data Integration...

*continued from page 22*



magnetics data created in ERMMapper, drillholes stored in acQuire, and a geological model created in Vulcan simultaneously. Then you can drape aerial photography over the model, map the drillhole assay results to colour, or add magnetics data. The ability to view disparate data in a common environment enhances geoscientific understanding and improves interpretation. The FracSIS Product Suite includes many useful tools and features to enhance data interpretation and visualisation, including:

- CAD drawing tools
- multiple coordinate system support
- export data to GXF, DXF, and ASCII
- web export
- analytical and measuring tools, including dip, distance, & azimuth
- volume visualisation
- image draping
- mapping colour or size from attributes
- saving and loading colour legends
- section views
- label and text annotation tools

FracSIS's data integration and 3D visualisation capabilities improve communication. With the centralised database, all users can access the same data, visualise it to suit their purposes – without duplication or loss of data integrity – and communicate their interpretations easily and

effectively. FracSIS is the catalyst for informed discussion and decision-making.

Fractal Technologies also offers FracSIS training and custom development services, database creation and data validation. Please visit our web site at <http://www.fractaltechnologies.com> or contact us at [info@fractaltechnologies.com](mailto:info@fractaltechnologies.com) for further information.



## AEG Distinguished Lecturer

The Distinguished Lecture Series for 2002-2003 is being given by **Cliff Stanley**

The following lectures are offered:

- **Lecture 1:** Lithogeochemistry: *What you discover depends on where you stand*
- **Lecture 2:** Hydrothermal alteration zones at two massive sulphide deposits: *Contrasts in lithogeochemical expression due to host rock controls*
- **Lecture 3:** Molar element ratio analysis of granitoid batholiths: *Insights into magmatic and assimilation processes that affect exploration strategies and tactics*

Organizations interested in putting on a lecture should contact **David Garnett** for further information.



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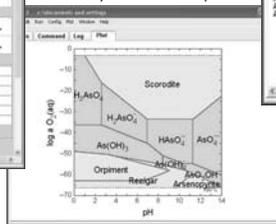
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## Geochemical Laboratory

Updates... continued from page 13



The Screen Metallics Fire assay is considered by many to be the ultimate measure of total gold in a sample. A large aliquot (commonly 1,000 grams) is pulverized and then sieved through a 106 or 75 micron screen. All of the sample retained on the screen is fused, reporting total gold in the plus fraction. The fine fraction is homogenized and fire assayed in duplicate. The weighted average of the fine and coarse fraction gold assays yields a calculated total gold in the 1 kilogram sample. An extra measure of care may be required to ensure optimum data. First, there is the choice of dry sieving at 106 micron or wet sieving at 75 microns. Furthermore, a disposable screen that can be fire assayed along with the sample ensures that no gold is lost in the fine mesh of a stainless steel sieve.

This litany of methods offered, while not the full measure of our experience, does reflect the preferences of many different clients and the practical outcome of years of laboratory management experience. Considering the varying needs of explorers around the world and this wide range of laboratory services, it is important to see flexibility and adaptation in lab methods where coarse gold is concerned. At ALS Chemex you will sometimes find hybrid methods in place, where we combine the best ideas from one region with those of another. Communication between lab and explorer is also critical. There is no cookbook. Most often, we cooperatively set a threshold above which samples are checked by screen metallics assay or some other special method; though the effort to optimize your gold data must not stop there. It is important to test homogeneity with regular replicate assays and resplits of coarse reject. In practice, we often find that using the proper hardware and consistent procedures, the homogeneity of prepared samples improves continuously throughout a project and the need for screen metallics or bulk sample assay methods decreases.

The economics of our business dictate that there must be options in sample preparation and assay. Experience has shown that most of the time, a "standard preparation" protocol responsibly applied yields meaningful data. A strong quality assurance program in conjunction with careful geological logging of samples should indicate when problems occur. However, geology has a way of keeping us on our toes. Each deposit is different and the solution to achieve optimal sampling and assays, while balancing cost and benefit, may not be obvious at the outset. These reasons and others make it almost unavoidable to conclude that the human factor in sample preparation and assay may be even more critical than the geological specifics. Success in tackling coarse gold is usually the result of a nexus of good geology, good geochemistry, and rigorous laboratory methods. Hence, communication and attention to detail are paramount. We hope you will see us as a problem solving resource and your partner in discovery – coarse gold or

# SGS

COMMERCIAL TESTING & ENGINEERING CO.,  
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### TECHNICAL SERVICES

We are pleased to announce that Charles D. (Charlie) Rose has been appointed as the Vice President of Technical Services effective immediately.

Charlie's educational background is in physics, mathematics, and engineering. Early in his career, he worked as a design engineer with a manufacturer of coal handling and processing equipment. He has been an independent consultant to the coal industry and electric utility industry since 1978. Charlie's clients have included major electric utilities and leading coal companies located worldwide. He has published numerous papers on topics such as sampling, on-line analysis, and statistical methods, and has made significant contributions to ASTM and ISO coal sampling standards.

Charlie's contact details are as follows:

4404 Landlewood Court

Dallas, TX 75276

Tel: 972.818.2600

Fax: 972.818.2791

Email: [Charlie@coalyard.com](mailto:Charlie@coalyard.com)

For further information contact CT&E at 630.953.9300.



## CALENDAR OF EVENTS

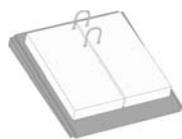
International, national, and regional meetings of interest to colleagues working in exploration, environmental and other areas of applied geochemistry.

■ August 29 - September 3, 2003, **21<sup>st</sup> International Geochemical Symposium (IGES), North Atlantic Minerals Symposium (NAMS)**, Dublin, Ireland. Information: The Secretary LOC - Eibhlin Doyle (e-mail [eibhlin.doyle@gsi.ie](mailto:eibhlin.doyle@gsi.ie)), <http://www.conferencepartners.ie/igesandnams2003>.

■ August 31-September 4, 2003, **Emerging Concepts in Organic Petrology and Geochemistry**, The Banff Centre, Banff, Alberta, Canada, by the Canadian Society for Coal Science and Organic Petrology (CSCOP) & The Society for Organic Petrology (TSOP). (Dr. Martin Fowler, Geological Survey of Canada, 3303-33rd St. NW, Calgary, Alberta T2L 2A7 Canada, Phone: 403-292-7038 FAX: 403-292-7159 EMail: [Mfowler@nrca.gc.ca](mailto:Mfowler@nrca.gc.ca) Web: <http://www.cscop-tsoap2002.com>)



continued on Page 25



## Calendar of Events

continued from Page 24

■ September 7-11, 2003 **6th International Symposium on Environmental Geochemistry (ISEG)**, Edinburgh, Scotland (Janet Beard, In Conference Ltd. 10b Broughton Street Lane, Edinburgh EH1 3LY, Scotland, UK, Phone: 44-0-131-556-9245 FAX: 44-0-131-556-9638 EMail: janet@in-conference.org.uk Web: <http://www.iseg2003.com>)

■ September 16-18, 2003 **International Conference on Tectonics and Metallogeny of Central and Northeast Asia**, Scientific Hall, Russian Academy of Sciences, Academy Town, Novosibirsk, Russia, by the Russian Academy of Sciences and U.S. Geological Survey. (Alexander A. Obolensky, United Institute of Geology, Russian Academy of Sciences, Novosibirsk, Russia 630090, Phone: 7-3832-33-30-28 FAX: 7-3832-35-27-92 EMail: obolensk@uiggm.nsc.ru Web: [www.uiggm.nsc.ru/uiggm/geology/admin/](http://www.uiggm.nsc.ru/uiggm/geology/admin/))

■ September 22-26, 2003 **7th International Conference on Gas Geochemistry**, Freiberg University - Conference hall "Alte Mensa", FREIBERG, Sachsen, Germany, by the Freiberg University of Mining and Technology and Saxon Academy of Sciences. (Dr. Jens Heinicke, Saechs. Akademie der Wissenschaften/TU-BAF, B-v-Cotta Str. 4, Phone: +49-3731-392212 FAX: +49-3731-392212 EMail: heinicke@physik.tu-freiberg.de Web: <http://www.copernicus.org/ICGG7>)

■ October 5-10, 2003, **The XII International Mineral Processing Congress**, Cape Town, South Africa. Information: [www.impc2003.org.za](http://www.impc2003.org.za).

■ October 12-15, 2003, **Tailings and Mine Waste '03**, Vail Cascade Resort Vail, Colorado. INFORMATION: Linda Hinshaw, Department of Civil Engineering, Colorado State University, Fort Collins, CO 80523-1372, Telephone: 970-491-6081, FAX: 970-491-3584/7727, Email: [lhinshaw@engr.colostate.edu](mailto:lhinshaw@engr.colostate.edu). Web [www.tailings.org](http://www.tailings.org).

■ November 2-5, 2003, **Annual Meeting of the Geological Society of America**, Seattle, Washington. INFORMATION: TEL 1-800-472-1988, [meetings@geosociety.org](mailto:meetings@geosociety.org).

■ February 23-25, 2004, **2004 SME Annual Meeting and Exhibit**, Denver, CO. INFORMATION: Meetings Department at 800-763-3132 or 303-973-9550. <http://www.smenet.org/meetings/index.cfm>

■ June 27-July 2, 2004 **11th International Symposium on Water-Rock Interaction**, Saratoga Springs, New York, USA (Dr. Susan Brantley, Secretary General, Dept. of Geosciences, The Pennsylvania State University, 239 Deike Building, University Park PA USA 16802, Phone: 814-863-1739 FAX: 814-863-8724 Web: <http://www.outreach.psu.edu/C&I/WRI/>)

■ October 10-15, 2004, **SEG International Exposition & 74th Annual Meeting**, Denver, Colorado, US, by the SEG. (Debbi Hyer, 8801 S. Yale, Tulsa OK 74137, Phone: (918) 497-5500 Email: [dhyer@seg.org](mailto:dhyer@seg.org) Web: <http://meeting.seg.org>)

■ November 7-10, 2004, **Annual Meeting of the Geological Society of America**, Seattle, Washington. INFORMATION: TEL 1-800-472-1988, [meetings@geosociety.org](mailto:meetings@geosociety.org).

■ February 28-March 2, 2005, **2005 SME Annual Meeting and Exhibit**, Denver, CO. INFORMATION: Meetings Department at 800-763-3132 or 303-973-9550. [http://www.smenet.org/meetings/calendar/event\\_calendar.cfm](http://www.smenet.org/meetings/calendar/event_calendar.cfm)

■ May 20-24, 2005: **Goldschmidt Conference 2005**. University of Idaho, Moscow, Idaho, USA. [www.gold2005.uidaho.edu](http://www.gold2005.uidaho.edu). Contact: [gold2005@uidaho.edu](mailto:gold2005@uidaho.edu)

■ September, 2005, **22nd International Geochemical Exploration Symposium (IGES)**, Perth, Western Australia, web site: [www.aeg.org](http://www.aeg.org).

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

### Virginia T. McLemore

*New Mexico Bureau of Geology and Mineral Resources*

*New Mexico Institute of Mining and Technology*

*801 Leroy Place*

*Socorro, NM 87801 USA*

*TEL: 505-835-5521 FAX: 505-835-6333*

*e-mail: [ginger@gis.nmt.edu](mailto:ginger@gis.nmt.edu)*



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## *Association of Exploration Geochemists Publications*

### **DISTINGUISHED LECTURER SERIES CD AND VIDEO TAPES**

- No. 1: 2002 - The Kola Geochemistry Project: An environmental investigation in Arctic Europe.* 2002 Distinguished Lecture Series by Clemens Reimann, Norway. .... US\$20.
- No. 2: 2002 - Geochemical Provinces: Do they exist and what is their relation to regional Geology.* 2002 Distinguished Lecture Series by Clemens Reimann, Norway. .... US\$20.

### **SPECIAL VOLUMES**

- Sp Vol. 4: *Application of Probability Plots in Mineral Exploration*, A.J. Sinclair. .... US\$12.
- Sp Vol. 14: *PROBPLOT*, An Interactive Computer Program to Fit Mixtures of Normal (or Log Normal) Distributions with Maximum Likelihood Optimization Procedures. C.R. Stanley. On 3.5" diskette. .... US\$55.

### **OTHER PUBLICATIONS**

- A Global Geochemical Database for Environmental and Resource Management, Recommendations for International Geochemical Mapping*, Final Report of IGCP Project 259, A.G. Darnley, A. Bjorkland, B. Bolviken, N. Gustavsson, P.V. Koval, J.A. Plant, A. Steinfeld, M. Tauchid and Xie Xuejing; with contributions by R. Garrett, and G.E.M. Hall. .... US\$20.
- Applied Biogeochemical Prospecting in Forested Terrain*, C.E. Dunn, G.E.M. Hall, and R. Scagel, short course notes. .... US\$50.
- Applied Biogeochemistry in Mineral Exploration and Environmental Studies*, C.E. Dunn, G.E.M. Hall, R. Scagel, D. Cohen, P. Catt, and M. Lintern, short course notes. .... US\$55.
- Biogeochemical Exploration, Simplified - with emphasis on arid terrains*, C.E. Dunn, J.A. Erdman, G.E.M. Hall, and S.C. Smith, short course notes. .... US\$50.
- Exploration Geochemistry; Design and Interpretation of Soil Surveys*, Reviews in Economic Geology Vol 3, ed. W.K. Fletcher. Co-sponsored by the SEG. .... US\$25.
- Geochemistry: Exploration, Environment, Analysis*, A one-year set of past issues ..... US\$70.
- Journal of Geochemical Exploration*, in Subscription Years pre-1997, per year. .... US\$70.
- Practical Problems in Exploration Geochemistry*, 1987, A.A. Levinson, P.M.D. Bradshaw and I. Thomson, 269 p. .... US\$80.
- Writing Geochemical Reports*, Guidelines for Surficial Geochemical Surveys, 2<sup>nd</sup> Edition, Edited by L. Bloom. .... Free

AEG Member discounts apply for most publications. All payments must be made in US funds in one of the following formats: VISA, Master Card, American Express, personal cheque, International Money Order, UNESCO coupons, and International Postal Orders. For further information, verification of member discounts, and to place orders, contact:

### **ASSOCIATION OF EXPLORATION GEOCHEMISTS**

**Betty Arseneault, AEG Business Office**

P.O. Box 26099, 72 Robertson Rd.

Nepean, Ontario, Canada K2H 9R0

Tel: 613-828-0199, Fax: 613-828-9288, email: [AEG@synapse.net](mailto:AEG@synapse.net)

# *ASSOCIATION OF EXPLORATION GEOCHEMISTS*

## **CODE OF ETHICS**



### *GENERAL PRINCIPLES*

1. Each member of The Association of Exploration Geochemists shall conduct his affairs in accordance with the highest standards of ethics, personal honor, scientific integrity, and professional conduct. The word “member” as used throughout this Code of Ethics shall refer to members of any class of membership in The Association of Exploration Geochemists.
2. Each member shall be held to a duty of honesty, integrity, loyalty, fairness, impartiality, candor, fidelity to trust, and inviolability of confidence.

### *DUTIES OF MEMBERS TO THE PUBLIC*

3. A member shall avoid and discourage sensational, exaggerated, and unwarranted statement with regard to professional matters that might induce participation in unsound enterprises.
4. A member shall not knowingly permit the publication of reports or maps he has prepared for any unsound, illegitimate, or illegal undertaking.
5. A member shall not give a professional opinion, make a report, or give legal testimony without being as thoroughly informed as might reasonably be expected given the purpose for which the opinion, report, or testimony is desired. In giving or making such an opinion, report, or testimony, a member shall disclose the extent to which such opinion, report or testimony is based upon incomplete knowledge or information.
6. A member may publish dignified business, professional or announcement cards, but shall not advertise his work or accomplishments in a self-laudatory or unduly conspicuous manner.
7. A member shall not issue a false statement or false information even though directed to do so by an employer or client.
8. No member may use his membership in the Association to promote his commercial interests, except that Fellows and Honorary Members may list their category of membership on stationery, business cards, and professional notices in accord with Section 2.12.
9. A member shall protect, to the fullest extent possible, the interest of his employers or clients so far as is consistent with the public welfare and his professional obligations and ethics.
10. A member who finds that his obligations to his employer or client conflict with his professional obligations or ethics shall either remove such conflict of duties or withdraw his professional services from such employer or client.
11. It is the duty of a member who has any interest, whether direct or indirect, which may conflict with the interests

of an employer or client to disclose the existence of the interest to such employer or client.

12. A member shall not use, whether directly or indirectly, any confidential information of an employer or client which is in any way competitive, adverse, or detrimental to the interest of such employer or client.
13. A member retained by one client shall not accept, without that client’s written consent, an engagement by another client if the interests of the two clients in any way conflict.
14. A member who has obtained by secret information during the course of this work for any employer or client shall not seek to make a personal profit from such information unless permission in writing to do so is granted by such employer or client, or until it is clear that the use of such information by the member shall not prejudice the employer or client in any way.
15. A member shall not divulge information given to him in confidence.
16. A member shall engage, or advise his employer or client to engage, and cooperate with other experts and specialists whenever the employer’s or client’s interests would be best served by engaging and cooperating with such experts and specialists.
17. A member shall not accept a concealed fee or secret commission for referring a client or employer to a specialist or for recommending geochemical services other than his own.

### *DUTIES OF MEMBERS TO EACH OTHER*

18. A member shall not falsely or maliciously attempt to injure the reputation or business of another member.
19. A member shall not state as his own knowledge or belief information which he has obtained from another member and shall freely attribute other members as the source of such knowledge or belief.
20. A member shall endeavor to cooperate with other exploration geochemists in the study and dissemination of exploration geochemistry.

### *DUTIES OF MEMBERS TO THE ASSOCIATION*

21. A member shall endeavor to ensure that candidates for membership are fit and proper persons to be elected members.
22. It shall be the duty of every member not only to uphold the standards of this Code of Ethics in precept and by example, but also, where necessary, to encourage by counsel and advice to other members, their adherence to such standards.

## Association of Exploration Geochemists APPLICATION FOR MEMBERSHIP\*



Please complete only the relevant section for membership. See below for mailing instructions.

I, \_\_\_\_\_, wish to apply for election as a \_\_\_Member / \_\_\_Student Member of the Association of Exploration Geochemists. I have read the Code of Ethics of the Association and in the event of being elected a Member/ Student Member agree to honour and abide by them.

**MEMBER:** *State Employer and Employee title*

I am actively engaged in scientific or technological work related to geochemical exploration and have been so for the past two years.

\_\_\_\_\_ as a \_\_\_\_\_  
 (employer) (employment title)

**STUDENT MEMBER:** *Student status must be verified by a Professor of your institution or a Fellow of the AEG*

I certify that the applicant is a full-time student at \_\_\_\_\_ in pure or applied science.  
 (institution)

\_\_\_\_\_  
 (Professor/ AEG Fellow Signature ) (Printed Name and Title)

Witness my hand this \_\_\_\_\_ day of \_\_\_\_\_, 20\_\_\_\_\_. \_\_\_\_\_  
 (Signature of applicant)

**NAME AND ADDRESS:** PLEASE PRINT (to be completed by applicant)

Name: \_\_\_\_\_ Telephone bus: \_\_\_\_\_  
 Address: \_\_\_\_\_ fax: \_\_\_\_\_  
 \_\_\_\_\_ home: \_\_\_\_\_  
 \_\_\_\_\_ e-mail: \_\_\_\_\_

**Annual Dues :**

All applications must be accompanied by annual dues. All payments must be in US funds. Select one of the four listed below.

- |   |  |      |              |       |
|---|--|------|--------------|-------|
| 1 | 2003 member dues   | US\$ | 70           | _____ |
| 2 | 2003 student member dues                                       |      | 40           | _____ |
| - | If receipt required, include a self-addressed envelope and add |      | 2            | _____ |
| - | If your check is not drawn from a U.S.A. or Canadian bank, add |      | 15           | _____ |
|   |  |      | <b>TOTAL</b> | _____ |

Payment by check, International Money Order, UNESCO Coupons, International Postal Orders, VISA, American Express and Master Card are acceptable. For credit cards users, minor variations in your billing may reflect currency exchange rate fluctuations at time of bank transaction.

Type: VISA \_\_\_ American Express \_\_\_ Master Card \_\_\_ Credit card account number: \_\_\_\_\_  
 Expiry date: \_\_\_\_\_ Name: \_\_\_\_\_ Signature: \_\_\_\_\_

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

**Please note:** Your application form 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 AEG 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, Ottawa, Ontario, CANADA K2H 9R0**  
 TEL: (613) 828-0199, FAX: (613) 828-9288, email: aeg@synapse.net WEBSITE: <http://www.aeg.org>



# 21<sup>ST</sup> INTERNATIONAL GEOCHEMICAL EXPLORATION SYMPOSIUM (IGES) — DUBLIN 2003

*University College Dublin*

*29<sup>th</sup> August to 3<sup>rd</sup> September, 2003*

<http://www.conferencepartners.ie/igesandnams2003>

## Technical Programme

A comprehensive technical programme has been developed both from invited speakers and from papers submitted to the organisers.

## Special Keynote address: Ross Large

## Thematic Sessions

*The Future of Geochemistry; Geochemistry in Mine Site Rehabilitation*  
*Environmental Geochemistry; Geochemical Exploration in Areas of Previous Mining;*  
*Irish Experiences; Exploration in Glaciated Terrains;*  
*Indicator Minerals in Exploration*  
*Isotope Geochemistry; Hydrogeochemistry;*  
*Biogeochemistry; Lithogeochemistry*  
*Geochemical Data processing and Presentation; Multi-Element Geochemistry*

## Speakers include:

John Armstrong, Stu Averill, Rob Bowell, Adrian Boyce, Mike Cambridge, Qiuming Cheng, David Cohen, Bill Coker, Mary E. Doherty, Colin Dunn, Dick Glanzman, David Gray, Eric Grunsky, Brian Gulson, Gwendy Hall, Phoebe Hauff, Jeff Jaacks, Robert Jackson, Ross Large, Ken Lawrie, Beth McClenaghan, Charles Moon, Paul Morris, Clemens Reimann, Clark Smith, Clifford Stanley, Agnete Steinfeld, Katie Walton-Day

## Posters

A full poster session is available. Submissions for poster presentation are still being received.

## Field Trips

Three field trips are being offered.

***The carbonate hosted base metal deposits of Ireland***  
***Rehabilitation of Irish mine sites***  
***Iberian Pyrite Belt***

## Short Courses

Eight short courses plus a ninth course associated with NAMS (see below) are being offered.

***Exploration for Hidden Deposits Using Geochemistry***  
***Metallogenic Modelling as a Basis for Geochemical Exploration***  
***Hydrothermal Geochemistry***  
***The Role of Geochemistry in Mine Closure***  
***Modern Methods in Processing Geochemical Data***  
***Hyperspectral Imagery Applied to Mineral Exploration***  
***Introduction to Hydrogeochemistry***  
***Quality Control in Geochemical Databases***  
***The Use of GIS in Mineral Potential Mapping***

## Trade exhibition

The following will be exhibiting at the Symposium: ACME Laboratories, Activation Laboratories, ALS Chemex, Genanalysis, Geosoft, OMAC Laboratories, SGS Minerals / XRAL, Exploration and Mining Division, Geological Survey of Ireland, Geological Survey of Newfoundland and Labrador, Geological Survey of Northern Ireland.

If you are interested in exhibiting please contact Conference Partners.

## Social Programme

A comprehensive social programme has been arranged for delegates where they can enjoy the hospitality for which we are famous. An accompanying persons programme has also been arranged.

## Sponsors

Our Gold Sponsors are: **AngloAmerican and Geosoft.**  
Our Silver Sponsors are: **ACME Laboratories, ALS Chemex, Genanalysis, OMAC Laboratories, and SGS Minerals / XRAL.**  
Other sponsorship opportunities exist – please contact Conference Partners for further information.

## Contacts

For any information relating to the Symposium or accommodation please contact Nicola Meenan at Conference Partners (Tel. +353 1 667 7188; fax +353 1 664 3701, or by e-mail [nmeenan@conferencepartners.ie](mailto:nmeenan@conferencepartners.ie)). The conference website is: **[www.conferencepartners.ie/igesandnams2003](http://www.conferencepartners.ie/igesandnams2003)**

## North Atlantic Minerals Symposium (NAMS)

At the same time as IGES the 3<sup>rd</sup> North Atlantic Minerals Symposium will take place, also at University College, Dublin. NAMS is an outcome of the signing of a Memorandum of Understanding between the government of Ireland and the government of Newfoundland and Labrador. The Memorandum aims to support the many ties between the two, while NAMS focuses on drawing attention to the considerable mineral development opportunities that exist on both sides of the Atlantic. NAMS seeks to identify the major issues facing the industry today and will provide a forum where many of these will be discussed during the meeting.

## Registration

You may register on line, by post or fax. The registration form is available from the website ([www.conferencepartners.ie/igesandnams2003](http://www.conferencepartners.ie/igesandnams2003)). The registration fees are as follows:

	<b>Early Rate</b>	<b>Late Rate</b>
IGES Member	<b>€445.00</b>	<b>€520.00</b>
IGES Non-member	<b>€545.00</b>	<b>€620.00</b>
IGES Student	<b>€150.00</b>	<b>€150.00</b>
NAMS	<b>€395.00</b>	<b>€470.00</b>
NAMS Student	<b>€150.00</b>	<b>€150.00</b>
Accompanying Person	<b>€ 99.00</b>	<b>€ 99.00</b>

# EXPLORE

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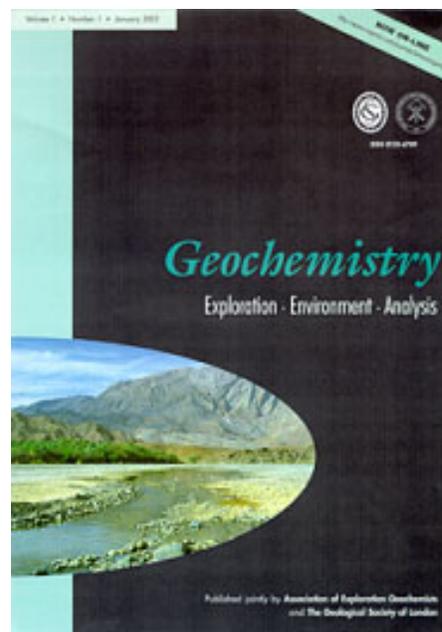
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