Measuring Exploration Success: An Alternative to the Discovery-Cost-Per-Ounce Method of Quantifying Exploration Effectiveness

ABSTRACT

Research is underway to develop a range of methods for assessing and managing exploration risk, progress, and value. As part of the research, a collaborative project was undertaken by SRK Consulting, working with Placer Granny Smith (the operating company of the Granny Smith Joint Venture owned by Placer Dome Asia Pacific, 60%, and Delta Gold, 40%) and Placer Dome Asia Pacific, to review and quantify exploration success in a mature program that has delivered several mines. In particular, an objective was to develop a measurement technique that is more commercially robust and informative than the traditional “cost per resource ounce discovered” method.

The project reviewed gold exploration over the past 13 years in the Laverton district of Western Australia. Placer Granny Smith has spent AUD$52 million (about US$30 million at recent exchange rates) defining 12 deposits with combined resources of more than 10 Moz (310 tonnes) of gold. Exploration centered on the Archean Granny Smith gold deposit, and was primarily targeted at outlining additional resources to feed through the Granny Smith mill. At an overall cost per ounce of less than US$5, this has clearly been a successful program. However, our analysis demonstrates that this figure fails to provide a complete value picture, and that the program could have delivered even greater value to the participating companies.

While the quantitative results of the review are specific to the Laverton district, the methodology can be applied to near-mine, advanced, and grassroots exploration programs for any deposit style in any geologic environment. Key outcomes of the review are as follows:

- Measuring exploration success in terms of the net present value of the deposit outlined produces a markedly different and arguably more commercially realistic outcome than measuring it in relation to the average cost of resources defined.
- Early recognition and prompt drill testing of key targets is critical in optimizing opportunities and realizing exploration value. Indeed, the principal destroyer of value in exploration is spending too much time and money prior to drill testing the best targets in any area.
- Continuous and robust ranking of exploration targets should be undertaken. Exploration should aim to rapidly identify and systematically test the best exploration targets, rather than systematically exploring the project areas.

Especially in the current climate of a depressed resources sector, the exploration industry needs to compete aggressively for the investor’s dollar. The industry needs more robust and quantitative methodologies for measuring exploration effectiveness, and for informing management, investors, and shareholders of exploration risk, reward, value, and progress to discovery. The probabilistic methods described below provide such a framework.
This will be the first issue of the Newsletter that will not enjoy the scrutiny of the former Executive Editor, John Thoms. John will be focusing on his new responsibilities as a Trustee of the SEG Foundation as well as on his continuing job as Business Manager for PUBCO. This is, therefore, a time of transition and I will be relying on the combined experience of Lisa Laird (Production Director), Alice Bouley (News Editor), and Noel White (Technical Editor) to maintain the high standard set by John. We plan to make some changes in the way the Newsletter is produced and presented, but also aim at preserving the main features of what is clearly one of the most important benefits to members of SEG. In particular, the staff will be working more closely with Sue Courtney (Membership Services Administrator) in order to produce an online version of the Newsletter that will be delayed by one issue but accessible to nonmembers. Some items can be better presented on the SEG website, and we will strive to more closely integrate these two publication media. The large number of events related to economic geology, for example, can be tracked in a more timely way on the continuously changing website than in the quarterly Newsletter. Other possibilities include detailed descriptions of research projects, additional illustrative materials, and news that must be communicated to the membership within a short timeframe. We will use e-mail to selectively highlight some of these changes, so members who have signed up on the SEG listserv (see announcement this page) will have a decided advantage in remaining current on events relevant to SEG.

Lastly, I would like to encourage members to write to me in response to these changes or any of the opinions expressed within the pages of the Newsletter. This will allow us to create a “Letters to the Editor” page that provides a forum for healthy debate on issues that are relevant to all of us in SEG. I look forward to hearing from readers and thank you in advance for your contributions.

Current contact information for all members is now listed in the Directory section on our website at www.segweb.org. Frequently members will update their mailing address but not phone, fax and e-mail information. We would encourage all members to check their current listing on the web and contact us with updated information at <membership@segweb.org>.

In an effort to keep members informed of current and upcoming events, the Society would like to use e-mail messages to supplement information in the SEG Newsletter and on the website. If you are interested in this new message service, submit your request by e-mail as follows:
Contents

FEATURE ARTICLE
1. Measuring Exploration Success: An Alternative to the Discovery-Cost-Per-Ounce Method of Quantifying Exploration Effectiveness

NEWSLETTER COLUMNS
2. From the Executive Editor
4. Presidential Perspective: Synergies between the Exploration Industry and Universities—Their Importance for the Future
5. From the Treasurer: 2000—SEG Group Rolls into New Millennium on Fast Track
6. SEG Report: Growth of Student Activities Supported by Foundation
7. SEG Canada Foundation Formed
8. Contributions to SEG and SEG Foundation

SEG NEWS
17. SEG Council Actions
18. Contributions to Global Exploration 2002 Conference
20. Regional Vice President Report: The State of Economic Geology Education in Asia (Japan, China, Philippines): A General Perspective
22. SEG International Exchange Lecturer Report—Mark D. Barton
24. SEG Luncheon and Awards Ceremony
26. Student Chapter News

EXPLORATION REVIEWS
27. Alaska
28. Western Canada
30. Western United States
32. Mexico
33. Asia
48. Oceania

MEMBERSHIP
37. SEG Membership: Candidates and New Fellows, Members and Student Members
48. Personal Notes & News
50. SEG Membership Application Form

ANNOUNCEMENTS
2. SEG Contact Information
2. Current Contact Information for SEG Members on Website
5. Join the SEG® Booster Club
43. 2001 Gordon Research Conference: Inorganic Geochemistry—Formation, Modification and Preservation of Ore Deposits
41. Ore Deposits Mapping Course—Arequipa, Peru
42. XX Curso Internacional de Postgrado en Metallogenia
42. Ore Deposits Mapping Course—Silver Bell
43. Suecofomarian Ore-Forming Environments Field Trip
44. Epithermal Gold Mineralization and Modern Analogues, Kyushu, Japan
44. SEG-GSA Annual Meeting
46. VII Argentine Congress of Economic Geology

PUBLICATIONS
47. Reviews in Economic Geology Vol. 14: Structural Controls on Ore Genesis
47. “Pima Mine Story” Now Available
47. Publications of Interest
51. Publications Order Form

CALENDAR
49. Activation Laboratories, Ltd.
28. Anman, Joseph A.
30. Baldocchi, Colada, Inc.
32. Barranca Resources
39. Canadian American
30. Cox, Dennis P.
35. Eriksson, A.J.
9. Exploration and Mining Geology
32. Fuchs, William A.
33. Geocorn, Inc.
49. James GeoAssociates P.C.
39. Lamkin, Lawrence T., Ph.D.
40. Learning Curve
46. Mining Activity Update
36. Mining/Pra Files
33. Montgomery & Associates
35. Pratt, Gerald M.
46. Petrographic Consultants International
34. Phelps Dodge
40. Pincock, Allen & Holt
34. Pottok, Roger
49. Resverano del Caribe S.A.
9. Resources Geosciences of Mexico
9. Sable Consulting
5. Sinclair Knight Merz
18. SPAR
9. YXK Exploration Company
39. Zonge Engineering & Research
Synergies between the Exploration Industry and Universities: Their Importance for the Future

Before discussing the topic above, I would like to introduce myself as SEG President for 2001-2002, the first President from the Southern Hemisphere in the history of the SEG. I am Professor of Economic Geology and Director of the Centre for Global Metallogeny in the Department of Geology and Geophysics at the University of Western Australia. I am not the David Groves from Newfoundland!

I have prior experience in presiding over a geological society through my role as President of the Geological Society of Australia (the GSA!), and prior experience at SEG as a Regional VP and Vice-President. I intend to be a pragmatic President, looking at issues such as membership and budget and the delivery of a more globally relevant scientific program and other products to our customers — you, the Fellows and Members of SEG. I hope to preside over an integrated team such as that which has existed between the Presidents (Past, Present and Elect), Vice-presidents (Past, Present and Elect) and Executive Director for the past three years of my experience, and which is leading to major improvements to programs and the way SEG does business.

In terms of our mining and exploration industries, we live in unprecedented times of globalization of exploration, increasingly numerous company takeovers of medium-sized companies, and the disappearance of many of the active smaller companies. These changes are due to factors such as a cyclical decline in metal prices, particularly gold, a corresponding lack of confidence in the so-called "old economies" and the resulting inability to raise capital for exploration. All of these factors seem to be leading to a major decline in "greenfields" exploration, worldwide, with greater emphasis on near-mine exploration and development. If Australia is typical of the trend, there has also been a major decrease in the size of research teams and technical support groups within at least some of the major companies. As pointed out by McGuig and Hronsky (Reviews in Economic Geology, 2000, v. 15, p. 553-559), these events provide opportunities for consultants, government agencies and universities to fill the research and technical support role. This is certainly true, but I see dangers for the future of exploration in such sweeping economic rationalization by the industry.

First, a number of recent analyses of the exploration industry have shown that the discovery rate for world-class to giant mineral deposits has declined in the last decade, despite increased exploration expenditure. Most economic geologists agree that any new major discoveries will be under cover, in either "brownfields" or "greenfields" areas, and that the recent lack of major discoveries is at least in part a function of imperfect knowledge of mineral systems and the inability of current technologies to unequivocally penetrate cover. Thus, it follows that future exploration success is at least partially tied to the success of current research, and importantly, the training of a new generation of highly skilled geoscientists who are brought up in a modern, digital world and have been intimately involved in development of the exploration concepts of the future.

This is where the synergy between mining and exploration companies and universities becomes particularly important, because it is these institutions that will provide the highly skilled geoscientists that the industry will need in order to discover the new generation of world-class deposits. These institutions, in turn, will increasingly need to draw on the expertise of consultants and government scientists through collaborative arrangements.

Herein lies a major potential problem. At the same time that economic rationalization is changing the face of the industry, governments that fund universities are also practicing economic rationalization, such that a "bums on seats" philosophy is widespread. However, at the same time, the number of geoscience students (i.e., relevant "bums") is declining as a result of changing perceptions of the industry in mature, environmentally aware societies in which mining is a relatively small proportion of GDP and the cyclical downturn in the fortunes of the resource sector where mining is still a major component of GDP. In some cases this downturn in student numbers can be exacerbated by decreasing support — owing to the economic rationalization — for employees who seek company funding to enroll in degree courses (e.g., MSc by course work).

Worrying symptoms of this downturn include the increasing numbers of non-replacements or junior replacements as some of the "giants" of economic geology in North America retire, and the increasing threat of closure of some departments that teach economic geology even in resource-rich countries. Even strong concentrations of researchers in economic geology centers (now arguably only nine of these worldwide) are under threat because they require external infrastructure support to maintain the critical mass to carry out team research and training. In many cases, this is provided, at least in part, by industry, both directly and indirectly through sponsorships or corporate memberships, and indirectly through support for students and student projects. Decline in this type of support because of economic rationalization in the industry, although it may seem expedient in the short term as budgets are cut, could have serious implications for the long-term survival of the individuals or groups that rely on
this infrastructure to survive. These are the geoscientists who will not only be involved in critical research, but who also will train the new generation of multiskilled exploration geologists to ensure the future of the industry. Importantly, SEG and SEG Foundation recognize the relevance of student training for the future of the industry through support of SEG student chapters and other initiatives.

To me, it is very clear that there is a need for continuing dialogue between the mining industry and universities, such that they clearly understand each other’s perspectives in these critical times. As McGuigg and Hronskey indicate, there is a need for universities to focus more on research that is directly relevant to the industry. At the same time, universities cannot lose sight of their fundamental research role, which can have longer term, commonly unpredictable, benefits, and is a fundamental requirement of students’ postgraduate work. Similarly, there is a need for industry to better understand the constraints that university researchers and teachers work within, and the fact that a relatively small amount of unified funds can ensure the survival of groups that are a critical and integral part of the development of the new generation of exploration geologists. The synergy between industry and universities must be preserved.

I stress that this is a personal view. It is likely that an ad hoc SEG committee will be formed in the near future to look at trends in the mining and exploration industry and the impact on research and training. The future of the industry depends on understanding where industry is going and the impact of current trends on the various components that, if preserved, can combine to ensure a brighter future.100

FROM THE TREASURER

2000—SEG Group Rolls into New Millennium on Fast Track

SEG, the SEG Foundation, and PUBCO continue to set new records on income and spending as they enter the new millennium. All three continue in sound financial condition. Operations continue to improve and expand, with direct spending on programs and publications attaining a record $1.3 million. The Finance Committee provided $737,000 in dividends, interest, and capital gains to assure that all three organizations finished the year ahead of budget and in the black (see footnote).

<table>
<thead>
<tr>
<th>Year End Results</th>
<th>SEG</th>
<th>SEG Foundation</th>
<th>PUBCO</th>
<th>Building Operating Expenses</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Revenues</td>
<td>508</td>
<td>519</td>
<td>515</td>
<td>1,065</td>
<td>643</td>
</tr>
<tr>
<td>Administration 1</td>
<td>496</td>
<td>372</td>
<td>57</td>
<td>45</td>
<td>240</td>
</tr>
<tr>
<td>Programs/Projects</td>
<td>125</td>
<td>124</td>
<td>120</td>
<td>188</td>
<td>349</td>
</tr>
<tr>
<td>Surplus/(Deficit)</td>
<td>153</td>
<td>23</td>
<td>138</td>
<td>1,382</td>
<td>44</td>
</tr>
</tbody>
</table>

1 Yr 2000 SEG Account does not reflect post-year-end transfer of $68,334 to restructure building operating expenses.

Allowing for the footnoted post-year-end cash adjustment, which includes $1,988 in interest income, the Society finished the year in the black (building expenses are paid by SEG but reimbursed from the Building Fund). In December, the Anonymous Donor made an additional gift of $203,000 such that, at year end, SEG was housed in its $3.6 million headquarters building, backed with an enviable Maintenance/Replacement fund of $1.8 million prior to pay for the operation and repair of the structure.

Foundation’s program spending and revenue growth continue to outpace expenses. Program spending increased to a record $313,000, plus a $64,000 grant was made to the Hickok-Radford Fund. Investment income exceeded $100,000 for a second year. SEGF received the final bequest from the McKinstry Fund—$51,000—and a further $15,000 in other contributions to finish the year with a surplus of $138,000.

PUBCO had a good year, finishing with a surplus of $44,000; Administration came in below budget, and investment income and capital gains more than offset increased publishing costs. PUBCO’s investment income also exceeded $100,000 for the second year in a row.

Assets are down by a total of $1 million due to unrealized losses in the portfolio, a decline of 6.2% across the Group, but we feel this compares favorably to the S&P 500 loss of 9.1% because of the Group’s strong cash and fixed income positions.

<table>
<thead>
<tr>
<th>Year End Financial Asset Values</th>
<th>SEG</th>
<th>SEG Foundation</th>
<th>PUBCO</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>General Funds</td>
<td>1,531</td>
<td>1,823</td>
<td>2,698</td>
<td>3,386</td>
</tr>
<tr>
<td>Restricted Funds</td>
<td>1,917</td>
<td>2,202</td>
<td>1,787</td>
<td>1,666</td>
</tr>
<tr>
<td>Total Funds</td>
<td>3,448</td>
<td>4,025</td>
<td>4,485</td>
<td>5,052</td>
</tr>
<tr>
<td>HQ Building</td>
<td>3,602</td>
<td>3,093</td>
<td>0</td>
<td>3,502</td>
</tr>
<tr>
<td>Total Assets</td>
<td>6,950</td>
<td>7,120</td>
<td>4,485</td>
<td>14,555</td>
</tr>
<tr>
<td></td>
<td>10.19</td>
<td>11.95</td>
<td>12.01</td>
<td></td>
</tr>
</tbody>
</table>

The outlook for 2001 is bright. The combined budgets for direct program and publishing expenses by SEG, SEGF, and PUBCO are $1.25 million. The Finance Committee is gearing up to provide another $700,000 in investment income so that budgeted programs and expenses will finish in the black, and with such strong support, the SEG enters its seventh year without asking for a dues increase.100
Growth of Student Activities Supported by Foundation

As new president of the SEG Foundation, I’d like to use space in this first Newsletter column to reflect on the growth and changing demographics of SEG membership that are producing a rapidly evolving and daunting demand on the Foundation’s financial resources. In spite of a depressed mineral industry, membership in SEG has grown from 2,082 in 1992 to 3,500 at the end of 2000, an increase of 41 percent in eight years. Much of this growth has been achieved by addition of new members outside North America, and this is increasing the demand for SEG services and activities throughout the world. Currently, about two-thirds of our members are from industry and about half of these are “self-employed,” a change that creates demand for new and varied member services, particularly in Latin America—the region of greatest membership growth. For example, more lectures, field trips, and workshops focused on applied topics—some in Spanish—were presented in 2000 than in any previous year.

Student membership of the Society has grown from about 115 in 1996 to 314 at the end of 2000, a 174 percent increase in four years. Further, student interest in the Society and its programs has produced a great increase in the number of SEG Student Chapters—presently at 31, up from 12 in 1996. Eleven are at Canadian universities, and others are at schools in the United States, Europe, Australia, and South Africa. For $10 per year, student members receive all benefits of a regular SEG membership.

Financial support from the Foundation for student programs has greatly increased—an investment in the future of our profession. The cost of providing membership benefits to students, presently at a total of $10,500 per year, is subsidized by the Foundation. SEG Student Research Grants have increased from a total of $7,000 awarded to six recipients in 1999, to a total of $88,800 awarded to 57 recipients in 2000. The Foundation also provides funds to support student-organized field trips to mines and ore districts. These field trip grants have grown from $4,000 in 1999 to a total of $20,000 in 2000. The success of the student research grants program, coupled with the dramatic increase in the number of SEG Student Chapters and corresponding increase in student membership, will require even more funding in the future.

Although many of the Society’s programs are organized and administered by volunteers, magnitude and logistics of the ever-increasing work load require that some tasks be assumed by staff at SEG Headquarters. Last year, the Foundation provided $312,550 for Society programs, and $56,881 (18.2%) of this amount was spent to cover costs of salaries, supplies, and other general expenses of organizing and running programs. These General and Administrative expenses for the last four years were lower, on average, than for any year prior to 1995. So, while our program support has been increasing, our G & A expenses have remained at less than 20 percent of total funding support for SEG programs.

The SEG Foundation was founded in 1966 and by 1997, 31 years later, SEG had contributed a total of $1 million to fund Society programs and activities. The second million level in funding provided to SEG will be reached in 2001, only four years later. SEG members can be proud of their Foundation.

This year I plan to provide each SEG member with news about the growing activities and financial needs of the Society. A “newsletter” was sent to each member in March and another will be sent in November.

As a final note, members should be aware that increasing needs and complexity of the Society’s programs and activities cannot possibly be financed by dues alone. Rapid growth of Foundation’s financial resources in the past eight years has been realized, in about equal amounts, by contributions, both large and small, and by the increase in value of the Foundation’s investment portfolio. Members and friends of the Society are encouraged to participate in growth of the Foundation’s financial resources so that existing Society programs can be sustained and that other new and worthwhile programs to meet needs of our growing membership can be initiated.

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Join The SEG Foundation’s Booster Club Today!

Simply pledge US$200 (or more) per year for five consecutive years and become a key supporter of SEG’s worldwide programs and activities. In 2000, the Foundation provided almost $250,000 in funding for:

- Grants to graduate students for field-based research in economic geology, student chapter field trips and other student activities — $119,400
- Continuing professional education through short courses, workshops, symposia, lecture series (4), and technical publications — $77,100
- Regional Vice President programs and activities — $20,600
- K-12 and public educational programs — $30,500
- Your support is vital to sustain not only these programs but also SEG’s growing efforts to provide critical services, particularly in the field of continuing professional education, that will benefit you and the entire membership. Please send your check or credit card authorization to:

The SEG Foundation
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Tel: +1.720.981.7882, Fax +1.720.981.7874
e-mail <development@segweb.org>
Society of Economic Geologists Canada Foundation Formed

There is now an all-Canadian version of the very successful SEG Foundation. In its 35-year history, the SEG Foundation has raised over $2.2 million and contributed more than $2 million to support SEG programs and activities, including significant support for students and SEG Student Chapters at Canadian universities. However, contributions by Canadians to the SEG Foundation are not tax deductible. Thanks to the efforts of SEG Treasurer Tom Loucks, a Canadian version of the Foundation, the SEG Canada Foundation, has been incorporated and has just received charitable status from the federal government. The new Board of Directors includes John Ashton, Gerry Carlson, Alex Davidson, Jim Franklin, Brian Houl, Tom Loucks, Ted Reeve, and, as of April 1, 2001, incoming SEG President David Graves.

The SEG Canada Foundation will solicit funds on a tax-deductible basis, which will be used to support education and research in the science of economic geology and to promote public education regarding Canada’s geology and its mineral-based resources. The ultimate goal of the Foundation is to support a broad range of activities that will enhance the qualifications of Canadian geoscientists, improve the quality of professional geoscience work, and underpin research with respect to all aspects of economic geology. Initially, the core activity of the Foundation is financial support of university student research projects and SEG Student Chapter field trips and other activities. Modeled after the SEG Foundation, SEGCF will use a similar format for reviewing grant applications and recommending disbursements to the SEG Canada Foundation board. The board is actively soliciting donations and hopes to support some of the Canadian student research grant applications already received for 2001.

Canadian SEG members have received a letter from SEG President Nielsen with an invitation to become charter donors to SEG Canada Foundation. Please be generous in your support of the education and training of Canada’s next generation of economic geologists.
Discussions on Professional Ethics

Honesty in Science: An Exception to the General Rule

DAVID M. ABBOTT, JR., (SEG 1983)
CONSULTING GEOLOGIST, 2205 FORGET STREET, DENVER, CO 80207, DAMGEO@AOL.COM

The discussions on honesty in science in the SEG Newsletter, nos. 41 and 42, pointed out that dishonesty is among the worst ethical violations a geoscientist can commit. However, experience shows that judging ethical actions involves the art of discrimination between situations. Sampling practice provides a specific case in point.

In mineral exploration, standard samples (samples whose mineral content is known), blanks (samples known to have no value), and duplicate samples are routinely inserted into groups of samples submitted for preparation and analysis in order to check the accuracy of the preparation and analytical procedures. These added samples are coded like the regular samples in order to ensure that they are treated no differently during the analytical processes. Also, the sequence of sample numbers may be randomized so that the analytical lab will be unaware in the order in which samples were collected. Such procedures necessarily involve concealing information from the lab and misleading the lab regarding the source of the samples.

The fact that the insertion of standards, blanks, and duplicates in a sample stream could be viewed as lying or deceiving was brought to my attention by the owner of a property who objected to the practice when he learned of it in a report on his property. The property owner complained that the dishonesty was revealed in the report on sampling in the section where the inclusion of samples not taken from his property (the blanks) was discussed. Why, this property owner wondered, should he be billed for the analysis of such samples? Wasn't the geologist acting unethical?

Answering the property owner's questions in order: first, apparently the reasons for the insertion of the blanks, duplicates, and standards (to the extent used) were not adequately explained. This a professional practice question. Clients need to know why various procedures are necessary and in their best interests. The extra cost to the client of analyzing the additional samples is justified by the data on the reliability of the analytical process (which includes sample preparation).

Second, the property owner is correct that the insertion of standards, blanks, and duplicates labeled as if they were part of the regular sample stream can be viewed as a form of deception. But this case of deception is ethically allowed for the following reasons (those interested in a thorough discussion of the justifications for exceptions to moral or ethical rules should refer to Bernard Gert, 1986, Morality: Its Nature and Justification, Oxford University Press, chapter 10):

- No one is harmed by the deception in sample labeling. Such labeling in no way affects the preparation and analytical procedures the lab performs.
- The purpose of inserting these “extra” samples is quality assurance and quality control, a very worthwhile objective. Indeed, it is common for labs to perform duplicate analyses of a routine percentage of samples as part of their own QA QC programs and to report the results to clients. If the variance between duplicates is too high, then the fact that a problem exists becomes clear and further tests can be run to identify the source of the problem. Sample analyses are only as good as their reliability and these procedures help quantify variability and thus reliability.
- This exception to the rule against deception is not restricted. Everyone submitting samples for analysis is allowed to insert standards, blanks, and duplicates.
- The use of standard, blank, and duplicate samples is reported. Although sample analysis results are not “public” in the sense that anyone may see them, the QA QC procedures should be described and made available to anyone with the right to look at the analytical data and, in that sense, they are “publicly” reported.

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SEG members may subscribe to EMG at the Special Affiliated Rate of $CDN 75.00/$US 55.00. Subscription forms are available from the EMG web site or by contacting CIM at 1210-3400 de Maisonneuve Blvd. W., Montreal, QC, Canada H3Z 3B8. Tel.: 1-514-939-2710; Fax: 1-514-939-2714; e-mail: publications@cim.org.
INTRODUCTION TO THE METHODOLOGY

A method to measure exploration risk, progress, and value

Mineral exploration is essentially an economic activity (Etheridge and Henley, 1997; Mackenzie, 1998; Singer and Kouda, 1999; Durcimet, 2000), and as such it must deliver tangible value to its investors. However, because of the long lead times for discovery, it is difficult to measure that value and report on progress at the more conventional business reporting time scales. This difference in value generation and reporting time scales is one of the fundamental barriers to effective strategic planning, management, and communication between the practitioners of exploration and their corporate managers and investors.

Researchers working in this field have developed a range of probabilistic risk assessment and management tools for mineral exploration, and these methods are being extended to the measurement and communication of exploration progress and value in a language that is much more commercial than technical. The underlying methodology is very similar to that which is commonplace in the petroleum exploration industry and in a number of other high-risk business endeavors.

The particular objectives of the study described here and undertaken with Iacer Granny Smith were as follows:

1. To use the extensive records of exploration programs, methods, models, and expenditure in the Iacer Granny Smith files to build a comprehensive case study of the relationships between exploration risk, progress, decision points, and value creation over a large, long-term, and successful program.
2. To compare the more and less successful projects within the overall exploration program, particularly to identify where alternative decision strategies and risk management practices may have influenced the value delivered to the stakeholders.
3. To analyze the relationships between expenditure, resource ounces discovered, and real commercial value delivered by the different projects and the program overall.

Estimating value at any stage of exploration

One aspect of our risk assessment methodology involves relating the probability of exploration success to the value of the target sought to estimate the technical value of an exploration project at any stage in its progress. The measure most commonly used to provide the target value is the Net Present Value (NPV) of the threshold resource that has to be delivered for a particular deposit style, region, etc. If exploration fails to deliver a deposit exceeding the company threshold NPV, then shareholder value will be destroyed and the business of exploration becomes un-economic.

There are many factors that contribute to the economic feasibility of a mine (e.g., metal prices, mining costs, metallurgical factors, permitting issues, proximity to existing infrastructure or mill). These are all embedded in the target NPV. Linking NPV's with typical deposit sizes in terms of tonnes, grade, and mining costs these represent is useful for the exploration geologist. This will differ considerably depending on the deposit style being sought and the exploration environment (near-mine versus grass-roots programs). However, in an attempt to relate profitability to exploration effectiveness, workers have determined that the preferred method links the deposit target value to exploration very simply, based on examination of the following criteria:

- Exploration stage or position of the prospect on the pathway to discovery and possible exploitation.
- Probability of Success or the likelihood that the prospect will advance to the next stage of exploration (P_3).
- Cost of advancing the prospect to the next exploration stage (C).
- Target Value, the company's corporate target range or threshold NPV's (TV).

In our approach, the Expected Value (EV) of an exploration prospect at any particular exploration stage is defined as the probability of the exploration project advancing to the next exploration stage times the target value, less the cost of advancing to the next stage. This is shown in the following formula (e.g., Mackenzie, 1998):

\[ EV = P_3 \times TV - C. \]

(Where EV = Expected Value; TV = Target Value; P_3 = Probability of advancing exploration project; and C = Cost of advancing exploration project)

This simple formula generates an expected value for each prospect at each of the main exploration stages, or decision points, by working back from the company's target value. The principal exploration stages are shown in Table 1.

Measuring exploration value for early stage exploration prospects

By incorporating the target value rather than the resource ounces, and knowing average exploration costs to advance exploration, it is possible to estimate an Expected Value at each exploration stage. The difficulty then becomes estimating the probability of success or likelihood that a prospect will advance to the next exploration stage.

The probability of success for very early phase exploration prospects is based on the elements of the geologic mineralization model present at the individual prospect area. This method uses a simple approach firmly based on the geologic process model, its critical success factors, and the application of Bayesian probabilistic analysis. This method requires:

- Building the underlying geologic process model:
- Identifying the critical success factors:
- Assigning probabilities to each factor.

The probability of the occurrence of a mineral deposit can be derived from the product of the relative probabilities of each of the critical success factors, assuming that probabilities of occurrence of each of the critical factors are independent:

\[ P = P_1 \times P_2 \times P_3 \times P_4 \ldots P_n \]

(Where P = probability of advancing exploration project and P_1, P_2, ..., P_n = probability of occurrence of each of the critical success factors of the geologic process model).

Iacer Granny Smith is currently evaluating this method to rank its early phase exploration prospects. Application of the Bayesian methodology to the project area is generally demonstrated below:

- The geologic process model for mineralization is established: This involves identification of the critical processes without which a deposit would not have formed. In general, the following terms apply: P_1 represents the probability of occurrence of a source of
Table 1. Definition of exploration stages

<table>
<thead>
<tr>
<th>Stage</th>
<th>Description</th>
<th>Goals</th>
</tr>
</thead>
</table>
| Stage A. Ground acquisition (project generation) | | To build an expert team for the belt/region  
To have knowledge, knowledge management and data/information availability for the belt  
To select and acquire ground in well endowed belts, considering availability, political/environmental risks |
| Stage B. Prospect definition (reconnaissance exploration) | | To define drillable targets (often via geological, geophysical surveying)  
To build area knowledge, quality data management systems, suitable geologic models  
To use efficient exploration methods, geologic skills of exploration team  
To define prospect risks and target ranking tools, exploration audit process  
To test presence of mineralizing system |
| Stage C. Drill testing (systematic RC, DD) | | To test geologic and mineralization models, interpreted from mapping and geochemical sampling  
To test geologic information gathered during prospect definition  
To test presence of mineralizing system to the stage of indication of sufficient continuity and grade as to indicate potential for an economic resource |
| Stage D. Resource delineation | | To have confidence in size and grade potential, continuity of grade and geologic setting  
To understand controls on grade distribution (low cost curve position) |
| Stage E. Feasibility | | To determine metallurgy, metal prices, mineability, cost, prices, mineral balance sheet  
To result in decision to mine, asset with defined NPV |

Probabilities/risks associated with progressing from Stage A to Stage B, i.e., P(A→B)
Probability that the process of Ground Acquisition (A) will result in the acquisition of high quality, well endowed and available ground that is worthy of further work

Probabilities/risks associated with progressing from Stage B to Stage C, i.e., P(B→C)
Probability that this process will define drillable targets (features that meet criteria of the geologic model and knowledge of the area)

Probabilities/risks associated with progressing from Stage C to Stage D, i.e., P(C→D)
Probability that the drill testing phase will result in one or more "economic drill intersections" that would be further drill tested. The decision to continue would be supported by other geologic information that would give some initial confidence in the continuity of mineralization

Probabilities/risks associated with progressing from Stage D to Stage E, i.e., P(D→E)
Probability that a "drill-out" will result in the definition of a preliminary resource that is sufficiently robust at present prices to warrant proceeding to feasibility

Probabilities/risks associated with progressing from Stage E to target NPV
Probability that the feasibility study will deliver an ore reserve

mineralizing fluid. Pz relates to the presence of structure of right age to provide fluid conduit to the site of deposition. Pz refers to the structural or physical components of the site of mineralization — structural trap site or area of dilatation, and finally, Pz corresponds to the chemical processes that ensured efficient metal precipitation or deposition at the trap site.

- For each of these factors of the geologic process model, a value between 1.0 and 0.0 is assigned. A value of 1.0 indicates that the process component definitely operated at the required level, and 0.0 indicates that it definitely did not operate. A value of 0.5 is assigned where information about the factor is not known or data are not available. Therefore a relative probability >0.5 indicates that there is a degree of evidence that the factor is present, whereas a relative probability <0.5 indicates that there is a degree of evidence that the process component did not operate.
- Each exploration project is carefully reviewed in relation to the geologic process model for the target or region. Relative probabilities are assigned to each factor for each project. For example, for Pz, a favorable trap site might be that the prospect is located in an area with rock types of high rheology contrast (e.g., 0.7) or in an area where aeromagnetic interpretation indicates abundant thrust faulting (e.g., 0.8), whereas an area of one monotonous rock sequence and no evidence of faulting is considered to be less favorable (e.g., 0.3). Any feature allocated 0.5 (unknown) highlights the need for this information to be gathered at this prospect to advance exploration. A worked example is shown in Table 2.

Table 2. Examples of prospect ranking using Bayesian methodology

<table>
<thead>
<tr>
<th>Prospect Name</th>
<th>P1</th>
<th>P2</th>
<th>P3</th>
<th>P4</th>
<th>Pw</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prospect X</td>
<td>1.0</td>
<td>0.8</td>
<td>0.7</td>
<td>0.9</td>
<td>0.50</td>
</tr>
<tr>
<td>Prospect Y</td>
<td>0.5</td>
<td>0.8</td>
<td>0.9</td>
<td>0.9</td>
<td>0.32</td>
</tr>
<tr>
<td>Prospect Z</td>
<td>0.3</td>
<td>0.8</td>
<td>0.9</td>
<td>0.9</td>
<td>0.19</td>
</tr>
</tbody>
</table>

Pw – Product of probabilities assigned
MEASURING EXPLORATION SUCCESS, CONT.

- These four factors are then multiplied together to form an overall probability, \( P_e \). The \( P_e \) is that all of the essential components of the ore system are present at the target or region. This is assumed to be the same as the probability that there is mineralization at the target region, and therefore that the prospect could advance to the next stage of exploration.

The benefits of the Bayesian probabilistic approach are that it is semi-quantitative, geologically based, simple to apply and mathematically sound; a consistent, disciplined approach to evaluating targets within and between regions, and encourages detailed evaluation of each prospect; a method that facilitates communication of exploration risk with management and professional staff from other disciplines; a way to assess exploration risk profile and cost in a consistent and quantitative method; and that it highlights where more information is required, e.g., when \( P_e = 0.5 \) and how the exploration programs may be designed accordingly.

Measuring exploration value for later stage exploration prospects

To estimate the probability of success or likelihood that an advanced-stage exploration prospect will proceed to the next exploration stage requires estimation of regional or belt-wide probabilities for the style of target sought by the company. A range of probabilities can be estimated at each exploration stage, based on the thorough knowledge and experience at each belt, e.g., number of prospects generated, and the number that advanced to drilling and to resource definition, and finally to feasibility studies. Accumulation of knowledge in the early exploration stages and strong focus in “well-endowed” belts or in belts with high level of geologic knowledge is a major value-creating step in the exploration business.

Higher belt-wide probabilities can be achieved when the company focuses on a “well-endowed” belt and/or by building up thorough knowledge of the belt. Note that a high level of knowledge of the belt can consist of either “intellectual” knowledge about the geology of the belt or “historic” knowledge based on previous productivity of the region. The former becomes critically important in the valuation of new grassroots exploration plays in which the mineralization potential has not been realized as the deposits have yet to be found. Even where historic production has not occurred, a belt could still be considered highly prospective and correspondingly highly valued if there is a high level of knowledge about the belt and the company is exploring using a well-constrained, explicit model for mineralization.

An important point is that continued accumulation of increasingly detailed knowledge of a belt will not continue to increase the value of an exploration property. At some point the cost of data gathering will start to destroy the value of the project. It is recognized that the crucial step in adding value to an exploration property is to obtain an economic drill intercept and drilling should proceed at a relatively early stage.

In general, projects with very high NPV will be harder to find and therefore have lower probabilities of success (especially low if the company is exploring in a less enriched belt). The converse will apply when projects will have much lower target NPV than the corporate targets, such as near-mine small resources sought for existing mills, but much higher probabilities of success. In near-mine environments, deposits with modest contained gold may have relatively large NPVs because of their low capital cost. These are of great value to existing mining operations.

One of the main aims of the Laverton district review is to study in detail a mature exploration belt in order to generate a robust set of probabilities and costs for later stage exploration properties. While the set of numbers generated will be most appropriate for the Laverton greenstone belt and the deposit model(s) being sought by Placer Granny Smith, these probabilities and costs will also be applicable in similar Archaean greenstone terranes. The method behind the evaluation is also relevant to a wide range of commodities and exploration environments.

MEASURING LAVERTON EXPLORATION SUCCESS

The data reviewed

Exploration in the Laverton district (Figure 1) was prompted by the discovery of the Granny Smith deposit in 1987 (Hall and Holyland, 1990). Initially, exploration was funded independently by Placer Dome Asia Pacific. In 1993, the Granny Smith Extended Joint Venture was established, with exploration funding contributed by the Placer Granny Smith partners—Placer Dome Asia Pacific (60%) and Delta Gold (40%).

In the Laverton district, data from statutory government annual technical and expenditure reports were compiled for 21 exploration project areas between 1987 and 1999. Exploration was divided into the series of exploration stages (defined in Table 1) and the number of prospects generated was compared to the associated expenditure per exploration stage. This allowed individual prospects and budgets to be tracked through the exploration process.

During the 13-year period, AUD $52 million was spent on exploration and 12 economic deposits were defined, with combined resources of more than 10 Moz (310 t) of gold. The actual NPV and the profit returned from these resources is confidential, but relative values will clearly demonstrate that there is no always a relationship between the resource size and profitability.

The 21 exploration projects reviewed are listed below, in order of increasing expenditure (Table 3—see page 14). Projects were classified in terms of favorable geologic domains and less favorable domains, based on confidential company criteria. Costs are in current dollars, and were not inflated into current dollar values. Placer Dome considers that exploration technology changes over time, and that the increase in exploration effectiveness over the period studied is likely to offset inflation. Furthermore, drilling rates—for example (which contribute a large proportion to the total exploration expenditure)—are cheaper in current dollars than they were in 1988 in unindexed dollars for similar ground conditions. Simply escalating the exploration expenditure per year according to annual inflation was not considered to adequately account for these factors and so actual dollars were used for this analysis. Similarly, the NPV values used were dollar values at decision to mine and do not take into account inflation, changes in the gold price, and other variables.

Exploration activity for each year was summarized for individual exploration projects including lease numbers, how many exploration prospects were at each exploration stage (taking into account projects at the same stage that have been ongoing over multiple years or reporting periods), plus associated exploration costs per exploration stage. Where reported costs were attributable to more than one exploration stage, these costs were apportioned to the relevant exploration stage accordingly taking into account typical cost of meters drilled and samples collected). Note that, due to inconsistent recording of legal, lease rental and tenement acquisition and option payments, these were not included.
Figure 1. Regional geology of the Laverton district of Western Australia showing principal gold deposits owned by various companies. Solid geologic interpretation is modified from SRK Consulting multiclient product (1999).
Table 3. Summary of exploration projects reviewed at Laverton

<table>
<thead>
<tr>
<th>Project</th>
<th>Project Duration</th>
<th>Geologic Domain</th>
<th>Total expenditure (AUDs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project 1</td>
<td>6 years</td>
<td>Favorable</td>
<td>$14.0 M</td>
</tr>
<tr>
<td>Project 2</td>
<td>13 years</td>
<td>Favorable</td>
<td>$12.5 M</td>
</tr>
<tr>
<td>Project 3</td>
<td>7 years</td>
<td>Favorable</td>
<td>$11.4 M</td>
</tr>
<tr>
<td>Project 4</td>
<td>9 years</td>
<td>Favorable</td>
<td>$9.1 M</td>
</tr>
<tr>
<td>Project 5</td>
<td>7 years</td>
<td>Less favorable</td>
<td>$2.0 M</td>
</tr>
<tr>
<td>Project 6</td>
<td>3 years</td>
<td>Favorable</td>
<td>$1.1 M</td>
</tr>
<tr>
<td>Project 7</td>
<td>7 years</td>
<td>Favorable</td>
<td>$0.7 M</td>
</tr>
<tr>
<td>Project 8</td>
<td>6 years</td>
<td>Favorable</td>
<td>$0.3 M</td>
</tr>
<tr>
<td>Project 9</td>
<td>4 years</td>
<td>Favorable</td>
<td>$0.2 M</td>
</tr>
<tr>
<td>Project 10</td>
<td>2 years</td>
<td>Less favorable</td>
<td>$0.2 M</td>
</tr>
<tr>
<td>Project 11</td>
<td>4 years</td>
<td>Favorable</td>
<td>$0.1 M</td>
</tr>
<tr>
<td>Project 12</td>
<td>2 years</td>
<td>Favorable</td>
<td>$0.1 M</td>
</tr>
<tr>
<td>Project 13</td>
<td>2 years</td>
<td>Favorable</td>
<td>$0.1 M</td>
</tr>
<tr>
<td>Project 14</td>
<td>1 year</td>
<td>Less favorable</td>
<td>$0.1 M</td>
</tr>
<tr>
<td>Project 15</td>
<td>2 years</td>
<td>Less favorable</td>
<td>$0.1 M</td>
</tr>
<tr>
<td>Project 16</td>
<td>2 years</td>
<td>Less favorable</td>
<td>$0.1 M</td>
</tr>
<tr>
<td>Project 17</td>
<td>3 years</td>
<td>Favorable</td>
<td>$0.04 M</td>
</tr>
<tr>
<td>Project 18</td>
<td>2 years</td>
<td>Favorable</td>
<td>$0.04 M</td>
</tr>
<tr>
<td>Project 19</td>
<td>1 year</td>
<td>Favorable</td>
<td>$0.02 M</td>
</tr>
<tr>
<td>Project 20</td>
<td>1 year</td>
<td>Less favorable</td>
<td>$0.02 M</td>
</tr>
<tr>
<td>Project 21</td>
<td>1 year</td>
<td>Less favorable</td>
<td>$0.01 M</td>
</tr>
<tr>
<td>Generative exploration</td>
<td>13 years</td>
<td>Throughout the district</td>
<td>Additional $2.2M</td>
</tr>
</tbody>
</table>

Laverton exploration probabilities of success and costs

Information was extracted on the number of prospects at each exploration stage versus associated exploration costs. For brevity, the seven major projects are detailed and others summarized, as compiled in Table 3.

This table shows average exploration expenditures in advance exploration prospects through the five exploration stages based on Peter Graney Smith's 13 years exploration history in the Laverton district. It also provides a summary of the number of prospects that advanced from one stage to the next allowing an average probability of success to be calculated.

Synthesizing the above data, a summary table (Table 3), was generated (note all are AUDs, and unadjusted to current dollars).

Findings of the analysis for the Laverton district can be summarized as follows:

- The average probability for exploration projects advancing from generative to reconnaissance exploration stage is 0.54 (or almost 1 in 2), with an associated average exploration expenditure of AUD$50,000. This reflects the maturity of exploration, for which many targets identified have now been tested.
- The probability that the project proceeded to systematic drill testing stage is 0.17 (or 1 in 6), requiring an average AUD$230,000 of expenditure. These early stage probabilities are similar to the range identified in other project reviews.

- However, later stage exploration probabilities at Laverton are considered quite high. The probability of transition to resource delineation stage is 0.58 (or 1 in 2 projects), and subsequently 88% (or 5 out of 6) of these projects advanced to feasibility. The success rate reflects the gold endowment of the district and the mature near-mining exploration environment.
- Average expenditure to advance through resource delineation stage is AUD$600,000 and through feasibility stage is AUD$2 100,000.

Resources defined and exploration effectiveness

A summary of resources defined, discovery cost per ounce and relative NPV values for individual exploration projects between 1987 and 1999 is shown in Table 6 (see page 16) and graphically in Figure 2.

![Figure 2. Graph of relative NPV (x axis not labeled as data confidential) and resources defined per project at Laverton.](image)

The first 4 projects have delivered the bulk of the resources defined by Peter Graney Smith and confirm a very successful exploration campaign and the gold endowment of this belt. The principal findings include the following:

- Project 1 is the most successful project in the Laverton district. It is the most economically attractive (in NPV terms), contains one of the largest resources and also has a low discovery cost per ounce. These combine to deliver excellent use of exploration expenditure.
- Project 5 also has a relatively high NPV despite containing only modest resources. It has a quite high discovery cost per ounce (and required a proportionally higher drill budget) than the larger resources such as projects 1 and 2.
- Projects 2 and 3 have moderate relative NPVs. However, in terms of resources delivered and discovery cost per ounce—the more traditional measure of exploration success—they could be considered the best exploration successes.
- It is important to note measure exploration success only by resource ounces defined. The economics of larger resources versus smaller deposits (which have disproportional NPVs compared to sizes of resources defined) should be factored into where exploration dollars are spent.
- Obviously, there will be more smaller resources than larger deposits. Linking the resource and NPV of the exploration target to where exploration dollars are expended is critical to optimizing exploration value.
- Project 5 stands out as having high exploration expenditure with no resources defined. The location of project 5 in the less geologically favorable geologic domain raises the question as to why exploration continued. In this project, the ratio of reconnaissance stage projects to drill testing stage is 30 to 1 and is the highest for any project. Reconnaissance stage exploration in this instance, continued too long and project value was destroyed in the process.
Table 4. Summary table of Laverton projects showing number of exploration prospects, cost of exploration (AUD$), and average cost per prospect for each of the exploration stages (AUD$)

<table>
<thead>
<tr>
<th>Project name</th>
<th>Project generation stage (A)</th>
<th>Reconnaissance stage (B)</th>
<th>Drill testing stage (C)</th>
<th>Resource delineation stage (D)</th>
<th>Feasibility stage (E)</th>
<th>Total project exploration expenditure</th>
</tr>
</thead>
<tbody>
<tr>
<td>PROJECT 1</td>
<td>No. of prospects</td>
<td>Combined cost</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>0</td>
<td>$0</td>
<td>5</td>
<td>8</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Combined cost</td>
<td></td>
<td>$0.27M</td>
<td>$2.81M</td>
<td>$0.28M</td>
<td>$10.68M</td>
</tr>
<tr>
<td>PROJECT 2</td>
<td>No. of prospects</td>
<td>Combined cost</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>$0.19M</td>
<td>18</td>
<td>7</td>
<td>6</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Combined cost</td>
<td></td>
<td>$1.81M</td>
<td>$1.50M</td>
<td>$2.22M</td>
<td>$6.73M</td>
</tr>
<tr>
<td>PROJECT 3</td>
<td>No. of prospects</td>
<td>Combined cost</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>$0.18M</td>
<td>18</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Combined cost</td>
<td></td>
<td>$3.86M</td>
<td>$0.35M</td>
<td>$2.52M</td>
<td>$4.43M</td>
</tr>
<tr>
<td>PROJECT 4</td>
<td>No. of prospects</td>
<td>Combined cost</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>$0.01M</td>
<td>26</td>
<td>5</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Combined cost</td>
<td></td>
<td>$1.79M</td>
<td>$0.74M</td>
<td>$1.54M</td>
<td>$4.98M</td>
</tr>
<tr>
<td>PROJECT 5</td>
<td>No. of prospects</td>
<td>Combined cost</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>$0.01M</td>
<td>30</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Combined cost</td>
<td></td>
<td>$1.70M</td>
<td>$0.34M</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td>PROJECT 6</td>
<td>No. of prospects</td>
<td>Combined cost</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>0</td>
<td>$0</td>
<td>2</td>
<td>3</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Combined cost</td>
<td></td>
<td>$0.25M</td>
<td>$0.26M</td>
<td>$0.16M</td>
<td>$0.46M</td>
</tr>
<tr>
<td>PROJECT 7</td>
<td>No. of prospects</td>
<td>Combined cost</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>0</td>
<td>$0</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Combined cost</td>
<td></td>
<td>$0.20M</td>
<td>$0.06M</td>
<td>$0.15M</td>
<td>$0.34M</td>
</tr>
<tr>
<td>OTHER PROJECTS (COMBINED)</td>
<td>No. of prospects</td>
<td>Combined cost</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>$0.08M</td>
<td>54</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Combined cost</td>
<td></td>
<td>$1.49M</td>
<td>$0</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td>GENERATIVE EXPLORATION</td>
<td>No. of prospects</td>
<td>Combined cost</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>263</td>
<td>$2.20M</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Combined cost</td>
<td></td>
<td>$0</td>
<td>$0</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td>Total number of prospects</td>
<td>290</td>
<td>$2.7M</td>
<td>156</td>
<td>26</td>
<td>15</td>
<td>13</td>
</tr>
<tr>
<td>Total cost for all prospects at each exploration stage</td>
<td>156</td>
<td>$11.4M</td>
<td>28</td>
<td>15</td>
<td>13</td>
<td></td>
</tr>
</tbody>
</table>

Table 5. Synthesis of historical exploration activity by exploration stage

<table>
<thead>
<tr>
<th>Exploration stage</th>
<th>Number of prospects</th>
<th>Expenditure (AUD$1987–99)</th>
<th>Avg Cost/Prospect (AUD$)</th>
<th>Probability of advancing from previous stage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Generative</td>
<td>290</td>
<td>$2.7M</td>
<td>$10K</td>
<td>0.54: 1 in 2</td>
</tr>
<tr>
<td>Reconnaissance</td>
<td>156</td>
<td>$11.4M</td>
<td>$70K</td>
<td>0.17: 1 in 6</td>
</tr>
<tr>
<td>Systematic Drill testing</td>
<td>26</td>
<td>$6.0M</td>
<td>$230K</td>
<td>0.58: 1 in 2</td>
</tr>
<tr>
<td>Resource delineation</td>
<td>15</td>
<td>$6.9M</td>
<td>$460K</td>
<td>0.87: 5 of 6</td>
</tr>
<tr>
<td>Feasibility</td>
<td>13</td>
<td>$27.6M</td>
<td>$2.1M</td>
<td>0.90: 9 of 10</td>
</tr>
</tbody>
</table>
A large part of the total exploration expenditure was spent on reconnaissance stage exploration (AUD511M). This phase is a crucial value-adding phase of exploration. A review of when key exploration stages were reached for each exploration project highlights two significant lost opportunities:

- Project 4 was acquired and the exploration target that yielded the resource was immediately recognized as the best exploration target. However, that target was not effectively drilled for 5 years.
- Within project 4, potentially significant mineralization was discovered in the mid-1990s, but substantial drilling of the prospect was not carried out until two years later.

CONCLUSIONS

A methodology is presented to measure exploration success and value which challenges the traditional discovery cost per ounce of gold. The preferred methodology links profitability of the target deposit to the exploration prospect. Critical factors to estimate for individual prospects include:

- Project exploration stage (i.e., generative, reconnaissance, systematic drill testing, resource delineation, feasibility);
- The probability the prospect will advance to the next exploration stage;
- The associated cost of advancing the prospect;
- Target value, being the threshold or range of NPVs that provides a minimum return to the company, based on geologic parameters of target tonnages and grades.

An Expected Value can then be determined using the simple formula (e.g., Mackenzie, 1998):

\[ EV = P_e \times TV - C \]

(Where: \( EV \) = Expected Value; \( TV \) = Target Value; \( P_e \) = Probability of advancing exploration project; and \( C \) = Cost of advancing exploration project).

A review of historic exploration was undertaken in the Laverton district, Western Australia to examine the probability of success and associated costs, to gain an understanding of typical exploration profiles over time. Placer Granny Smith's exploration expenditure amounted to around AUD$2 million over 13 years for 21 exploration projects. Data compilation of exploration activity and associated expenditure concentrated on defining key exploration stages and decision points. Six exploration projects contained a combined total of 12 gold resources.

Comparing the resources defined at each project to the actual NPV-Profit estimated at decision to mine demonstrates that some of the smaller resources have disproportionately high NPVs. There are obviously also more of the smaller resources than the larger deposits. It is clearly important not to measure exploration success only as discovery cost per ounce of resource defined. The relationship between resource size and characteristics such as "mineability" should be factored into where exploration dollars are spent, particularly in near-mine exploration environments.

<table>
<thead>
<tr>
<th>Project</th>
<th>Total expenditure to 1999 (AUD$)</th>
<th>Resources defined or gold produced</th>
<th>Discovery cost per ounce per project (AUD$)</th>
<th>Relative NPV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project 1</td>
<td>$14.0M</td>
<td>2.83 Moz (861t)</td>
<td>$4.9</td>
<td>Highest</td>
</tr>
<tr>
<td>Project 2</td>
<td>$12.5M</td>
<td>2.29 Moz (701t)</td>
<td>$5.5</td>
<td>Medium</td>
</tr>
<tr>
<td>Project 3</td>
<td>$11.4M</td>
<td>4.47 Moz (1351t)</td>
<td>$2.6</td>
<td>Medium</td>
</tr>
<tr>
<td>Project 4</td>
<td>$9.1M</td>
<td>0.55 Moz (171t)</td>
<td>$16.5</td>
<td>Medium</td>
</tr>
<tr>
<td>Project 5</td>
<td>$2.0M</td>
<td>None</td>
<td>Not applicable</td>
<td>0</td>
</tr>
<tr>
<td>Project 6</td>
<td>$1.1M</td>
<td>0.05 Moz (1.5t)</td>
<td>$22.0</td>
<td>Lower</td>
</tr>
<tr>
<td>Project 7</td>
<td>$0.7M</td>
<td>0.05 Moz (1.6t)</td>
<td>$14.0</td>
<td>Lower</td>
</tr>
</tbody>
</table>

It is also useful to examine exploration expenditure over time, in particular, where exploration dollars were focused. The time review of exploration yielded two obvious lost opportunities at Laverton, for which exploration targets were recognized but not immediately followed up. These targets ultimately yielded significant resources, but the decline in the gold price in the interim, combined with decreased operating efficiency, resulted in a significant opportunity cost.

The prompt recognition and early drill testing of the best exploration targets is critical in optimizing and realizing value of exploration properties. The transitions from reconnaissance stage to drill testing stage, and through to resource delineation stage should be minimized. Exploration should aim to test the best exploration targets systematically, rather than at random points of exploration area. The geologic ability within a company to put the first "economic drill intersection" into its proper geologic setting and recognize its true importance is a critical factor in exploration success.

Constant appraisal of exploration targets is required. This method of measuring exploration value can also be integrated into an effective prospect-rank ranking scheme. This ranking methodology will assist with recognition, documentation, and direction of exploration funds to effectively test the best exploration targets.

ACKNOWLEDGMENTS

Placer (Granny Smith) Pty Limited, Placer Dome Asia Pacific and Delta Gold are kindly thanked for permission to publish this article. Tony Rix of Placer Granny Smith assisted with compilation of historic exploration data. The methodology discussed in this paper is being developed by SRK Consulting, and in addition to the SRK authors listed, Peter Williams and Stuart Munroe are acknowledged for their involvement.

REFERENCES


The SEG Council held a regularly scheduled meeting at the Marriott Hotel in Denver, Colorado, on February 26, 2001. Members of the Council present were F.M. Beck, J.M. Franklin, D.J. Groves, J.W. Hedlundqust, M.W. Hitzman, B.G. How, T.A. Luncks, R.L. Nielsen, R.W. Schafer, C.E. Severn, R.H. Sillitoe, H.J. Stein, C.E. Vidal, and N.C. White. Others present were A.J. Erickson, Jr., C.A. Harrigan, A.J. Macdonald, R.A. Newell, and N. Vidal. President Franklin called the meeting to order at 7:15 p.m. The following actions were taken at the meeting:

- Approved the agenda.
- Approved the action minutes of the regular Council meeting held on November 13, 2000, at the Hilton Hotel in Reno, Nevada.
- Received the report of the President as Chair of the SEG Executive Committee, and ratified the following actions taken by the Executive Committee during the period November 13, 2000–February 25, 2001:
  - Approved the following nine applicants for Fellowship (List 00-03, 00-04, and 00-05): K. Bogdanov, K., Bulgaria; D.E. Groves, USA; B.G. How, USA; R.P. Mayor, Switzerland; D.M. Schneider, Norway; G.L. Steele, CIldoe; B. Strachan, Bulgaria; T. de la Cruz, Mexico; and A.J. Wilson, Australia. (12/4/00)
  - Proposed a restructuring of SEG committees that would require a number of changes in the SEG Bylaws—as amended on March 25, 1999. (2/24/01)
  - Endorsed the system of direct allocation of staff time to all program activities to accurately determine administrative costs. (2/24/01)
  - Advocated the consideration of new venues for the holding of the winter/spring SEG business meetings to replace the current SME meetings. (2/24/01)
  - Agreed that a membership drive would be implemented by SEG staff under the leadership of President-Elect Groves. (2/24/01)
  - Decided that all advocacy actions by SEG be conducted through AGI. (2/24/01)
  - Requested that the Executive Director determine the practicability of changing the Society year to match the fiscal year. (2/24/01)
  - Accepted the resignation of the Treasurer, T.A. Luncks, and thanked him for his long service. (2/25/01)
  - Recommended an ad hoc committee consisting of the President of SEG, President of SEG Foundation, and President of PUBCO, to define guidelines and commence a search for a new Treasurer. (2/25/01)
  - Accepted, with revision, the report of the Advisory Committee presented by G.G. Snow, Chair. (2/25/01)
  - Accepted the report of the Membership Committee presented by J.W. Warnaars, Chair. (2/25/01)
  - Agreed that President Franklin continue as SEG’s representative at Canadian Geoscience Council for one more year. (2/25/01)
  - Recommended that the Executive Director approach N. White to accept an appointment as Corresponding Editor for Geotimes. (2/25/01)
- Agreed that all educational programs be conducted within the existing program structure. (2/25/01)
- Recommended that SEG Foundation cover travel expenses of students who wish to present posters at the 2002 Denver conference. M. Hitzman to provide a plan of fund allocation by the GSA Boston 2001 meeting. (2/25/01)
- Recommended that Student Chapter applications from Sofia University/University of Mining and Geology (Bulgaria), University of New Brunswick (Canada), University of Leicester and University of Birmingham (Midlands–United Kingdom), and University of Geneva (Switzerland) be accepted by Council. (2/25/01)
- Approved presentation of amended SEG Bylaws to the Council. (2/25/01)
- Accepted the report of the Chair of the Program Committee. (2/25/01)
- Approved the report of the Chair of the Program Committee. (2/25/01)
- Agreed to hold the next meeting of the Executive Committee at the SEG Building in Littleton, Colorado, on July 15, 2001. (2/25/01)
- Accepted and approved the Treasurer’s report for the period January 1–December 31, 2000.
- Approved the amended SEG budget for the year 2001.
- Ratified the action of the Finance Committee in choosing Invesco Portfolio Solutions to manage the investment portfolio of SEG Group (SEG, SEG Foundation, and PUBCO) for a trial period of one year.
- Accepted the Executive Director’s report.
- Accepted the report of the President of Foundation.
- Announced the appointment of the new Editor of Economic Geology, Mark Hannington, to succeed Marco Emard by mid-2001.
- Received a presentation on the activities of the Mineral Information Institute (MIN) by L. Landefeld, Chair of the Board, and N. Fugate, Executive Director. SEG was thanked for its previous support, the importance and flexibility of MI products were illustrated, and a model for SEG-assisted distribution was explained.
- Received a presentation on Continuing Education by A.J. Erickson, Chair of the ad hoc Continuing Education Committee. Requested that the Committee perform the following actions:
  - Send the existing list of short courses to the Chair of the Short Course Committee.
  - Compile a list of courses currently being given in practical geology and geophysics, including field courses at universities. Use this list to identify gaps and report on these to the Short Course Coordinator.
- Accepted the report of the Vice President for Regional Affairs.
- Accepted the report of the Chair of the Program Committee.
- Approved the recommendations of the ad hoc Internet Committee for website priorities and electronic publishing. The following specific actions were taken:
  - Approved the appointment of Larry Meinert to a three-year term as “Editor, SEG mineral deposit database (MDB) web series” and established that the editor would report to the Council through the Executive Director.
  - Ratified an expenditure of $8,000 in 2001 to cover the cost of setup and administration related to the MDB web series.
  - Approved a pilot project to post back issues of the SEG Newsletter on the website starting with the January 2001 issue in April 2001.
- Approved the following slate of candidates recommended by the Nominating Committee for officer and Councilor positions coming open April 1, 2002: President-Elect—Jonathan Price, Vice President—John F.H. Thompson, Regional Vice President—Lawrence J. Rubb, Regional Vice President—North America—David A. Giles, and for Councilor—Bruce Germerd, Craig A. Fairley and Antonio Arribas R., Jr.
- Approved an amended slate of Committee Chairs and alternates proposed by the Committee on Committees.
- Approved the report of the Admissions Committee.
- Approved the Lindgren Award Committee’s recommendation that the award be given in 2001.
- Approved a motion to change the Bylaws to remove the requirement that the Lindgren Award be given on an annual basis.
- Accepted the interim report of the International Exchange Lectureship Committee as read.
- Approved the Thayer Lindley Visiting Lectureship Committee’s recommendations of Antonio Arribas R., Jr. and J. Richard Kyle.
- Approved a motion to review the current procedure of ranking award nominees prior to selection by the Council.
- Received the report of the Short Course Committee and agreed that the President-Elect would respond to the Chair of the Short Course Committee concerning the committee’s previous proposal on the future format of short courses.
- Accepted the report of the Student Affairs Committee.
- Accepted the report of the Editorial Advisory Board.
- Approved a motion to accept a streamlined draft of the Fellowship Application form and endorsed the required change in the Bylaws from three to two sponsors for SEG Fellowship.
- Agreed that Murray Hitzman would serve as a replacement to Joe Briskey as SEG’s representative on AGI for a period of one year. Expressed thanks to Briskey for previous service rendered.
- Adjourned the meeting at 12:30 p.m., after agreeing to hold the next Council meeting in Boston, Massachusetts, in conjunction with the GSA Annual Meeting, November 3–8, 2001.
Global Exploration 2002
Integrated Methods for Discovery

The Society of Economic Geologists, in collaboration with the Society for Geology Applied to Mineral Deposits (SGA), the Association of Exploration Geologists (AEG), and the Society of Exploration Geophysicists, will convene Global Exploration 2002—Integrated Methods for Discovery in April 2002. The meeting is a sequel to the highly successful 1993 Integrated Methods in Exploration and Discovery conference. The 2002 meeting, like its predecessor, will emphasize the effective integrated use of a variety of exploration tools and techniques for discovery. The venue will be Denver, Colorado, USA.

TECHNICAL SESSIONS
The 2002 meeting promises an exceptional technical program with select speakers discussing some of the great mineral deposits and districts of the world. All technical papers will be invited. There will be a single-track program, with fewer papers of better quality and greater length than at most meetings. Emphasis for all presentations will be the integration of geology, geochemistry, and geophysics. Four keynote addresses will highlight some of the best new thinking in mineral exploration. Technical sessions have been organized around six half-day theme sessions entitled:

- Four-Dimensional Portraits of Giants
- Case Studies—Regional Exploration
- Case Studies—District Exploration
- In the Shadow of Headframes—Exploration in Old Districts
- Under the Covers—Exploration for Hidden Deposits
- The Dollars and Sense of Exploration

POSTER AND CORE PRESENTATIONS
These will be integral to the technical program. Presentations will be given during dedicated time periods to maximize the exchange between presenters and meeting participants. Poster presentations will be selected with an emphasis upon attracting contributions from students. Core displays will complement many of the technical and poster presentations.

FIELD TRIPS
Field trips will be conducted in connection with the conference and include:

- Zacatecas, Mexico
- Carlin Trend Gold Deposits, Nevada
- Porphyry Copper Deposits, Arizona-Sonora
- Sudbury, Ontario
- Cripple Creek, Colorado
- Kelso Lake, Colorado

The Carlin Trend and Arizona-Sonora porphyry copper field trips will highlight the use of integrated data sets in the field.

WORKSHOPS
Workshops will be offered on Giant Ore Deposits, Exploration Technology, GIS, and Diamonds.

PUBLICATION
A high-quality volume of technical papers will be distributed to participants at the conference. Authors will be required to submit an extended abstract for the meeting program and a complete manuscript for the conference volume.

For further information, go to our website at www.seg2002.org, or contact us at seg2002@segweb.org

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The State of Economic Geology Education in Asia (Japan, China, Philippines): A General Perspective

INTRODUCTION

The global era in economic geology that is now upon us has opened with a barrage of technological breakthroughs, not only in the more classical fields, but also in relatively unexplored regions such as sea-floor hydrothermal activity, the deep biosphere and the like. These developments exert new demands on the education system. There is a need for universities to transform from ivory towers of higher learning to institutions geared towards the production and dissemination of utilitarian knowledge for national and global development. One critical issue now is the speed at which this transformation is taking place.

Asia is composed of nations varying from underdeveloped to developing to fully industrialized, and thus may serve as an observer of this education-system metamorphosis. There is typically a direct proportionality between a country's budget for education and its national budget. Hence, poorer nations are able to conduct less research, and have fewer faculty development activities and thus program expansion compared to their more affluent neighbors. There is no single model to characterize the current state of economic geology education for the whole of Asia because of the financial heterogeneity of the region. Therefore, we present reports from three case countries: Japan, China and Philippines.

JAPAN

Research and education in economic geology in Japan is conducted largely at universities and the Geological Survey of Japan, the latter incorporated within the National Institute of Advanced Industrial Science and Technology beginning in April 2001. According to the 1998 membership roster of the Society of Resource Geology, 68 national and public universities and 16 private universities offer economic geology within geology and earth science departments or mining schools. The Science Council of Japan reported in 1999 that there were 70 university staff teaching mainly economic geology 30 years ago. This number has now decreased by more than half, resulting in part from the closure of a number of domestic mines. Despite the decrease in academic positions, the number of researchers in economic geology has remained unchanged. This is reflected in the amount of research being presented at national conventions. For example, at the Annual Meeting of the Society of Resource Geology in 2000, 72% of the total 61 presentations came from the university staff and students. Interestingly, of the 100 graduate students in economic geology for 1997, 23% originated from developing countries. This is a high proportion of foreign students compared to other graduate school programs in Japan.

Among the participants of the Annual Meeting of the Society of Resource Geology, 65% to 83% are university staff and students, indicating that a large part of research activities in the Society is academic-based. Some of this work is published by the Society in English in the journal Resource Geology, and in Shihgen-Kaishin in Japanese. The contents of the former are indexed in the Science Citation Index.

Research topics presented at the last Annual Meeting included high-and low-sulfidation epithermal gold deposits, magmatic hydrothermal systems, hydrothermal alteration, sea-floor hydrothermal systems and volcanogenic sulfide deposits, manganiferous deposits, geochronology of pelagic sediments, and environmental technology around waste disposal sites and factories.

The economic geology laboratory of the University of Tokyo is managed by the Geosphere and Biosphere Science Group of the Earth and Planetary Science Department. Here the research emphasis is on the geological, geochemical and microbiological processes of mass transfer within the Earth's crust and the upper mantle. Research interests include (1) migration and transfer of fluid-mobile elements, including those which constitute ore deposits; (2) interaction between geosphere and chemosynthetic deep biosphere; (3) sea-floor hydrothermal activity in arc-back and mid-ocean ridge systems; (4) modeling of ore genesis in relation to the evolution of the Earth, island-arc tectonics, arc-magmatic activity and water-rock interaction; and (5) related laboratory experiments. "Aeolian Park" is an international collaboration on the interaction between the subsurface biosphere and the geo-environment. This research project is supported by the Japan Geology Research Foundation and explores hydrothermal activity of the Izu-Bonin arc in the western Pacific, thought to be analogous to the Earth's environment during the Archean. This project aims to improve the understanding of ore formation throughout geological time. The Department of Geosystem Engineering at the University of Tokyo also offers a course for economic geology (Applied Geology) in the Graduate School of Engineering.

The economic geology laboratory of Kyushu University is located in the Department of Earth Resources Engineering, Faculty of Engineering. There are now five undergraduate, seven M.Sc., and six Ph.D. students, plus one postdoctoral researcher. This laboratory is devoted to exploration for mineral deposits and energy resources, utilization of mineral, evaluation of natural environments, and prevention of natural disasters. Current research subjects include (1) the study of ore genesis, particularly epithermal gold deposits, (2) fossil fuel geochronology, and (3) monitoring of volcanic activity by juvenile glass in volcanic ash. Some recent Doctor of Engineering theses in economic geology include the stable isotopic composition of the epithermal gold systems in...
western Kyushu and northeastern Hungary; the epithermal gold deposit at Hoshino, north-central Kyushu; the behavior of silica and gold in epithermal systems; chemical weathering and engineering properties of Precambrian metamorphic rocks in Sri Lanka; geothermal geology of Takigami, Kyushu; recycling of waste caustic soda solution containing aluminum; and fission track thermochronology of the Songlou and the Dahuaqiaoliang mountains, northeast China.

CHINA

Geological education in China developed rapidly during the 1950s to 1980s. However, the number of students in economic geology decreased during the 1980s. Before the 1990s there were seven independent Geological Colleges in China. With the reorganization of the educational system as a result of market economy reforms, only the China University of Geosciences remains, including the Wuhan and Beijing campuses. The other colleges were renamed as engineering institutes or were merged into comprehensive universities. An example of this is the Changchun Institute of Geology, which merged with Jilin University. Such developments gave rise to an increasing demand for economic geologists with the implementation of the Grand Development of Western China.

What does this mean, that demand increases, but university programs are cut? There are more than 600 universities on the Chinese mainland, and 150 colleges offer courses in geology, 130 of which are involved in the study of economic geology. In the last three years, about 500 to 700 bachelor's degrees and 180 to 250 masters' and doctoral degrees in economic geology have been granted per annum. Apart from these, 15 research institutes have also awarded 240 to 300 master's and doctoral degrees during the same period. In a year's time, China produces at least 250 to 350 post-graduates in economic geology. However, the actual number of professionals specializing in economic geology is quite difficult to quantify, because every province and autonomous region in China has its own Bureau of Geology and Mineral Resources, which in turn have their own Institutes of Geology composed of several geologic teams. This is exclusive of the several other ministries such as the Ministry of Geology and Mineral Resources, Ministry of Nuclear Industry, Bureau of Nonferrous Metals, Ministry of Chemical Engineering, which are also sustained by their own economic geology research institutes. Of the 70,000 geologists in China, economic geologists may number between 2,000 and 3,000.

There are three national centers for the study of economic geology: the China Exploration and Research Center for Mineral Resources in the Institute of Geology and Geophysics at the Chinese Academy of Sciences (CAS), which has a current cooperative project with the Japan International Cooperation Agency; the Ore-forming Process National Key Laboratory in Nanjing University; and the Mineral Deposit Geochemistry Open Laboratory at the Institute of Geochemistry, Guizhou, CAS. Research in economic geology is confined largely to the investigation of metallic commodities, particularly Cu, Au, Pb-Zn, Ag and Sn.

PHILIPPINES

In the Philippines, economic geology and related topics in the geosciences are being taught at three schools—Adlum University (AU), Mapua Institute of Technology (MIT) and the National Institute of Geological Sciences (NIGS) of the University of the Philippines, Diliman. These three offer the bachelor's degree in geology and mining engineering, and teach economic geology to geology majors and also to mining engineering students. Both NIGS and MIT have graduate programs in geology. However, only NIGS pursues a graduate specialization in economic geology.

The number of courses devoted to economic geology and related topics is varied. Among the three schools, courses taught regularly at the undergraduate level are mineral resources (metallic and nonmetallic), geochronology, ore microscopy (or mineralogy), applied geophysics and geostatistics. At AU, special topics on economic geology, ore deposits, mining geology, mine economics, and mineral resources of the Philippines are available. Also at AU and MIT, students are trained in economic geology through the completion of a two-month mine and mill practice at different operating mines in the country. Most faculty members have earned graduate or have completed graduate (and postgraduate) degrees from institutes outside the Philippines. At MIT and NIGS, most faculty members are geologists, whereas at AU, most are mining and civil engineers. In the last three years, the number of students pursuing economic geology has decreased significantly owing to the decline in employment opportunities in the mining industry.

NIGS is the only institute that has traditionally pursued research in economic geology. The majority of research is conducted by faculty members, research staff, the latter mainly graduate students. The Institute currently has research on the adakite-gold relationship in Eastern Mindanao, epithermal gold mineralization in northeastern Zamboanga, platinum-group elements and chromite in Zamboanga, Bohol and Zamboanga, volcaniclastic massive sulfide mineralization in Rapan-Rapan and Zamboanga, geophysical applications of gamma ray spectrometry (Marinduque Island), magnetite and gravity (Baguio and Bohol) for mineral exploration, and ancient to present-day geothermal systems in the Bicol Arc.

COOPERATION IS THE KEY

There is no question of the availability of competent economic geologists from academic institutions in Asia. The urgent issue now is how to harness their energies to gain the maximum from their capacity. The bachelor's degree program in geology does not appear much different among Asian countries. However, in the graduate and post-graduate programs, the playing field is uneven. Foremost among the differences is the number of research facilities by which detailed studies can be conducted within a particular country.

There is very little that developing countries can do about the availability of research funds and laboratory equipment. However, there is much remedial effort to develop manpower through scholarships extended by other countries. As earlier mentioned, a good number of graduate students at Japanese universities come from developing countries. In study programs such as this, both the benefactor and recipient profit. Foreign students earn degrees and in turn their influx to these universities translates into the introduction of new perspectives and ideas. Furthermore, collaborative research work among various countries has been proven to be an effective way of sharing knowledge. This collaboration is ongoing and is continually being developed through memorandums among different institutions in Asia.

In summary, despite the marked decline in the commercial appeal among students, economic geology education in Asia has continued to develop, albeit at varying rates in different countries. Industrialized countries are at the forefront, exploring revolutionary ideas, whereas others are at the “catching-up” phase. However, the technological advancement that requires late-blooming countries to hasten changes in their educational system is the same technology that now bridges the gap between different institutes by providing a common platform for knowledge sharing. Economic geology will still be a very important part in the continuing development of countries in Asia. Thus, universities in Asia should and must be willing to accept, to adjust, and to interact with the new world order of globalization.
SEG International Exchange Lecturer Report
October 1999–April 2000

MARK D. BARTON (SEG 1979)
PROFESSOR OF GEOLOGY, UNIVERSITY OF ARIZONA, TUCSON, ARIZONA

Cardboard slide mounts and the transition from 10 to 95 percent relative humidity do not agree. So I discovered the evening of my first SEG-HIL talk at the Sossego exploration camp in the Serra dos Carajas, Brazil (Fig. 1). After three days travel from Arizona, the slides presented difficulties that were nothing that could not be resolved with a bit of tape and time. Still, I wondered that first evening what I had gotten myself into by setting up three legs for a single lecture series. By the time six months of intermittent travel to three continents ended, I had discovered much about giving talks in unusual circumstances and had accumulated many memorable experiences.

Figure 1. The lecturer, finally relaxed, with many of the audience—around midnight at the Sossego camp, Carajas.

When taking on the International Exchange Lectureship from North America for 1999, I had expected to visit one region in a focused trip. As it turned out, support from several sources combined with other opportunities made more extensive travel on behalf of the Society possible. Ultimately those took me to Brazil and Chile, doing fieldwork while getting the chance to bootleg a number of lectures. It all started in Rio with a visit to Rich Leveille in the offices of Phelps Dodge, sponsor of my South America travel. The next day, travel to Carajas was extended by an eight-hour weather-induced detour via Belem, followed by a long minibus ride from Marabu, ending up in Carajas—where I was happy and relieved to join up with my colleague Robert Marashki and meet Antonio de Almeida from Phelps Dodge. Antonio would be my wonderful host and tour guide for the stay in Carajas that consisted of many conversations, extended visits to Igarape Babia-Almena, Sossego, Ni, and the other iron mines and a number of talks discussing mineral deposits and their geology. I want to acknowledge here all those whom I visited, too numerous to be fully acknowledged here.

What to talk about? That was a question I struggled with for some time before traveling. Too often talks drawn from economic geology leave many faculty and students feeling that the field is narrow and specialized. They miss out on the breadth and excitement that this truly integrative subject offers. Ultimately, two of my four talks dealt with iron oxide-rich hydrothermal systems. I chose this focus because of the current exploration interest in these systems and the insights that come from study of young examples in the United States and, because they form a bridge to other aspects of geology. One can draw connections among tectonic settings, magmatic compositions, and paleoenvironment in a way that can draw the attention of those (mainly in universities) who are not focused on the mineral deposits.

Two other talks were on lithophile element mineralization in the western United States and on extension, fluid flow, and mineralization. These two brought mineral deposits into a broader geologic context, illustrating how basic field observations remain central to addressing the important questions, and pointing out that even in this day of technological sophistication, basic issues remain unresolved.

Late October and early November found me in Brazil and Chile, doing fieldwork while getting the chance to bootleg a number of lectures. It all started in Rio with a visit to Rich Leveille in the offices of Phelps Dodge, sponsor of my South America travel. The next day, travel to Carajas was extended by an eight-hour weather-induced detour via Belem, followed by a long minibus ride from Marabu, ending up in Carajas—where I was happy and relieved to join up with my colleague Robert Marashki and meet Antonio de Almeida from Phelps Dodge. Antonio would be my wonderful host and tour guide for the stay in Carajas that consisted of many conversations, extended visits to Igarape Babia-Almena, Sossego, Ni, and the other iron mines and a number of talks discussing mineral deposits and their geology. I want to acknowledge here all those whom I visited, too numerous to be fully acknowledged here.

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The next leg, lasting most of March, was also in the Southern Hemisphere—Australia and New Zealand—worked in with several other commitments. Two of the highlights were student chapter-run activities. The first was James Cook University, where grad students led by Mike Roberts and Martin Fairclough, and aided by Pat Williams, put together a day-long symposium focused on Fe oxide-Cu-Au systems. In attendance were more than 60 from the university and industry, listening to a dozen extended presentations and many lively discussions (Fig. 2). All this was followed by a barbecue in the remnants of a tropical storm system that had been pounding the coast for the last day. This was a splendid effort on behalf of the student chapter and should serve as a model for what many student chapters could accomplish. Townsville was made all the more memorable for me by flying in as a tropical cyclone developed just off the coast. The storm dropped more than 200 mm of rain in 24 hours with attendant flooding, affecting the pool of my host, Pat Williams, which took on the dismaying aspect of a settling pond.

These Australian travels had begun two weeks earlier in Tasmania and I then worked my way up the east coast to Townsville. Several days in Tasmania allowed several talks during a stimulating visit with Ross Large, Garry Davidson, and the group at CODES (Centre for Ore Deposit and Exploration Studies, University of Tasmania). CODES is an impressive model of how industry-academic cooperation can be forwarded with the right people and structure.

Furtitious scheduling led me benefit from a quick visit to western Tasmania with Mike Solomon—a wonderful drive and discussions—with a talk on lithophile systems to the western Tasmanian division of AusIMM (Australasian Institute of Mining and Metallurgy) at Rosebery (and another last-minute reorganization of materials!). David Evans of Renton Bell coordinated the talk and a tour of the mine. Flying north, a quick visit and several talks followed in Canberra at Australia Geological Survey Organisation and the Australian National University, coordinated by Ken Lawrie. With the weekend intervening, I took the opportunity to drive from Canberra to Brisbane, visiting North Parks (hosted by Stuart Smith) and a number of national parks in northeastern New South Wales. Ultimately, this trek ended in Noel White’s driveway in Brisbane, initiating a very pleasant three-day stay in that city with Noel. Several talks hosted by Sue Goldberg at the University of Queensland and Toon Vaeta at MIM were among the key activities before my heading on to Townsville.

The student chapter from the University of Arizona coordinated a splendid week-long field trip with nearly 20 participants from the U of A, Stanford, Oregon State, and University of Nevada, Las Vegas, to the geothermal systems of New Zealand. The trip was led by Stuart Simmons from the Geothermal Institute, University of Auckland (currently chairman of the SEG Student Affairs Committee), who is keen on encouraging such field trips among student chapters. We visited Martha Hill, White Island (Fig. 3), Broadlands, Waiotapu (Champagne Pool) and others. The trip was a non-stop litany of geological highlights and a great experience for all participants. A visit and talk at the University of Auckland concluded Southern Hemisphere travels.

April found the third and final leg of my trip, this time in England. Lasting only a bit over two weeks, this packed in a number of talks, a meeting, a bit of geology, and some unassisted driving in downtown London that I don’t care to repeat. My trip was ably coordinated by Sarah Gleeson, from Leeds, who had earlier invited me to participate in the mid-April Geoscience 2000 (Geological Society) meeting in Manchester. Beginning with the University in Leeds, visits and talks followed in London (Imperial College, Natural History Museum) and at the University of Southampton, before I returned to Manchester via weekend geology in Cumbria. Jamie Wilkinson was a great host in London. I was particularly pleased to meet many of the people at Imperial and the Natural History Museum, coordinated by Richard Herrington, and to see how these adjacent institutions benefit from one another and their fine facilities. In Southampton more talks followed, along with discussions and a tour of the new facilities with Steve Roberts.

My travels concluded in southwest England with several days in Cornwall coordinated by Sarah Gleeson, Jamie Wilkinson, and Robin Stiles from the Camborne School of Mines. Ending as it had begun in Carajas, in the rain, my final day was a fascinating excursion through the St. Just area, closing with a view from the ancient mine at Botallack of an engine house stack and the headframe of the Geevor mine.

Carajas to Cornwall, an adventure I won’t forget. At the beginning, a world-class district in ascendancy; at the end, a world-class district in dormancy. But in every region, fascinating and enjoyable interactions with geologists committed to a better understanding of the Earth and its natural resources.
1. Some of the nearly 150 members and guests at the SEG luncheon held on February 27, 2001, at the Marriott Hotel, Denver, Colorado. Seated on the far side of the table, center, are Cesar Vidal, Regional VP for South America, and his charming wife, Norma.

2. President James Franklin presenting the energetic and popular William Chavez, Jr., with a certificate recognizing the latter as a Thayer Lindsley Visiting Lecturer for 2000–2001.

3. Constantino Mpoocois, SEG International Exchange Lecturer, receiving his 2000–2001 award from President Franklin. Constantino commenced his three-week-long North American tour in Denver, Colorado, and was undeterred by the failure of his airline baggage to accompany him.

4. President James Franklin explaining some of the finer points of Society leadership to an apparently skeptical President-Elect David Groves. The changing of the guard took place on April 1, 2001.
Paul Bailly graciously accepts the well-deserved Ralph W. Marsden Award for 2000 from President Franklin. The award is presented in recognition of outstanding service to the Society by a long-standing member.

Jeffrey Hedenquist receives the Silver Medal for 2000 from President Franklin after enjoying an unprecedented, complimentary citation speech by Noel White. The award is given for mid-career achievement of excellence in mineral deposit geology.

Following the citation of Don Alberto Benavides de la Quintana as 2000 Penrose Gold Medal recipient by Prof. Ulrich Petersen, Don Alberto delivers his acceptance speech. Both the citation and acceptance speeches for this and the Silver Medal and Marsden Award will be published in a future issue of Economic Geology.

The new-look SEG exhibit booth "manned" by Alice Bosley, Director of Editing, and Sue Courtney, Administrator of Membership Services.

The 2001 President of the SEG Foundation, Richard Nielsen, reporting on Foundation activities and plans for the future.
SEG STUDENT CHAPTER NEWS

STUDENT MEMBERS FROM THE Université du Québec à Montréal SEG Student Chapter held a three-week field trip to Péru in January 2000. The group was composed of 20 third-year B.Sc. students accompanied by Alfred Jaouich, a professor in pedagogy and environmental studies, and by Stéphane Digonnet, a Ph.D. student in economic geology and metallurgy.

The purpose of this field trip was to see active geologic environments, mining exploitation unknown in eastern Canada, and environmental problems associated with this exploitation. Our itinerary included visits to three mine sites, as well as mapping of recent volcanosedimentary deposits around the Misti and Checheni volcanoes. In addition, we examined a geologic cross section from the Pacific Ocean to the high-altitude Titicaca Lake.

The project provided an opportunity to complement experiences acquired during undergraduate courses, field school, and summer jobs, which are generally in Québec. Several stops were made, and three mines visited. The mines included (1) Cerro Verde, (2) Cuajone, and (3) Oropampa. This field trip also permitted us to discover new and interesting people and cultures.

After a long flight, approximately 20 hours, we arrived in Arequipa for the first leg of the journey. We had a day of rest and altitude-acclimatizing before we headed for the Andes. The first stop was the Cerro Verde mine, at 2,500-m elevation. The Cerro Verde open pit is owned by the Minera Péru Company and was discovered in 1868. The reserves of this mine are estimated at 62 Mt with 1% copper oxide and content of 0.6% Cu in sulfides. The Cerro Verde copper porphyry deposit was emplaced during the early formation of the Coastal batholith (60 Ma). The intrusion, which is the primary source of copper, is granodiorite in composition. It was later altered by hydrothermal fluids that formed the high-grade concentration of copper oxides, mainly cuprite and chrysocolla. In the hypogene zone, chalcocite is the main copper-carrying sulfide. The mine is currently exploiting the rich supergene zone by means of an open pit. The primary sulfide zone will only be mined when the grade of the oxides falls too low. We toured all of their facilities, including the impressive copper oxide leaching plant that covers the bottom of the valley. A member of the geological staff gave a formal presentation on the subject.

The second part of our journey took us on some narrow and twisty roads to the Cuajone mine site, 3,200 m a.s.l. Along the route we made a few stops to view the geologic features of the Andes, and we also stopped to let herds of llamas cross the dirt road. Cuajone is considered a city in itself, with its own hospital, school, and golf course—the highest in the world. It is situated about 640 km from Lima in the southwestern part of Peru. The Cuajone open pit has been exploited by the Southern Peru Copper Company for more than 30 years, along with its sister site, Induquela, a few hundred kilometers away.

The Cuajone deposit is principally igneous—the central part of the deposit is composed of a little porphyry and andesite that intrude a thick sequence of basalt and rhyolite. In 1970 the work on removing the superficial barren cap began. By 1976, the first copper ore was extracted from the open pit. Since then, more than 3,96 Mt of ore has been extracted at an average grade of 0.98% Cu. The deposit is characterized by three intrusions: (1) one is rich in Cu and Mo, (2) one, to the east, is rich only in Cu and (3) the last is a Zn-Ag-Cu-Mo breccia. The exploitation of the latter was to begin in late 2000. With a production of 185,000 tons a day, the company still has more than 42 years of reserves with 0.4% Cu cutoff grade.

The third part of the journey took us to a very remote area of Peru. After a long, grueling drive in a cramped little bus, we arrived at the summit of a windy and snowy pass at more than 5,000 m. What a view! We then made our way down the other side, to the Oropampa mining district and the Oropampa mine, our final destination. Oropampa is situated at more than 3,800 m and is owned and operated by the Buenaventura Mining Company. In 1998 the company extracted more than 2,921,851 oz Ag and 16,020 oz Au, as well as some copper, from 247,300 tons of ore. The mine consists of an epithermal fissure system, known as the Calera vein, and its annexes. These veins cut a volcanic sequence of silicic rock by means of a conjugated fault system. High- and low-sulfidation veins are marked by a five-phase epithermal fluid circulation. The reserves for this deposit are set at more than 40 Moz of Ag and 400,000 oz of Au.

A fourth stop was planned for Tintaya, but we were unable to make it over the 5,000-m pass. We actually had to push the bus in a foot of snow to turn it around. The trip finished at Oropampa, where we spent a few days studying the recent volcanic deposits and hydrothermal systems.

The fifth phase of our journey took us to the foot of the Misti and Checheni volcanoes, just a few kilometers from Arequipa. We had a volcaniclastic deposit workshop on the slopes of Checheni and Misti.

The sixth part of our trip took us to the Titicaca Lake in the southern part of the country to finish our Andean geologic transect, and we also had a Quaternary geologic workshop on recent sedimentary lake deposits. Our final destination was the visit of Machu Picchu and its archeological sites.

We would like to thank the Society of Economic Geologists and the UQAM student chapter for financial and logistical help that made this field trip a reality. Thanks to the Southern Peru Copper Company for letting us visit their facilities. Thanks to Stéphane Digonnet; Alfred Jaouich; Li Van étudien, UQAM, Mr. Gilbert Prichonnet; Fantasia Travel agency Arequipa, and La Fondation de l’UQAM for their great support. We offer a special thanks to the Buenaventura Mining Company for their hospitality and a good reserve of oxygen on our arrival.

Participating students were Simon Langlois, Nicolas Désilet, Caroline Dufour, Roxanne Gratton, Odile Provencer, Patrick Poulin, Pascal Meilleur, Benoît Simard, Étienne Frénette, Isabelle Masse, Jean-Sébastien Lajoie, Sophie Lafontaine, Jean-François Leduc, Cloutier, Jean-François Henri, Nadine Adnin, Simon Gagné, Besma Guizani, Alexandre Montcalm, and Pierre Nadeau.
EXPLORATION REVIEWS

ALASKA

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Over the last quarter, the Alaska mining industry has been trying to take stock of where it has been in the last year and where it’s going in the new millennium (yes, I’m one of those). Where it has been is easy; declining gold prices, uncertain yet reasonable base metals prices, and soaring platinum and palladium prices. Where we are going is anything but clear: crystal balls are murky or opaque to everyone I know except revisionists who can tell us why the metals markets performed as they did but only after they performed as they did. Funny, that. The only things that seem certain are that high quality projects will continue to be advanced regardless of the commodity they contain and the only way to make new mineral discoveries is to break rocks and drill holes (well, drill!). The only other sure thing for 2001 is if you don’t ask, you don’t get!

WESTERN ALASKA

Cominco American’s Red Dog mine turned in another strong year in 2000. The mine produced a record 960,000 tonnes (t) of zinc concentrate and 139,000 t of lead concentrate while earning $127 million in net income. The mine shipped 911,000 t of zinc concentrate and 132,000 t of lead concentrate during the 2000 shipping season. The company’s $90 million mill optimization project is on schedule for a fourth-quarter 2001 completion. This design increase will push production to 1.3 Mt of zinc concentrate per year.

The Tundra Telegraph says Cominco American will soon announce a revised resource calculation for its Anaraq deposit 6 miles northwest of the Red Dog mine. The company also made yet another new exploration discovery they are calling Wullik, located between Anaraq and the Su-Lik deposits. Apparently limited drilling at Wullik was conducted in 2000 and it intercepted significant zinc-lead-silver mineralization.

Assay results from North Star Exploration’s Kiyah silver-gold prospect near Kaltag did not result in a significant new discovery but did indicate a large gold-silver system is present on the property. Plans for 2001 are pending.

North Star Exploration also announced plans to conduct additional work at its Dime Creek PGE prospect on the Seward Peninsula. Detailed work programs and budget have not been released.

EASTERN INTERIOR

Kinross Gold announced year-end 2000 results from its flagship, Fort Knox mine. The mine channeled out 362,959 oz of gold at a cash cost of $203 per ounce. During 2000 the mill processed 13.6 Mt of ore grading 0.94 grams of gold per tonne. Mill recovery was 89%. Total production costs including $888/oz for depreciation, depletion, and amortization were $294/oz, a $28/oz decrease over 1999 levels. The mine had an outstanding fourth quarter that saw production of 112,745 oz of gold at a cash cost of only $167/oz. With additional production from True North (see below) in 2001, the company is expecting its Fairbanks operations to produce 450,000 oz of gold at a cash cost of $196/oz.

Kinross Gold initiated the $50 million construction phase of its True North satellite deposit in January. Ore from the True North pit will be trucked to the Fort Knox mill via a dedicated haul road. Once operations begin, the mine will contribute $80,000 oz of gold per year to the Fort Knox mill and will generate 110 new jobs and $54 million per year in new revenue in the Fairbanks area.

Kinross Gold and joint venture partner Teryl Resources released their year-end results from continued drilling on the Gil deposit. Drilling completed during two work programs in 2000 consisted of 29,768 ft of drilling in 95 reverse circulation holes and 15,762 ft of drilling in 33 core holes. Gold results from Phase II drilling in the Main Gil area return 75 ft grading 0.138 oz/ton and 30 ft grading 0.085 oz/ton in hole 201, 65 ft grading 0.054 oz/ton in hole 161, 75 ft grading 0.024 oz/ton in hole 167 and 85 ft grading 0.055 oz/ton in hole 176. Phase II drilling in the North Gil area returned 110 ft grading 0.122 oz/ton in hole 166, 45 ft grading 0.073 oz/ton in hole 227, 55 ft grading 0.041 oz/ton in hole 235 and 65 ft grading 0.12 oz/ton in hole 238. Exploration plans for 2001 are in progress.

The U.S. Environmental Protection Agency (EPA) released its Scoping Responsiveness Study on Teck Corp. and partner Sumitomo Metal Mining’s Pogo mine permit. This document summarizes the public responses received by EPA as part of the scoping process for the Environmental Impact Statement being prepared by the EPA for the project. The EPA also reported that baseline data-gathering was nearing completion and that a draft EIS document would be published in April, followed by public hearings in May. Details regarding the EIS process can be viewed online at www.pogominers.com. Meanwhile, back at the farm, the partners reported that metallurgical pilot plant work completed in 2000 revealed positive grinding, flotation, leaching, and gold recovery data that are being incorporated into the mill design.

Western Keltic Mines announced that Barrick Gold Corp. has exercised its option to enter into the option phase of a joint venture on Western Keltic’s properties in the Goodpaster district east of the Pogo deposit. Barrick made a $500,000 cash payment and must spend $2,000,000 within three years to earn a 51% interest in the property. Plans for additional surface work and drilling for 2001 are being prepared. Western Keltic currently owns a 75% interest in the property and can earn an additional 10% interest from co-owner Rimfire Minerals.

Sumitomo Metal Mining has terminated its option with property owner Ron Bailey on the Rob claim block on Tibbs Creek in the Goodpaster district. The property encompasses the Gray Lead, Michigan, Blue Lead, and Wolverine prospects where extensive mapping, geochemical sampling, and drilling were conducted between 1995 and 2000. Results include grab samples up to 5.43 oz/ton gold.
and drill intercepts up to 13.5 ft grading 1.01 oz/ton gold from the Gray Lead prospect, grab samples up to 28.9 oz/ton gold from the Michigan prospect, grab samples up to 27.8 oz/ton gold and drill intercepts up to 77.4 ft grading 0.04 oz/ton gold from the Blue Lead prospect and grab samples up to 2.25 oz/ton gold from the Wolverine prospect.

Ventures Resource has renegotiated agreement with Doyon Limited whereby Ventures will have an additional two years (until 2005) to complete exploration work on the 3-million-acre Doyon land block. During 2001 and 2002, Ventures must pay Doyon an annual cash option payment of $250,000 and an additional cash or stock payment equivalent to $150,000. In 2003 and 2004 the cash payments will increase to $300,000 annually and the cash or stock payments will increase to $200,000 annually. Ventures has spent over $12 million exploring the property since 1996 and has identified several promising targets which merit additional exploration.

North Star Exploration announced additional results from diamond drilling at the Northway Road Metal prospect near Northway. Assay data for trace metals in hole RM00-4 indicate high values of copper, bismuth, antimony and lead are present in addition to gold and silver values. Based on analysis of the 2000 data, the company is planning to complete additional geophysical surveys and 10,000 to 15,000 ft of drilling in 2001.

Cusac Gold Mines Ltd. acquired 80% interest in the Taurus porphyry copper-molybdenum project near Tok. The deposit contains an estimated 50 Mt grading 0.5% copper and 0.07% molybdenum and is hosted in an early Tertiary granitic body. Exploration of the area in the 1990s suggested there is potential for gold in some areas. The company is searching for a joint venture partner to manage further exploration of the property.

North Star Exploration plans to conduct exploration on its Step Mt. zinc prospects north of Eagle. The company plans to conduct early spring 2001 fieldwork with the aim of drilling at least one of several known Mississippi Valley-type targets in the region during 2001.

SOUTHEAST ALASKA

Santoy Resources released additional results from the 2000 underground sampling program on the Salt Chuck copper-palladium prospect on Prince of Wales Island. The program consisted of underground sampling on the 300 level of the old mine workings. Channel samples returned an average grade over 491 ft of 0.59% copper, 2.0 g/t palladium and 0.64 g/t gold. Underground sampling has now covered all of the accessible areas of the 300 level and covers an area measuring 100 m east-west by 75 m north-south. Mineralization appears to be open along strike to both the east and west. Sampling results indicate significant palladium values are present even when elevated copper is not. In addition to underground sampling, four high priority surface exploration targets have been outlined by rock, soil and magnetometer surveys in the North Pole Hill area northwest of the old mine workings.

International Freegold Mineral Development announced that 2000 fieldwork on its Union Bay platinum group element property in the Alexander platinum belt in southeastern Alaska has returned high-grade platinum and palladium values from ultramafic rocks. Rock samples from these areas returned values ranging up to 18.1 g/t platinum plus palladium from outcrops on the property. Three contiguous 5-ft chip samples returned 3.4 g/t, 6.0 g/t and 17.31 g/t combined platinum plus palladium. Anomalously high platinum group element mineralization is associated with chromite and/or magnetite-bearing pyroxenite and olivine pyroxenite units in at least three areas of the property.

Red Diamond Mining Co. acquired the Mammoth project on Admiralty Island. Massive sulfide mineralization was first explored by limited drilling in 1988 and was thought to be the extension of the mineralized horizons mined at the nearby Greens Creek mine. Mineralization is hosted in a quartz-carbonate-mafic-ultramafic altered horizon and contains minor metals as the Greens Creek deposit. The company has recommended a $425,000 work program budget for 2001 that will include surface mapping and sampling, geophysics and limited drilling.

Alhina indicated that work completed in 2000 by Freegold returned values up to 21.3 g/t platinum plus palladium from the Raven zone and highly anomalous platinum and palladium from three other areas of the property. Mineralization is hosted in clinopyroxene-rich ultramafic rocks and is associated with elevated copper, nickel, and chromium. Alhina currently is searching for a new partner to continue exploration of the property.

Shear Minerals Ltd. commenced its spring 2001 field program on the Shullin Lake diamond project west of Deline. Six high priority targets will be evaluated by ground geophysics in order to prioritize these targets for drilling in 2001.

Golden Phoenix Minerals is seeking a joint venture partner for its Cirque massive sulfide prospect in the Bonnefield district. The prospect was discovered in the 1970s and drilled for the first time in 1999. Results of that program included 17.1 ft grading 0.083 oz/ton gold, 2.17 oz/ton silver and 11.55% lead plus zinc plus copper along with a second hole in the same area that returned 6.2 ft grading 0.026 oz/ton gold, 1.4 oz/ton silver and 11.49% lead plus zinc plus copper. Mineralization remains open along strike and down dip. Additional drilling and induced polarization ground geophysics are recommended on the property.

ALASKA RANGE

Alhina Minerals announced that International Freegold Mineral Development, Inc., has opted not to continue work on Alhina’s Tonsina platinum-palladium property north of Valdez.
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BRITISH COLUMBIA

Rimfire Minerals Corporation has an option to acquire 100% of the Thorn high-sulfidation epithermal, copper-gold-silver property from Kohina Pacific Gold Corporation, subject to a 3.5% NSR. Thorn is located in the northwest corner of the province, 125 km northwest of Telegraph Creek. The property covers a Late Cretaceous/Tertiary felsic intrusive/volcanic complex which has been cut by syenite-pyrite altered over a 1.4 x 2 km area. Quartz-pyrite-epargyrite-tetraedrite-alunite veins are dominantly hosted by altered feldspar quartz-biotite porphyry but mineralization also occurs in Triassic basalt/andesite. Eight holes were drilled in 1986 in the central part of the property; all intersected mineralization with the best being 0.1% copper, 3.6 g/t gold and 3.4 g/t silver over 7.8 m; much higher values have been recorded in surface samples. Rimfire completed an airborne electromagnetic survey over the property in 2000.

Doublestar Resources Ltd. acquired numerous properties formerly owned by Falconbridge Limited in B.C., including Sustut and Carface. Sustut is a volcanic-hosted red bed copper deposit located 115 km north of Smithers. Chalcocite, bornite, chalcopyrite, native copper, hematite, and pyrite are disseminated within fractures and matrix of shallow dipping, Late Triassic Tuktu Group volcanioclastics. Sustut has a resource of 21 million tonnes (Mt) grading 1.2% copper. Drilling by Doublestar in 2000 was directed at better defining mineralization in the Southeast zone, which contains about 10 Mt at 1.5% copper plus 5 g/t silver. Carface is a porphyry deposit on the west side of Vancouver Island containing a resource of 167 Mt at 0.4% copper plus minor molybdenum and gold.

National Gold Corporation optioned the Zinger gold property in the Purcell basin west of Cranbrook, in southeast B.C. In his annual exploration review for the Ministry of Energy and Mines, Tom Schreiber noted that previously the attraction on the property was mineralization in large quartz veins but it is now recognized that gold is more widely dispersed in the Proterozoic sediments in association with silicified zones and quartz stockworks. Mineralization is apparently controlled within specific stratigraphic horizons adjacent to high-angle structures.

Joint venture partners Redhawk Resources Inc. and ZincoX Resources Ltd. are exploring the oxide potential of the Remac property. The former Reeves MacDonald mine, which produced 5.8 Mt averaging 3.7% zinc and 1.0% lead between 1949 and 1977, is within the property. Targets are the zinc-rich, upper, oxidized portions of four carbonate-hosted sedimentary bodies in the Early Cambrian Reeves Formation. Oxidation extends to as much as 450 m below surface and the principal oxide deposit is 150 m wide in cross section. The best intersection from a recent drill program was 15% zinc over 15.0 m. The property is located 25 km southeast of Trail near the U.S. border.

In central B.C., 175 km northwest of Fort St. James, Alpha Gold Corp. drilled 29 holes (4,860 m) during 2000 to test skarn and alkaline porphyry-related gold-copper-zinc targets on the Lustdust property. Mineralization is related to contacts between Permian Cache Creek Group sediments and monzonite to rhyolite stocks and dikes. Skarn with chalcopyrite and sphalerite is within limestone and argillite.

During 2000, exploration also continued at Bonanza Ledge (International Wayside, Newsletter 43). Red Mountain (Wheaton River, Newsletter 43) and Fox (Gitenes: Newsletter 44). Gitenes completed an airborne electromagnetic survey, induced polarization surveys, mapping and prospecting at Fox, and is planning a drill program in early 2001.

NORTHWEST TERRITORIES

De Beers Canada acquired control of the Snap Lake diamond deposit (Newsletter 43) by buying Winspear Resources at a cost of C$305 million, and recently completing the remaining 32% by purchasing Aber Resource’s interest in Snap Lake for C$173 million. De Beers is expected to complete its development as quickly as possible with a view to achieving production within a few years. Snap Lake is 220 km northeast of Yellowknife and contains a resource of 22 Mt grading 2.0c/t, potential exists to double the resource.

Following favorable results from a previous bulk sample, De Beers is spending an additional C$10 million on bulk sampling of the Hearne and 5034 kimberlite pipes located 115 km southeast of the Ekati mine (Newsletter 43). De Beers had previously earned a 51% interest in the AK-CJ claims, also known as the Kennedy Lake project, which is a joint venture with Mountain Province Mining and Camphor Ventures.

NUNAVUT

One of the largest exploration programs in western Canada last year was by Miramar Mining Corporation and Hope Bay Gold Corporation, formerly Cambex Exploration, on their Hope Bay gold project (Newsletter 43). The property covers an 80-km-long Archean greenstone belt immediately south of the Arctic coast. Mineralization at the Boston deposit (5.7 Mt at 13 g/t), near the south end of the belt, is associated with pyrite in a series of irregular, anastomosing quartz veins within an ankerite-dolomite-sericite-paragonite altered shear zone, at a breccia in the shear zone. Although there are several smaller vein systems at Boston, most of the resource is in the B2 vein. Near the north end of the belt, mineralization at the...
**YUKON TERRITORY**

Exploration spending in the Yukon during 2000 was at its lowest level in more than 30 years, reflecting low metal prices, a lack of funding and a problem shared with B.C., a significant reduction of land available for exploration. In the annual Indian and Northern Affairs exploration overview, Mike Burke indicated that the $88.8 million spent in exploration was directed at a wide range of precious and base metal targets. Gold exploration was again dominated by intrusion-related targets in the Tinmin gold belt. The Klane ultramafic belt was the focus for PGE targets, and the main base metal exploration efforts were for VMS deposits in the Finlayson belt and sedex deposits at Howards Pass (Newsletter 44).

**Canadian United Minerals** drilled 350 m in eight holes on the Horn property north of Dawson. Although drill results are not available, previous channel samples on Horn, from pyroclastic flows developed in bedrock, have been as high as 85 g/t gold over 4.6 m. West of Mayo, **Redstar Resources** optioned the Clear Creek property from Newmont and drilled the Bear Paw breccia. Three of the 10 holes drilled intersected 2 g/t gold over core lengths of 27 to 35 m in quartz breccia, which has cut metasedimentary and intrusive rocks.

**WESTERN UNITED STATES**

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As part of the annual Christmas party circuit, AIPG (can you say that in an SEG publication?) held its annual exploration forecast meeting, during which several exploration managers presented brief discussions of plans and budgets for 2001. The general theme was reduced spending, and if you can’t see the headline from the drill rig, that is considered grassroots exploration, which is not in the cards. To put a punctuation mark on the talks, one company canceled before the time the programs were printed and the meeting was held because the office was closed and the staff was made redundant (I always liked that British phrase—it sounds as if there is a kindness in staff reductions). Several other office closures have also happened this winter in Reno. Of course, company names will not be mentioned to protect the guilty.

**COLORADO**

Robert Friedland and the U.S. and Colorado governments have decided to make nice. Friedland has agreed to pay $27.75 million over 10 years to settle claims against him and **Galactic Resources** over the cleanup of the closed **Summitville** mine. The settlement still requires court approval.

**Summit Minerals** has reported positive drilling results at the **Doctor** property in Gunnison County. Eleven out of 18 holes encountered significant oxide zinc mineralization varying from 1.47% Zn over 30 ft to 20.73% over 20 ft. Mineralization occurs along a steeply dipping zone that is at least 500 ft long, 50 ft wide, and 125 ft thick, and is open along strike. The principal zinc mineral is smithsonite.

**IDAHO**

**Formation Capital** has filed a plan of operation with the U.S. Forest Service to mine the **Sunshine** and **Ram** deposits (Custer County), which have combined reserves of 974,700 t of 0.69% Cu, 8.69% Co, and 0.02 opt Au. Mineralization is hosted in a tuff sequence within the Proterozoic Yellowjacket Formation.
MONTANA

ASARCO is planning to suspend operations indefinitely at the East Helena smelter (Lewis and Clark County) this spring. The closure is being forced by a lack of raw materials and poor market conditions. The smelter was opened in 1886. This has resulted in Sunshine Mining announcing the closure of the Sunshine mine in Idaho because of the lack of a smelter for the mine's product.

Idaho Consolidated Metals has jumped on the platinum group metals exploration bandwagon. The company controls about 30,000 acres along several horizons in the Stillwater Complex (Stillwater County) that apparently have significant platinum group metal anomalies. These include portions of the JM Reef (Stillwater mine developed along this horizon), “A & B” Chromite Horizons, and the Picke Pin Horizon. Permits have been granted to drill several of these targets.

NEVADA

The annual review meeting of the Ralph J. Roberts Center for Research in Economic Geology (CREG) was held in Reno during early February. As I have said in the past, if your company (or you) is not a member of CREG it is your loss. Talks were presented on new research at the Cove, Murray, and Ken Snyder mines in Nevada, as well as regional work along the Carlin and Getchell trends. Tommy Thompson is expanding the organization’s activities with studies in progress in the Yanacocha, Peru, and Veladero, Argentina, regions. These on the Rain, SXX, Railroad, Deep Star, Toiyabe, Turquoise Ride, and Getchell deposits have been completed and are available for purchase. Information on any, or all, of these studies can be obtained from CREG at UNR/CREG, Mail Stop 169, Reno, NV 89557 (775) 784-1382, or creg@mines.unr.edu.

Not all of the news out there is negative. Some people are actually doing exploration. My source of information, Deep Hole (cousin of Deep Throat), has told me of two successes. Apparently there is a deep discovery in the 1.0-1.5 Au range on the Ren property in the north part of the Carlin Trend. Also, there may be a very high grade drill hole intercept at a modest depth on a property west of Midas. Both of these are in Elko County.

X-Cal Resources has released an announcement about the Sleeper gold property in Humboldt County. Some of the statements that seem fairly bold are summarized herein. Three-dimensional modeling suggests a largely unexplored mineral system with deep crustal origin. At no cutoff grade there is an estimated 11.9 Moz of gold and at a 0.015 opt Au cutoff there is 7.6 Moz of gold. X-Cal refers to this as a “measured anomaly” (hope the SEC doesn’t see that). The final statement that caught my eye was that the “model suggests that a mega gold deposit may occur at depth.” I can remember drilling 5,000+ ft holes back in the good old molybdenum days. Are they coming back into vogue?

Desperate times produce desperate measures, or something like that. Golconda Resources is planning to drill a 2,000-ft hole at the South Monitor property in Nye County. Amex Gold (remember them?) drilled the property several years ago and discovered a low-grade gold resource in Tertiary tuffs. Golconda is considering that the mineralization is leachable from a larger “Carlin-Type” system in Ordovician limestone that may exist at a minimum depth of 1,250 ft. What if something like 50 pph gold is at those depths? Is that the margin of a larger deposit, or just another money sink? Good luck, guys.

White Knight Resources has announced the results of last year’s drilling program at Indian Ranch, Eureka County. Eleven holes were drilled targeting 1,650 ft. Several holes intersected Lower Plate units, and of course, since these lithologies host gold in other parts of Nevada, this must be encouraging. The only specific results released were 10 to 80 ft of less that 0.022 oz Au, commonly below 350 ft.

Vista Gold has taken a large step toward the closing of the Hycroft mine (Humboldt County) by selling the head trucks. Rising of the existing heap is producing 18 to 20 oz of gold per day.

Placer Dome has downgraded the reserve at Getchell (Humboldt County) to a resource category. The release states that, despite a multimillion-dollar exploration program, development of the N zone “has not progressed as quickly as expected due to challenging ground conditions and the complexity of the orebody.” Is this an understatement, or what? At a 0.2 opt Au cutoff, the new measured and indicated resource contains 9.5 Moz of gold, but there was no mention of grade! Placer Dome says it has “no intention of throwing in the towel.”

Coeur d’Alene is having success at finding additional potentially mineable silver mineralization at the Rochester mine, and the nearby Nevada Packard property (both in Pershing County). A total of 61,500 ft were drilled in 161 holes around the margins of the Rochester mine. Calculations are in progress to bring this new mineralization into reserve status. At the end of 1999 the reserve at Rochester was 48.3 million tons averaging 1.09 opt Ag and 0.01 opt Au. At Nevada Packard 73 holes totaling 23,920 ft were drilled, extending known mineralization laterally and at depth.

Are we learning how to live with these depressed (?) gold prices, and as Doug Silver pointed out in a recent Geotimes article, is this adding to our problems? A case in point is the Round Mountain mine (Nye County). Year 2000 production was 640,000 oz of gold (up 100,000 oz from 1999) with a fourth quarter cash cost of $183/oz of gold. They are replacing smaller haul trucks with new 240-t trucks, which will produce more gold at a lower cost/oz. How much will this add to the pressure on the gold price? Any bets on whether any of us will see $400/oz gold price in our careers?

In the same vein, well maybe the same dissemination, the Ruby Hill mine (Eureka County) produced 125,300 oz of gold in 2000 at an average cash cost of $106/oz of gold.

Great Basin Gold has outlined about 1 Moz of gold in the Clementine and Gwenvire vein systems at the Ivanhoe property in Elko County. Attention is now being turned to several other targets on the property. Drilling in these areas has encountered 1- to 15-ft zones with grades over 0.50 opt Au. The initial program will target a large, high-grade “plumbing system” beneath the Hollister resource, as well as in the South and North Velvet areas.

Placer Dome has recalculated reserves and resources at the Pipeline mining complex (Lander County) and Bald Mountain (White Pine County) using a gold price of $300/oz. Did you ever think that $300/oz of gold would be considered an optimistic price? At Pipeline, there are proven and probable reserves of 151,338,000 t with an average grade of 0.047 opt Au containing about 7.1 Moz of gold. There is also an estimated 60.6 million tons of mineralized material with an average grade of 0.047 opt Au. At Bald Mountain, proven and probable reserves are placed at 11,529,000 t with an average grade of 0.0288 opt Au. There is also an estimated 9.1 million tons of mineralized material with an average grade of 0.076 opt Au.
EXPLORATION REVIEWS, CONT.

MEXICO

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A victory of sorts was declared by both sides with regard to the issue of the Mavavi Biosphere Reserve, which I spent most of the column on in the October issue of the Newsletter. This biosphere reserve brilliantly covered the heart of the best copper exploration belt in Mexico. What were the odds?

However, unlike the other 12 biosphere reserves that were deemed to be such by Zedillo on his last day in office, this one did not quite make it in under the radar. It is frightening to see how easily these reserves got recommended and then put in place with no input from anybody except a government office and the NGO that proposed them. In the case of Mavavi, victory of sorts was declared by industry when the original 800,000-hectare reserve was scaled back to 300,000 hectares. This is a lot like getting excited about a successful operation to remove half a malignant tumor. I think now that the process and bureaucracy are in place we can look forward to a rapid succession of new proposals to save other pristine areas like those around Carrancas and the Nacostrucan caldera.

On a brighter governmental note, the new Mining Coordinator, Secretaria de Economia, Dr. Salvador Ortiz, and his new team met with mining industry representatives at the Randol convention in Puerto Vallarta in February. I came away impressed that the new group (which may yet include some of the best people from the previous administration) really wants to promote and support mining. If you have a problem that deals with mining issues of any type, Ortiz or someone in his group will work to help you. In particular I was impressed by head of the Mining Registry Ing. Luis Escudero's statement that every effort would be made to speed up paperwork on new claims, existing claims, and freeing up invalid claims. If there is an abandoned property or a caducity claim that you just have to have, if brought to his attention, Escudero will get it published. You may still have to file 3,000 claim applications only to lose to some guy with one application who should have been in Las Vegas. But you will have had the chance. Efforts will also be made with the Hacienda to see that if taxes are not paid on a claim within six months of being doc, the claim will be declared invalid. If true I may be able to delete the near-standard clause in our option-to-purchase contract which covers back taxes that come with the claim to be optioned.

After a lengthy quiet period at San Nicolas, or maybe it was just waiting attention, Teck now appears to be gearing up. They may even be on a track to production in 2003. Feasibility is in progress on a 15,000 ton-per-day open-pit mine that will have a 14-year life and produce 500,000 t per year of copper and zinc in concentrates. For a few of the early years when they are mining the 6% zinc zone, San Nicolas should be one of the biggest zinc producers in the world. Economics, of course, look best if they can catch a spike in the zinc prices during this period. This will make two big new mines for Zacatecas, now that the Peñoles Francisco I. Madero is nearly ready to start up.

An aggressive new entrant in Mexico is the Peruvian miner Mauricio Hochschild, which is exploring two of Western Copper's projects in Zacatecas. The most advanced is the Penasquito project outside Concepcion del Oro, where a substantial low-grade Zn-Pb-Ag-Au deposit is being defined adjacent to one of the huge breccia pipes on the property. The dikes at Penasquito are said to be some of the largest, most intense, hydrothermal features in Mexico. Unfortunately, so far they have yielded mostly pyrite. This may, however, be more of a function of poor host rocks near surface and the shallow level of erosion in the system. Western Copper and Hochschild—if they can get the critical mass built for even a small mine—will likely find that they are in the district for a very long term operation. The pipes cut the entire Cretaceous stratigraphic package and the top 700 m or so is not too favorable for replacement bodies. Below that, however, are nearly endless limestones and these are likely to host substantial skarns and manto. Hochschild is also working on Western's San Jeronimo project outside Zacatecas. This property is one of those that has multiple target types that we love at budget time. I believe for now the high-grade silver veins are being held back and work is on the VMS potential.

In Sonora there's lots of activity in the porphyry belt with Kennecott and the Peñoles-Codelco JV leading the way. Both have had very aggressive programs. Kennecott lived up to its promise to focus on drilling and has drilled something like 8 to 12 blind targets. Noranda and Rio Algom (Billiton) are doing the same thing, only not on so many targets. It can be frustrating stopping hole after hole in gravel, demonstrating little more than that the gravity interpretation was haywire. Unfortunately, without better geophysical tools it's the only way to do this. I hope these companies get to keep it up. Peñoles-Codelco are everywhere—at least, judging by the claim maps—but whether they'll have money to drill after paying taxes is another matter. Unrelated to this JV, Peñoles is going underground at Milpillas to verify the presence of a 30-million-ton 2.5% oxide copper deposit sitting on top of the low-grade porphyry.

Overall, exploration activity in Mexico is holding up fairly well, even on the junior front. Furthermore, a wide variety of commodities and target types are being considered, including the now ubiquitous platinum-palladium projects (and Sanjoy may have a very good one outside of Mazaltan). I look for a very interesting year in Mexico, with more exciting results than we have seen since the Francisco Madero-San Nicolas induced rush in Zacatecas a few years ago.

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According to Metals Economics Group (September 2000),
exploration allocations for the Pacific/Southeast Asia Region increased slightly: from US$196.1 million in 1999 (7.7% of worldwide total) to US$199.2 million (8.5%) in 2000. Expenditures on a country-by-country basis for those countries mentioned herein, however, have increased—with the exception of Indonesia, which experienced a substantial decrease. Expenditures in millions of U.S. dollars for year 2000 and percentage change, increase (+) or reduction (-), between 1999 and 2000 for each country are as follows: Indonesia, $68.8, -26.5%; Philippines, $19.5, +27.5%; Laos, $6.1, +13%; Thailand, $3.1, +210%; Vietnam, $1.9, +18.8%; Malaysia, $1.5, 1999 figure not available; Myanmar, 2000 figure not available; and Pacific/Southeast Asia region, $13.5, +36.6%.

INDONESIA

Facing private industry opposition to several items within the draft 8th Generation Contract of Work (CoW), a new law reorganizing the districts, illegal mining and various environmental and social issues, the Indonesian mining industry has seen better times. Exploration expenditures continued to decrease to a low of US$68.8 million in 2000 (Metals Economics Group, September 2000).

In spite of the various obstacles facing investors, some companies continue to report excellent results. Austindo Resources Corporation has been enthusiastically exploring their low-sulfidation epithermal Cibulung project, 150 km southwest of Jakarta on the island of Java, with positive results. The project is held 63% by Austindo Resources Corporation in joint venture with International Antam Resources Ltd (IAR) and PT. Aneka Tambang (“AntMan”). IAR holds a 57% interest while AntMan holds title to the project through 2 Kusa Pertambangan (KP’s). IAR is 82%-owned by AntMan and is listed on both the Australia and Jakarta stock exchanges. Economic Au-Ag mineralization is hosted in a series of quartz and quartz-adularia veins at surface for a distance of 1.4 km. Two high-grade shoots, Cikoneng and Cibulung, have been identified, with an inferred resource of 649,000 t at 9.76 g/t Au, 70.3 g/t Ag (Cikoneng), and 344,000 t at 9.83 g/t Au, 33.1 g/t Ag (Cibulung), for a total inferred resource for Cibulung of 933,000 t at 9.78 g/t Au and 57.4 g/t Ag ($312,000 oz gold, 1.83 Moz silver). An additional vein system (Gibeber) also occurs 400 m west of Cibulung and has known strike length of 500 m open to the south.

Kalimantan Gold Corporation Ltd. is scheduled to commence a diamond drilling program to test a large soil geochemical anomaly on its Berang Kanan prospect. Previous drilling from within the same area in late 1998 reported positive results.

The Herald Resources Ltd. 71%-owned subsidiary, International Annax Ventures Inc., has reported drill results from their Dairi project and the Sepokomil prospect-Anjing Hitam Pb-Zn shale-hosted, stratiform, massive sulfide deposit located on the Bukit Barisan Highland between north and west Sumatra provinces. The Anjing Hitam deposit has been outlined by 21 holes along 100-m spaced sections and remains open for expansion through continued drilling. The main sedex horizon is estimated to be approximately 28 m in true thickness from about 200 to 300 m down dip with extended zinc and lead content ranging from 20 to 30%. International Annax Ventures Inc. also reported that the recovery of massive sulfide grading 23.0% combined Zn-Pb over 5.5 m in hole 45D of the Bengkulu sector, 2.5 km north of the Anjing Hitam deposit confirms the presence of high-grade sedex style mineralization in this area.

LAOS

In December 1999, Oxiana agreed to purchase an 80% interest in the Sepon copper-gold project from Pacific Resources Investments Ltd (Rio Tinto subsidiary) subject to government approval, final legal and commercial due diligence by Oxiana, and project financing. The project was approved by the Laos PDR government and a bankable feasibility study began in August 2000, including infill drilling and metallurgical studies. The bankable feasibility study is expected to be completed by June 2001. Oxiana agreed to pay Rio Tinto US$4 million at closing, US$8 million at decision to mine when project financing is in place, and US$22 million/yr for 5 years beginning in the second year of commercial production. Rio Tinto is entitled to a 15% net revenue royalty beginning in the eighth year of commercial production subject to metal price hurdles.

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The Sepon project is located in southwest Laos near the border with Vietnam. Estimates indicate the main copper deposit (Khanong) contains an inferred resource of 41.4 Mt at 2.4% Cu using a copper cutoff grade of 0.5% Cu including 18.5 Mt at 4.2% Cu using a copper cutoff grade of 1.5% Cu. While 51.5 Mt at 2.22 g/t Au is contained in five main deposits totalling 3.6 m oz. Prefeasibility studies by Rio Tinto showed that the deposits are capable of producing around 40,000 t of cathode copper (Leach SX-EX) and 125,000 oz/annum of gold (Cheat Leach/CIT) for more than 20 years.

The feasibility study is being approached in two stages, the gold stage to be completed around middle of this year, and the copper stage by the end of the year. Late last year the 35,000 m drill program got under way focusing on the Khanong and Naion deposits and confirmed the results reported earlier by Rio Tinto, including gold intersections of 30.8m at 4.72 g/t, 16m at 5.37 g/t, 9m at 12.1 g/t and 7m at 9.8 g/t.

Preliminary CTL tests on core samples from all five gold resources, Naion, Discovery, Discovery West, Namok, and Khanong, were conducted with gold recoveries from oxidized ore ranging between 83% and 93%. Recoveries from partially oxidized ore ranged between 72% and 93%.

Pan Australian Resources NL has also been active in Laos in September, managing to secure a Call Option Agreement with Normandy Anglo Pte Ltd in order to acquire an 80% interest in Bhu Bia Mining Ltd (100% subsidiary of Normandy Anglo), the latter holding a Mineral Exploration and Production Agreement with the Lao Government. In return for their 80%, Pan Australian Resources NL has agreed to issue a total of US$500,000 in Pan Australian shares to Normandy Anglo, in addition to a US$500,000 payment in cash upon a decision to mine. An additional US$1 million per year for 2 years will be paid to Normandy Anglo following commencement of mining operations.

The main area of interest within the contract area is Phu Kham, approximately 100 km northeast of the Lao capital, Vientiane. An upper gold oxide inferred resource of 10 Mt at 1.0 g/t Au, a lower heap leachable copper inferred resource of 40 Mt at 0.5% Cu, and a primary sulfide inferred mineral resource of 85 Mt at 1.1% Cu at a 0.5% cutoff have been identified.

**MALAYSIA**

Perilya Limited has continued work on its Tampon prospect in the Malaysian State of Sarawak (Borneo island) where they have a 50:50 JV with Manam Copper Mining Sdn Bhd (wholly owned subsidiary of Mega First Corporation Bhd). The prospect is located 10 km east of the mined-out Manam porphyry copper-gold mine (130 Mt at 0.52% Cu, 0.36 g/t Au) and covers a 5 km-long, west-northwest-trending zone of coincident Cu, Au, and geophysical anomalies within which the Bongkud, Napong, and Junction anomalies have been identified.

Drilling to date on the Bongkud anomaly, a strongly veined and mineralized gold-rich porphyry target discovered in early 1999 has returned intersections of 331 m at 0.31% Cu, 0.70 g/t Au, 123 m at 0.43% Cu, Au 0.95 g/t Au, and 74 m at 0.57% Cu, 0.95 g/t Au. The target occurs below an oxidized zone averaging 42 m in thickness. Here supergene ore has returned copper grades up to 3.5% while hypogene ore averages 0.31% Cu and 0.70 g/t Au.

Menzies Gold Ltd continued work on its project in the Malaysian State of Sarawak (Borneo Island). In the Pejiru area, a 456-m DD hole was drilled to test for deeper high grade mineralization and structures while 869 m of RC drilling tested northwest-striking structures at Skiat. At Jelong, mapping, soil sampling, and rock chip sampling revealed an area of silification and brecciation. Drill-inferred resources of 11,270,000 Mt at 1.41 g/t Au and 10,400,000 Mt at 1.82 g/t Au, both based on a 0.51 g/t Au cutoff, have been reported for the Pejiru and Jugan areas, respectively.
Avocet Mining PLC continues to successfully mine its open pit Pejom gold mine, announcing in December 2000 a production target of 100,000 oz Au for the year to March 31, 2001. While exploration continues to test continuity of mineralization around the Kalampong pit.

MYANMAR

Ivanhoe Myanmar Holdings, Ltd (IMHL) continues to pursue gold-copper targets in three areas, Lebyn-Shwemenbon, Kyauksayit and Thitseinbin, located in the Shan scarps, approximately 150 km south-southeast of Mandalay. The three areas lie within their original 1400 km² Block 10 secured during competitive bidding in 1996. At Lebyn, stibnite has been worked on and off since the 1930s and is currently being mined by Mining Enterprise 2 (state government). There, stibnite is associated with gold and is the focus of IMHL’s exploration program. At Shwemenbon, approximately 5 km east of Lebyn, the Thayetchaung and SGA prospects are characterized by Au-Cu skarn mineralization in Jurassic calcareous units in close association with diorite intrusions. drilling in the dry season (January-June) of 2000 returned encouraging results. Approximately 5 km south of Lebyn at the Kyauksayit prospect, auriferous mesothermal quartz veins hosted by Carboniferous mudstones and slates have been the focus of recent exploration activities where trenching and sampling are currently ongoing during the 2001 dry season. Approximately 8 km southwest of Kyauksayit, at the Thitseinbin prospect, an outcrop of sulfide mineralization has been identified in sericite schists and marble.

PHILIPPINES

The Philippines has for several years been faced with numerous problems which have affected the mining industry and levels of foreign investment. With a peak in exploration activity in 1997, there were two Financial and Technical Assistance Agreements (FTAA), 39 active Exploration Permits (EP) and 39 Mineral Production Sharing Agreements (MPSA). As of September 30, 2000, these figures had been reduced to two FTAA, six EPs and 15 MPSAs. Against this backdrop of apparent reduced activity, a number of companies have continued to pursue their exploration and development programs and manage the problems at hand. Significantly, although the total number of MPSAs and EPs has declined, the Philippines has experienced a 27.3% increase in total exploration expenditure in 2000 as compared with 1999 (Metals Economics Group, September 2000).

Philex Gold Inc., in joint venture with Anglo American Exploration (Philippines), Inc., caught the attention of all those exploring in the Philippines late last year when they reported in November the latest results from their diamond drill hole program on the Buyongan project in Surigao del Norte, northeastern Mindanao. A total of 11 holes were drilled, intersecting the alteration halo of a porphyry Cu-Au system below Quaternary cover. Important intersects included TSD-2 with a weighted average value for a 204 m intercept from 134 to 338 m of 0.38% Cu and 0.05 g/t Au including a 93 m intercept from 245 to 338 m averaging 0.57% Cu and 0.17 g/t Au; TSD-6 with a 0.1% copper and 0.1 g/t gold cutoff averaging 0.90% Cu and 2.07 g/t Au for a 329 m intercept from 93 m to 122 m; and TSD-9 with a 0.1% copper and 0.1 g/t gold cutoff averaging 0.94% Cu and 1.14 g/t Au for a 279 m intercept from 79 m to 358 m. The exploration program is continuing.

The above results have possibly prompted several companies, including Climax-Arimco, Manila Mining Co. and Mindoro Resources Ltd, to resume exploration activities around the Philex-Anglo discovery.

Climax-Arimco also hold the Didipio project located approximately 200 km north-northeast of Manila, where their Dinkidi copper-gold mine (porphyry Cu-Au deposit) is scheduled to begin commercial production by early 2003. Mine reserves include 577,000 t at 3.8 g/t Au and 0.40% Cu for an estimated 21,000 oz Au and 22,400 t, and 15,200,000 t at 0.5 g/t Au at a grade of 0.04 g/t Au for an estimated 60,000 oz Au. The deposit has an expected mine life of 12 years at a production rate of 2 Mtpy of ore (~5,500 tpd), producing 1.2 Moz gold and 99,300 t of copper metal. A number of similar targets occur within the area covered by the FTAA and will be the focus of future exploration.

Greenwater Mining Corp., a local subsidiary of Placer Dome, has finished a geological and geophysical survey of their Runun project in Nueva Vizcaya in northern Luzon. A drill program is now scheduled to take place this year.

Wealth Minerals, in a joint venture with Dalton Pacific (100% subsidiary of Orixana Minerals, see Sepon project in Laos), has been undertaking geological and geophysical programs on their property in Isabela, northeastern Luzon.

 Phelps Dodge Corporation has been drilling on its Sultan Kudarat property in Mindanao, and completed drill programs on the Boolo and Zamboanga properties.

Through its wholly owned subsidiary MRL Gold Phils Inc., Mindoro Resources Ltd acquired an interest in the Archangel property, 120 km south of Manila, late last year, from Equico Corp. Ltd. (formerly Egitano Gold Phils Inc.). According to the agreement, Mindoro has the right to earn up to a 75% interest in the Archangel project. The area is characterized by porphyry Cu-Au (Bajihago prospect) and high sulfidation Au-Cu mineralization (Kay Tanda and Pulung Lupa prospects) had previously been the focus of exploration by WMC (1987-1989) and Chase-BHP (1995-1998). Work by these companies eventually defined an inferred resource for the high-sulfidation Kay Tanda prospect of 8,390,000 t at 0.68 g/t Au (181,000 oz), based on widely spaced drilling.
THAILAND

Kingsgate Consolidated NL, through its 100% subsidiary Akara Mining NL, continues to forge ahead with its 100%-owned Chatree gold project following news in May that they have received final approval from the Ministry of Industry for the development. Formal construction began in November 2000, with the first gold pour likely to be late 2001.

Measured, indicated and inferred resources total 14.5 Mt at 2.6 g/t Au and 12 g/t Ag (0.8 g/t Au cut-off) for 1.2 Moz Au and 5.4 Moz Ag, while open-cut proven and probable reserves are 8.2 Mt at 3.1 g/t Au and 34 g/t Ag (0.8 g/t Au cut-off at US$250/oz) for 807,000 oz Au and 5.8 Moz Ag. Planned gold and silver production in the first operating year is estimated to be 146,000 oz gold equivalent at a cash cost likely to be less than $100/oz.

The Chatree deposit is a low-sulphidation adularia-sericite epithermal system hosted by argillic and/or Tertiary-age Tertiary pyrite with minor sphalerite, galena, and chalcopyrite.

Pan Australian Resources NL has also made progress with regard to the Puthep copper project by announcing that it has entered into a Participation Agreement with Padaeng Industry Public Company Ltd of Thailand, one of Thailand’s largest mining companies. The firm can earn a 51% flow-through interest in the project by completing a bankable feasibility study that began in February 2000. Union Miniere has also taken a 42% stake and key management role in Padaeng by buying out the Western Metals stake. The first phase of the feasibility study kicked off with a 12 DD hole and 215 RC drill program in order to increase this resource that now stands at 11.6 Mt at 0.34% Cu (average of both Puth 1 and 2 deposits).

The Puthep project consists of two copper deposits (Puth 1 and Puth 2) approximately 12 km apart, characterized by chalcopyrite-chalcopyrite mineralization hosted by volcano-sedimentary sequences.

The Herald Resources Ltd. 71%-owned subsidiary, International Annax Ventures Inc., reported an agreement with the Pands (Choosak) Industrial Minerals Group of Thailand to explore the Bo Hin Khao prospect near Loei in northeast Thailand, where zinc sulfide and oxide mineralization is associated with barite over an 8-km trend. The property was formerly worked for barite; however, investigation in the early 1990s revealed the presence of significant carbonate-hosted, replacement zinc mineralization associated with the barite. Mineralization is hosted in a dolomitized limestone bed in a Permian-Carboniferous age argillite sequence where previous drilling yielded 12 m at 16.7% Zn, 12 m at 10.7% Zn, and 6.4 m at 8.6% Zn. International Annax Ventures Inc. is hoping for a bulk mineable, open-pitable zinc-barite resource. Activities during the last quarter of 2000 included detailed pit mapping and mapping at 1,000 scale of the survey grid area, in addition to metallurgical tests on selected zinc oxide and zinc sulfide-bearing material. A proposed RC drilling program has been postponed due to concentration of company resources on the Dai Lri project in Sumatra (see Indonesia).

VIETNAM

Asian Mineral Resources has begun a 4,000 m drill program on its Ta Khoa nickel prospect in northwest Vietnam in order to test four targets (Ban Phuc, Ban Tang, Ban Nguon, Hong Ngai) delineated through airborne geophysical survey and ground follow-up. Falconbridge has to date spent over $1.5M and is funding the current drill program as part of its option to acquire 51% of Asian Mineral Resources holding in Ta Khoa by spending $5.5M before May 2003.

Olympus Pacific Minerals Inc. has reported further interesting results on its Phuoc Son gold project in central Vietnam. Recent underground channel sampling of artisan workings at Bai Goi, just north of Bai Go, indicates the presence of another high-grade gold shoot similar in character to both Bai Goi and Bai Dau. The three occurrences are along the Dak Sa shear over a strike length of more than 2 km. Interesting drill results reported late last year include 37.3 m at 15.46 g/t Au, 4.92 g/t Ag, 0.04% Pb, and 0.01% Zn, and 1 m at 22.04 g/t Au, 45.0 g/t Ag, and 4.89% Pb.

Tibercor Minerals Ltd. had a good start to its recent drill program which was also testing a geophysical anomaly on their Nui Phao property in northern Vietnam. Drilling intersected gossan followed by porphyry-rich retrograde skarn down to 121.5 m in drill hole NP-5, indicating the presence of a tungsten-polymetallic resource. Word has it that tungsten grades are comparable to other operating tungsten mines.

NEW! ★ MiningPro Matrix ★

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SEG MEMBERSHIP NEWS

CANDIDATES FOR SEG FELLOWSHIP

To all SEG Fellows:

Pursuant to Article I, Section 2, of the Society’s Bylaws, names of the following candidates, who have been recommended for Fellowship by the Admissions Committee, are submitted for your consideration. Each applicant’s name and current position are followed by the names of the three SEG sponsors. If you have any comments, favorable or unfavorable, on any candidate, you should send them in writing before June 15, 2001. If no objections are received by that date, these candidates will be presented to Council for approval.

Address Comments to:
Chair, SEG Admissions Committee
SOCIETY OF ECONOMIC GEOLOGISTS
7811 Shaffer Parkway • Littleton, CO 80127 • USA

Bell, Robert C. Inco Technical Services Limited, Mississauga, ON, Canada; A. James MacDonald, Richard A. Jemielita, Richard H. Sillitoe.


Feeney, Craig A., Metal Mining Agency of Japan, Tokyo, Japan: Jeffrey W. Hecquemont, Richard H. Sillitoe, W. E. I. Minter.

Fleming, Harvick E., University of Cape Town, Rondebosch, South Africa: Brian G. Hoad, Richard J. Goldfarb, W. E. I. Minter.

Hurlbut, Perry K., Retired, Midland, Texas: Murray W. Hitzman, Frank E. Koutsky, Wolfgang E. Elsner.

The Society also welcomes the above candidates as new members.

The society welcomes the following new Fellows

C. Tucker Barrie, C. T. Barrie and Associates, Inc., Ottawa, ON, Canada; David R. Lentz, University of New Brunswick, Fredericton, NB, Canada; Malcolm E. McCallum, Colorado State University, Fort Collins, CO; Harrison H. Schmitt, University of Wisconsin, Albuquerque, NM; Brian Thomson, Kinross Gold, Belmont, Bulawayo, Zimbabwe; Jeffrey Volk, Barrick Goldstrike Mines, Inc., Spring Creek, NV; Koichiro Watanabe, Kyushu University, Fukuoka, Japan.

The Society Welcomes the Following New Members

Raul P. Andrade de Palomeca, Vancouver, BC, Argentina; Kerr Anderson, Naton Mining P.L.C, County Meath, Ireland; William J. Anderson, MPH Consulting Limited, Toronto, ON, Canada; Charles E. S. Arps, National Museum of Natural History, Oegstgeest, The Netherlands; Francisco J. Baars, CPRM—Brazilian Geological Survey, Belo Horizonte, Brazil; Robert M. Baker, Dupont, Guinevere, FL; Finn M. Barrett, Geological Consultant, Victoria Park, WA, Australia; Gary J. Baschuk, Barrick Goldstrike Mines, Inc., Elko, NV, John D. Bernt, Geological Consultant, Burnside, NV; David G. Bond, Getchell Gold Division of Placer Dome, Inc., Winnemucca, NV; David S. Boyer, Magna Chem LLC, Seattle, WA; Adrian M. Brewer, Geological Consultant, Kershbrooke, SA, Australia; Larry J. Buchanan, Apex Silver Mines, Ashland, OR; Peter A. Buckle, Gineco Exploration Services, Townsville, QLD, Australia; Jon W. Cameron, Geo Metrics MNI, Stratford, TX; Robert S. Cameron, Phelps Dodge Corporation of Canada, Ltd., Vancouver, BC, Canada; Jose M. Castello Branco, Rio Nacera Gold Mines SA, Uruapan, Mexico; Alfredo L. Casillo, Sulta, Argentina; Roberto Cavagnin, Consulting Geophysicist, Gilford, BC, Canada; Nilda Gerutto, Universidad Nacional de La Pampa, Santa Rosa, Argentina; Jaime Chavez Abanto, BHP—Tintaya SA, Trujillo, La Libertad, Peru; Julio O. Chavez Tlataviva, Minera Del Surroeste SAC, Lima, Peru; Suck Won Choi, Korean National University, Chungnam, Korea; Genesio Ciricosta, Place Dome Exploration, Hawthorne, Nevada, SA, Australia; Alan H. Clark, Queen’s University, Kingston, ON, Canada; Gerry M. Conia, Anglo American Exploration (Phillipines), Inc., Laguna, Philippines; Dudley H. Corben, Angolgold Ecuador, Quito, Ecuador; Jose E. Crespo Ramon, Geological Consultant, Valladolid, Spain; Peter R. De$Leven, Arca Resources Ltd., Vancouver, BC, Canada; Stephen P. deWit, Hudson Bay Mining and Smelting, Vancouver, BC, Canada; Hello O. Dintz, Nicandi Exploracao Mineral, Rio De Janeiro, Brazil; Paul E. Dirksen, Orvana Minerals, Courc d’Alene, ID; Marco A. Dominguez, Minera Del Surroeste SAC, Lima, Peru; Pat G. Embree, Granite Construction Company, Davis, CA; Stan A. Endersby, Nugget Mines Ltd., White Rock, BC, Canada; Jorge C. Espinoza, Misu Mining Company, La Paz, Bolivia; Reynaldo C. Estacio, Anglo American Exploration (Phillipines), Inc., Baguio City, Philippines; Curt Everson, Nevada Pacific Gold, Spring Creek, NV; James R. Foster, Geonics Exploration Inc., Vancouver, BC, Canada; B. Ronald Frost, University of Wyoming, Laramie, WY; Jocelyne B. Galapon, Philex Mining Corporation, Benguet, Philippines; Carey R. Galeschuk, Tantallum Mining Corporation of Canada Limited, Luc De Bonnet, MB, Canada; Glen L. Garratt, Mingcord Exploration Consultants, Ltd., Vancouver, BC, Canada; Robert G. Gifford, Geological Consultant, Puy Mordi, BC, Canada; Neil L. Godden, WMC Resources Limited, Belmont, WA, Australia; Rene I. Gonzales, Anglo American Exploration (Phillipines), Inc., Quexon City, Philippines; Jayanta Guha, Université du Québec à Chicoutimi, Chicoutimi, QC, Canada; Felix Guillen Guillen, BHP Tintaya SA, Callao, Lima, Peru; Sorin Halga, Samex Services Limited, Essex, Great Britain; Edward Hamilton, McCelland Analytical, Pacheco, CA; Paul J. Heitbersy, North Limited, East Malvern, VIC, Australia; Anthony M. Hesper, Western Metals Copper, Ltd., Townsville, QLD, Australia; Gregory J. Holk, California State University—Long Beach, Long Beach, CA; Maurice W. Hoyle, Universal Resources Limited, Mundaring, WA, Australia; John W. Hoyt, Geological Consultant, Tucson, AZ; Michael R. Hudson, Pimmicno Ltd., Lima, Peru; Roger W. Hulstein, Whitehorse, VT, Canada; Perry K. Hurlbut, Geological Consultant, Midland, TX; Marcelo G. Iodoya, Minamericas SA, Buenos Aires, Argentina; Allan M. Ignacio, Anglo American Exploration (Phillipines), Inc., General Santos City, Philippines; Jorge E. Islas Falcé, Panamerican Silver Company, Chihuahua, Mexico; Paul W. Jewell, University of Utah, Salt Lake City, UT; Dennis Jones, Angolgold Corporation, Toronto, ON, Canada; Rolando Jordan, Asociación Mineros Modernos, La Paz, Bolivia; Italo T. Jordan Gamarra, BHP.
GORDON RESEARCH CONFERENCE: INORGANIC GEOCHEMISTRY
Formation, modification, and preservation of ore deposits:
Tectonic, climatic and surficial factors
AUGUST 19–24, 2001, AT PROCTOR ACADEMY, NEW HAMPSHIRE, USA

Gordon Research Conferences aim to generate dialogue among researchers and members of industry through the presentation of cutting-edge advances in an "off-the-record" informal environment. This conference will examine some of the world's largest Cu, Au, Ni, Fe, Al and Mn ore deposits, and the processes that influence their modification and preservation. Tectonics, fluid circulation, climate and weathering, bacterial activity, and metal enrichment will be addressed. Four speakers from the minerals industry will highlight questions related to exploration and development, followed by eight technical sessions, and a final discussion of research frontiers.

- Titles of talks now listed at www.grc.uri.edu under Inorganic Geochemistry
- Limited financial assistance available for students and assistant professors. Apply to Jeff Hedenquist (Gordongeochem@aol.com). Decisions available in May.
- To submit a poster, send a one-page abstract to Jean Cline (jcline@nevada.edu). Decisions available in May.
- Registration fee (inclusive of room and board): $595 (double), $650 (single)
- For further information and to apply, visit the GRC web site, www.grc.uri.edu

SESSION TITLES, CHAIRS, AND SPEAKERS:

- Metal mobility: Gordon Southam, Jill Banfield, Charlie Alpers, Derek Lovley
- Climate, tectonics and metal mobility: Dick Frolking, Jerry Dickens, Dave Leach
- Metal enrichment —Cu and Au: Dick Sillitoe, Paulo Vasconcelos, George Brinhill, Philippe Freysinnet
- Tectonics and ore deposits: Dick Totebl, Rich Goldfarb, Suzanne Kay
- Metal enrichment —Ni, Fe and Mn: Hiroshi Ohmoto, Mark Harley, Charles Butt, Nic Beukes
- Paleosurface: Preservation and destruction: Steve Kesler, Bruce Taylor, Mark Hamilton
- Crustal fluid circulation: Nick Sibson, Nick Oliver, Alison Ord, Martin Appold
- Experimental advances: An informal session: Bob Bodnar
- Research Frontiers: Ross Large, Murray Hitzman, Bob Bodnar, Larry Cathles, Noel White
Co-chairs: John Thompson, Jeff Hedenquist
Vice-chair: Jean Cline

Gordon Research Conferences, University of Rhode Island, PO Box 981, West Kingston, RI, 02892-0981, USA. Fax 1-401-785-7614.
Ore Deposits Mapping Course
AUGUST 19–22, 2001 • AREQUIPA, PERU

To be held at the Cerro Verde porphyry copper deposit, Arequipa, Perú

COURSE INSTRUCTORS:
Dr. Eric H. Petersen, University of Utah
Dr. William X. Chávez, Jr., New Mexico School of Mines

This SEG-sponsored field-mapping course is designed to familiarize participants with salient aspects of techniques used in recognizing and mapping important features of hydrothermal ore deposits. The course will take place at the Cerro Verde porphyry copper deposit near Arequipa, southern Peru. The area within and around this Paleocene-age porphyry system provides ample opportunities for participants to observe features of world-class hydrothermal ore deposits. The course will be offered in Spanish and English (se ofrecerá este curso tanto en español como en el inglés).

In this course, emphasis is placed on the recognition of the lithologic, structural, and mineralogic features characteristic of porphyry copper-molybdenum ore deposits. We will spend three days within the main pit areas at Cerro Verde, performing nine-scale bench mapping of rock types, fracture systems, and quantitative fracture mapping, veined orientations and types, and alteration assemblages. Using Bruntion-on-the-fly mapping methods, instructors will demonstrate the collection of field data at various mapping scales, as appropriate, for the detail of mapping required. Field exercises will emphasize exploration-style and ore deposits mapping techniques, and will include backed-up mapping in the mapping at Cerro Verde.

A course reader will be provided to show participants examples of mapping at exploration and in-mine scales. Participants will be able to check their mapping with that of the instructors throughout the field course.

We will gather in Arequipa on the evening of Sunday, August 19, to discuss course logistics. The course will take place during Monday–Wednesday, August 20–22, ending at late afternoon on the 22nd, allowing participants time to depart Arequipa that evening. Because this is a hands-on course, the number of participants is limited to 20. Participants are asked to provide their own Bruntion compasses; base maps for our mapping will be provided. Course costs include 3 nights lodging (double occupancy), transportation to and from the mine, 3 breakfasts, and 5 lunches in the field.

Early (by July 15) registration cost for the course is US$450 for SEG members and US$550 for non-members; a limited number of student registrations are available (US$100)

For additional details and registration information, please contact Dr. Eric H. Petersen at ehpetersen@ mines.utah.edu or Dr. William X. Chávez, Jr. at wxc@chavez.com

Curso Intensivo en Mapeo de Yacimientos Hidrotermales
19 AL 22 DE AGOSTO, 2001 • AREQUIPA, EL PERÚ

A tomar lugar en la mina del pórphido cuprífero Cerro Verde, Arequipa, Perú

INSTRUCTORES:
Dr. Eric H. Petersen, Universidad de Utah
Dr. William X. Chávez, Jr., Escuela de Minas de Nuevo México

Este curso, auspiciado por la Society of Economic Geologists, está destinado a brindar a participantes con métodos importantes de mapeo de yacimientos metálicos, con énfasis en características generales de sistemas hidrotermales. El curso tomará lugar en la mina Cerro Verde, un pórphido cuprífero de edad Paleoceno en el sur del Perú. El curso se ofrecerá en español y el inglés.

Se base este curso en el mapeo detallado de características importantes—tanto en exploración como en geología mina—de sistemas hidrotermales, con énfasis en reconocimiento de las características de estructura, litología y mineralogía importantes en la evaluación de prospectos y minas. Pasaremos tres días en la mina de Cerro Verde, mapeando bancos que representan la diversidad de parámetros típicos de los pórphidos de cobre y sistemas hidrotermales parecidos (como skarn y sistemas epitermales). Mapearemos sistemas de fracturas, veintas (orientaciones y tipos), incluyendo un ejercicio en paragenesis de veintas y su mineralogía. También aprenderemos a interpretar capas (utilizando oxídos de hierro en la zona limítrofe de Cerro Verde.

Un guía será provisto a participantes mostrando ejemplos de mapas hechos a varias escalas y con variaciones en detalle. Participantes podrán comparar sus mapas con los de los instructores por todo el curso, permitiendo enseñanza continua.

Juntaremos en la ciudad de Arequipa en la tarde del 19 de Agosto para discutir la logística del curso, incluyendo seguridad en la mina. El curso llevará a cabo los días 20–21–22, terminando en la tarde del 22, permitiendo participantes a tomar un vuelo en la noche del 22. El costo del curso incluye tres noches de alojamiento tipo doble, transportation ida-vuelta a la mina desde el hotel, tres desayunos y tres almuerzos en terreno. Se limita la inscripción al curso a 20 personas.


Para más detalles e información de inscripción, por favor de contactar a Dr. Eric H. Petersen en <ehpetersen@ mines.utah.edu> o Dr. William X. Chávez, Jr. en <wxc@chavez.com>.
XX Curso Internacional de Postgrado en Metalogenia

The course will be offered at the Facultad de Ingeniería en Geología, Minas, Petróleo y Ambiental de la Universidad Central del Ecuador, sponsored by the UNESCO and SEG in collaboration with the Instituto Geológico y Minero de España (Spain) and the Universidad del País Vasco (Spain).

LOCATION AND DATES
Quito, Ecuador: 18–26 June 2001

COURSE CONTENT
The course will emphasize recent advances in the geology, geochemistry, and exploration of some key deposit models that can be found in Central and South America, but that have had less scientific impact than other styles of mineralization. The course includes five days of theoretical and applied sessions with associated discussions. It is organized in three modules covering aspects of the geology and geochemistry of epithermal systems (A. Ariasbas, Placer Dome, SEG '88), strata-bound volcanic-hosted massive sulfides (F. Torres, IGME, SEG '93), sulphide and VMS deposits (F. Velasco, UPV, SEG '96), as well as the exploration and evaluation of gold-alluvial deposits (L.C. Pérez, Luzenc), and the geology and recent advances in the exploration of ore deposits in the Central Andes (C. Vidal, Buenaventura, SEG '92) and A. Páldudias (U. Quito).

The course will be complemented with a four-day field trip to massive sulfide and epithermal systems in Ecuador. The visit to the mines is oriented to describe methodologies of fieldwork and application of theoretical data to practical problems.

LANGUAGE
The course will be presented in Spanish.

ASSISTANCE AND GRANTS
The course is designed for postgraduate students and geologists interested in ore deposits of Latin America and the Caribbean area.

Applicants from research institutes, universities, and geological surveys of Latin America can apply for a grant that can cover the whole or some of the transportation and living expenses during the course.

FOR INFORMATION
Ing. Pedro Espin M.
(Director, Curso Internacional de Metalogenia)
Tel: 00593-2-557814
Fax: 00593-2-566738
E-mail: ispglempa@andinet.net
or
Dr. Fernando Torres
E-mail: ftaigei@iponet.es
or visit the website:
http://www.utige.ch/sciences-terre/mineral/min_ore.html

Ore Deposits Mapping Course
OCTOBER 31 – NOVEMBER 3, 2001 • TUCSON, ARIZONA
Silver Bell District
Prior to the GSA Annual Meeting in Boston
Course Instructors:
Dr. Spencer K. Tuttle, University of Arizona • Dr. William X. Chávez, Jr., New Mexico School of Mines

This SEG-sponsored field course is designed to acquaint participants with techniques in detailed surface mapping of hydrothermal ore deposits. The Silver Bell district provides opportunities for participants to map at exploration and mine scales. This course will emphasize the recognition of the lithologic, structural, and mineralogic features characterizing porphyry- and skarn-type ore deposits.

We will map features exposed in surface outcrops and in open-pit mine benches of the Imperial Pit area and surroundings, familiarizing participants with Brunton-and-tape methods of mapping. Stressing recognition of "what is important" in exploration-style ore deposits mapping, the instructors will demonstrate how to incorporate details appropriate for the geologic and geochemical evaluation of a mineral deposit. We will use various mapping scales to permit inclusion of a range of geologic information. A course reader will be provided to show participants examples of the rock alteration types comprising our field area. Sessions dealing with quantitative structure mapping and leached capping interpretation are planned. Participants will be able to check their mapping with that of the instructors, providing feedback during the course.

Participants will gather in Tucson on the evening of Wednesday, October 31, for an orientation and safety discussion. The course will end about noon on Saturday, November 3. This will allow participants time to travel to Boston for the GSA Annual Meeting, which begins on Sunday, November 4.

Because this is a hands-on mapping course, the number of registrants is limited to 20. Brunton compasses will be provided, as will base maps. Course costs include 3 nights double occupancy lodging (October 31, November 1 and 2), 3 breakfasts and lunches, transportation to and from the Silver Bell area, and course materials.

Early (by September 14) registration cost for this course is $895 for SEG members and $945 for non-members; a limited number of spaces are available to students at $150.

For additional details, please contact:
• Spencer Tuttle at stuttle@geo.arizona.edu or
• William X. Chávez, Jr., at wchavez@nmt.edu.
2ND ANNOUNCEMENT

Svecofennian Ore-Forming Environments Field Trip
AUGUST 18-25, 2001

Volcanic-associated Zn-Cu-Au-Ag and magnetite-apatite, sediment-hosted Pb-Zn and intrusion-associated Cu-Au deposits in northern Sweden is a 9-day pre-meeting field trip (Aug. 18-25th), which will be held in conjunction with the Joint 6th Biennial SEG-SGA Annual Meeting, Krakow, Poland. The trip will cover three of the most important zones of mineral deposits in Sweden: 1) three days in the Early Proterozoic Skellefte mining district that includes the volcanic-hosted massive sulfide deposits and regional outcrops; 2) a one-day tour to the Paleozoic Laiavall sandstone-hosted lead-zinc deposit in the Swedish Caledonides, and 3) three days in the Early Proterozoic Nordanstigen mineral province, including visits to the Kiruna and Malmberget magnetite-apatite iron deposits and the giant Arktik copper-gold deposit.

FIELD TRIP ITINERARY:
Day 3 (20 Aug, Mon): Skellefte district, Renstrom area and Petkinas mine.
Day 4 (21 Aug, Tue): Skellefte district, Malmberget mine, drive to Arjeplog (Laiavall).
Day 6 (23 Aug, Thu): Arktik mine, Nauntinen prospect.
Day 8 (25 Aug, Sat): Kiruna mine and area, late afternoon fly Kiruna-
Stockholm=Cracow.

FIELD TRIP LEADERS are Rodney Allen, Volcanic Resources Limited, and Lulea University, and Olof Martinsson, Lulea University. Early bird (by June 20) registration costs have been set at US$1040 per SEG/SGA member, US$1050 per non-member; and US$875 per student member. For more information, contact Sue Cournay, Membership Services, Society of Economic Geologists, Inc., 7511 Shaffer Parkway, Littleton, CO 80127; Tel. +720.981.7882 Ext. 204; Fax: +720.981.7874; e-mail: <membership@segweb.org>.

Epithermal Gold Mineralization and Modern Analogues, Kyushu, Japan

Society of Economic Geologists-Sponsored Field Trip • October 28–November 3, 2001

The field trip will introduce participants to the most important Plio-Pleistocene low- and high-sulfidation epithermal gold provinces of the island of Kyushu in southwest Japan. Participants will traverse portions of the Hokusuki gold province and have the opportunity to go underground at two localities to examine, first-hand, low-sulfidation epithermal veins, including the spectacular, high-grade veins of the Hishikari mine. Typical features of the Nansatsu-type high-sulfidation deposits Kasuga, Akeshi, and Iwata will be examined as the group extends across the Nansatsu district in southern Kyushu. A 375-km traverse of the island from south to north over several days will take participants along the backbones of the present-day active volcanic arc, visiting the impressive Sakurajima andesitic volcano, the unforgettable Quaternary Aso caldera, and several active geothermal systems and their features, along with a short tour of the Hachibonai geothermal power plant.

Organizers and Field Trip Leaders: Dr. Craig A. Feebrey (Metal Mining Agency of Japan) Project Director, Chichibu University)

Registration Fee: US$1600; SEG members US$1290; SEG and SGA Student Members US$950. Registration fee includes SEG guidebook, accommodation, meals, and transportation in the field following arrival in Kyushu. Limited funding is available to help support the participation of one or two students or young professionals from regions with economic difficulties. Please note that the total number of participants is strictly limited to 20. The deadline for registration is June 28, 2001.

For details of the complete program and registration, plus application for student support, please send your name, affiliation, address for correspondence, telephone, fax, and e-mail, and status (SEG, SGA) to: The Society of Economic Geologists, Inc., 7511 Shaffer Parkway, Littleton, CO 80127; Tel. +720.981.7882; Fax: +720.981.7874; e-mail: seg@segweb.org; or Craig A. Feebrey, Metal Mining Agency of Japan, Tokyo Bldg., 2-24-14, Toranomon, Minato-ku, Tokyo 105-001, Japan; Fax: +81.3.5512.1426; e-mail: feebrey@mmaj.gr.jp.
ANNOUNCEMENTS

SENG NEWSLETTER No 45 • APRIL 2001

ANNUAL MEETING
SEG•GSA
Boston, Massachusetts • November 5–8, 2001

The SEG program for the 2001 annual meeting with the Geological Society of America has been organized by John F. Slack. For registration information, see the GSA website: www.geosociety.org/meetings/index.htm. For additional information on the SEG program contact:

JOHN F. SLACK
U.S. Geological Survey, National Center, MS 954, Reston, VA 20192
Phone: (703) 648-6337, Fax: (703) 648-6383, E-mail: jfslack@usgs.gov

SPECIAL SESSION:

Iron-Oxide-(Copper-Gold) Systems—Deposit Studies to Global Context

Sunday, November 4, 8:30 a.m. to 5:00 p.m. Organized by Mark D. Barton, Department of Geosciences, University of Arizona, Tucson, AZ 85721; phone: (520) 621-8529, fax: (520) 621-2672, e-mail: barton@geo.arizona.edu. This session focuses on the characteristics and origins of diverse types of Fe-oxide-(Cu-Au) hydrothermal deposits, including their relationships to magmatic, tectonic, and clastic processes. Emphasis will be on Proterozoic deposits in circum-Atlantic terranes (including Brazil, the Baltic, and central Africa) and on Phanerozoic deposits of the Cordillera, particularly in the Andes. Confirmed speakers are Warren Day (USGS), Mike Foose (USGS), Sunil Ghanty (GSC), Murray Hittman (Colorado School of Mines), James Lang (Consultant, Vancouver), Richard Leveille (Phelps Dodge), Robert Marschik (University of Freiberg, Germany), Olaf Martinsson (University of Lulea, Sweden), Art Rose (Penn State University), Martin Smith (University of Brighton, England), Par Welhied (Swedish Geological Survey), and Marcus Zentilli (Dalhousie University). Topics to be covered in the session include Fe-oxide-(Cu-Au) deposits in the United States (Adirondack Mountains, New Jersey Highlands, eastern Mississippi basin, southeast Missouri), Canada (Great Bear magmatic zone), central Africa (Zambian and Cu-Au occurrences), Scandinavia (particularly Sweden), and South America (Carapachay and Sossego, Brazil; Chilean manto and Fe-Cu-Au deposits: Punta del Cobre and Candelaria, Chile). Other talks will focus on comparisons of these deposits with ones in Australia and western North America, and on magmatic and hydrothermal synthesis. More details on this session, including the names of keynote speakers and titles of their talks, will be given in the July issue of the SEG Newsletter.

FIELD TRIPS:

Zinc and Iron Deposits of the Adirondack Mountains and New Jersey Highlands.

Tuesday, October 30, through Saturday, November 3. Trip leaders: John F. Slack, U.S. Geological Survey, MS 954, Reston, VA 20192; phone: (703) 648-6337, fax: (703) 648-6383, e-mail: jfslack@usgs.gov; Craig A. Johnson, U.S. Geological Survey, MS 963, Denver, CO 80225; phone: (303) 236-7935, fax: (303) 236-1930, e-mail: cjohnson@usgs.gov; Michael P. Foose, U.S. Geological Survey, MS 954, Reston, VA 20192; phone: (703) 648-6337, fax: (703) 648-6383, e-mail: mfoose@usgs.gov; James M. McClelland, Department of Geology, Colgate University, Hamilton, NY 13346; phone: (315) 852-7202, fax: (315) 852-7831, e-mail: indiann@colgen.net; Puffer, John H., Department of Geological Sciences, Rutgers University, New Brunswick, NJ 08902; phone: (732) 935-5238, fax: (732) 935-1985, e-mail: ipuffer@andromeda.rutgers.edu; Volker, Richard A., New Jersey Geological Survey, P.O. Box 427, Trenton, NJ 08625; phone: (609) 292-2576, fax: (609) 653-1004, e-mail: rvolker@nigs.dep.state.nj.us; Metzger, Robert W., 69 Hunters Lane, Sparta, NJ 07871; phone: (973) 729-7824, e-mail: bobmetz@tdsnet.net. Trip includes underground visits to the Batlow zinc mine (NY) and the Sterling Hill zinc mine (NJ). Surface visits to non-traceable magmatic deposits of the eastern Adirondacks (e.g., Lyon Mountain and Skill Mountain mines) and New Jersey Highlands (e.g., Sulfur Hill and Andover mines), and tours of the Sterling Hill Mining Museum and Franklin Mineral Museum in New Jersey. The trip begins and ends in Boston. Maximum: 36. Costs (to be determined) will include field trip transportation, all meals, accommodations (double occupancy), and guidebook. Details of the trip itinerary and specific costs will be given in the July issue of the SEG Newsletter.

Environmental Geochemistry and Mining History of Massive Sulfide Deposits in the Vermont Copper Belt

Thursday, November 8, through Saturday, November 10. Trip leaders: Jane M. Hummarstrom, U.S. Geological Survey, MS 954, Reston, VA 20192; phone: (703) 648-6165, fax: (703) 648-6383, e-mail: jhummarstrom@usgs.gov; Robert R. Seal II, U.S. Geological Survey, MS 954, Reston, VA 20192; phone: (703) 648-6290, fax: (703) 648-6383, e-mail: rseal@usgs.gov; John F. Slack, U.S. Geological Survey, MS 954, Reston, VA 20192; phone: (703) 648-6337, fax: (703) 648-6383, e-mail: jfslack@usgs.gov; and Matthew A. Kierstead, PHEL, Inc., 210 Lonsdale Avenue, Pawtucket, RI 02860, phone: (401) 728-8780, fax: (401) 728-8784, e-mail: mkierstead@pheadco.com. Trip includes surface visits to the historic Elizabeth (1793 to 1958) and Elvy (1820 to 1903) copper mines. In 2000, Elizabeth became the first metal mine designated as a Superfund site in the eastern U.S., based on ecological impacts of acid mine drainage. The trip will cover...
geological, environmental, historical, and societal aspects of the mine and ongoing EPA activities. Scientific focus will be on recent data obtained on mine wastes and waters in the vicinity of the Elizabeth and Ely mines, and the utility of such data in developing mine reclamation strategies. Trip begins and ends in Boston. Maximum: 50. Costs (to be determined) will include field trip transportation, all meals, accommodations (double occupancy), and guidebook. Details of the trip itinerary and specific costs will be given in the July issue of the SEG Newsletter.

**DISTINGUISHED LECTURER:**

The Distinguished Lecturer for 2001 is Terry Seward. The title of his talk will be posted at a later date.

**TOPICAL SESSIONS:**

- **Special Session in Honor of Half Zantop (T15).** Session organizers: Helen M. Mango, Department of Natural Sciences, Castleton State College, Castleton, VT 05735; phone: (802) 686-1758; fax: (802) 686-1770; e-mail: Helen.Mango@castleton.edu; and J. Bruce Gemmill, Centre for Ore Deposit Research (CODES), University of Tasmania, GPO Box 322-S, Hobart, Tasmania 7001 Australia; phone: (3) 6226-2895, fax: (3) 6226-7662; e-mail: Bruce.Gemmill@utas.edu.au. Speakers will include Helen Mango, Bruce Gemmill, Naomi Oreskes (University of California–San Diego), and Doug Ruble (Geological Institute of Washington).

  This session will honor the scientific accomplishments and teaching excellence of the late Half Zantop, who was a long-time member of SEG (1979) and professor at Dartmouth College in Hanover, New Hampshire. Speakers will present the results of geological research conducted by former students and coworkers of Half, and research done independently by other colleagues. One focus will be on epithermal ore deposits of Mexico, but contributions are also encouraged on diverse topics in economic geology and geochemistry including isotopes.

- **Sediment-Hosted Lead-Zinc Deposits: Roles of Basin Evolution, Tectonics, and Geochemistry in Ore Genesis (T23).** Session organizers: Donald F. Sangster, 2355 Russett Drive, North Gower, ON K0A 2T0, Canada; phone: (613) 489-2191, fax: (613) 489-2928; e-mail: dsangster@sympatico.ca; George P. Cole, Cominco American Incorporated, 15918 E. Euclid Avenue, Spokane, WA 99216; phone: (509) 922-8787, fax: (509) 922-8767; e-mail: George.Cole@COMINCO.com; and John F. Slack, U.S. Geological Survey, National Center, MS 954, Reston, VA 20192; phone: (703) 648-6337, fax: (703) 648-6383, e-mail: jfslack@usgs.gov. Keynote speakers are: Duncan Large, Consultant, Braunschweig, Germany, talking on “Sediment-Hosted Lead-Zinc Deposits—20 Years of Progress,” and Murray W. Hitzman, Colorado School of Mines, Golden CO (with coauthor Don Sangster), talking on “Zinc Oxide and Zinc Silicate Deposits—A New Look.”

  Recent studies have revealed important insights into the genesis of sediment-hosted lead-zinc deposits occurring in carbonate and elastic sedimentary rocks and their metamorphosed equivalents. The session will cover deposits of both MVT and Sedex affinity, and also non-sulfide zinc oxide and silicate deposits. Contributions are encouraged on the role of depositional, diagenetic, tectonic, magmatic, and geochemical processes, and on the absolute age and duration of mineralization, in the formation of sediment-hosted lead-zinc deposits.

**PRELIMINARY SEG BUSINESS AND TECHNICAL SESSIONS**

**Saturday, November 3**

2:00 p.m.–3:00 p.m. ...... SEG Publications Board
4:00 p.m.–5:00 p.m. ...... SEG Program Steering Committee
5:00 p.m.–9:00 p.m. ...... SEG Program Committee
( dinner buffet 7:00–7:30 p.m )

**Sunday, November 4**

8:00 a.m.–12:00 p.m. ...... SEG Special Session
12:00 p.m.–1:30 p.m. ...... Break for Lunch
1:30 p.m.–5:30 p.m. ...... SEG Special Session

**Monday, November 5**

8:00 a.m.–12:00 p.m. ...... Technical Session (Oral)
8:00 a.m.–12:00 p.m. ...... SEG Executive Committee
12:00 p.m.–1:30 p.m. ...... Break for Lunch
1:30 p.m.–5:30 p.m. ...... Technical Sessions (Oral)

*Special Session in Memory of Half Zantop*

5:00 p.m.–9:00 p.m. ...... SEG Council Meeting
( dinner buffet 7:00–7:30 p.m )

**Tuesday, November 6**

8:00 a.m.–12:00 p.m. ...... Technical Session (Oral)
10:30 a.m.–11:30 a.m. ...... SEG Distinguished Lecturer
11:30 a.m.–12:00 p.m. ...... SEG Luncheon Reception
12:00 p.m.–2:00 p.m. ...... SEG Luncheon
1:30 p.m.–5:30 p.m. ...... Technical Session (Oral)
2:00 p.m.–5:00 p.m. ...... SEG Foundation Trustees
5:30 p.m.–7:00 p.m. ...... SEG Student/Member Happy Hour
7:30 p.m.–10:00 p.m. ...... SEG Past Presidents Dinner

**Wednesday, November 7**

8:00 a.m.–12:00 p.m. ...... Technical Session (Oral)
1:30 p.m.–5:30 p.m. ...... Technical Session (Oral)

**Thursday, November 8**

8:00 a.m.–12:00 p.m. ...... Technical Session (Poster)
VII Argentine Congress of Economic Geology
SALTA, ARGENTINA • SEPTEMBER 26–28, 2001


KEYNOTE SPEAKERS
- Sergio Gorustovich (Secretario de Minería, Industria y Recursos Energéticos)
- José Perello (Society of Economic Geologists)
- César Vidal (Society of Economic Geologists)

THEMES
Participants are invited to present papers related directly or indirectly to mining geology, especially about Argentina and South America.
- Metallogeny, Advanced Mineralogy, Mineral Deposits, Industrial Minerals
- Prospecting and Exploration Methods and Metallurgical Processing
- Mining Evaluation and Management
- Legal and Environmental Studies

FIELD EXCURSIONS
Pre- and post-congress guided field trips to the most important mineral deposits and mining prospects are planned. The trips will include visits to places such as San Antonio de los Cobres-Salar del Hombre Muerto (Puna Austral) and Humahuaca-China Aguilera (Cordillera Oriental-Puna Septentrional). Further details will be available on the Third Circular and Congress Web Site.

SHORT COURSES AND CONFERENCES
Short courses and conferences are planned. Further details will be available on the Third Circular and Congress Web Site.

HOTEL AND TOUR BOOKINGS
The Company DINAR S.A., official agent of the VII Argentine Congress of Economic Geology, is in charge of all details concerning hotel and tour bookings.

For further information contact the official agent:
DINAR S.A.
Mitre 101
400 Salta, Argentina
Tel-Fax: 0341-326-2617, 0342-62634, 0342-32636
Depamento Operativo, Operations Department
At.: Rubén López, Solicitados Suppa
dhreserva@salnet.com.ar
dinar@salnet.com.ar

For PANORAMA MINERO, the official magazine of VII Argentine Congress of Economic Geology, contact:
Tel.: +54-11-396-2-907, 396-2-1857
pminero@panoramaminero.com.ar

Official address of the Congress:
VII Congreso Argentino de Geología Económica
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4000 Salta, Argentina
Tel-Fax: 0341-325-3121, 325-415
congecsalta@amcat.com.ar • seecon@seandec.org.ar
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Benefactor Member (minimum US$2,000) or Sponsors (minimum US$500) should contact the Congress at the above address.

MINING ACTIVITY UPDATE

Mining & Exploration Information

- News Summaries
- Deposit Statistics
- Research Information

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NEW IN 2001

Structural Controls on Ore Genesis is an overview of current observational and interpretive methods in structural geology as applied to the study of ore deposits and mineral exploration.

Reviews in Economic Geology
Volume 14
Edited by
Jeremy F. Richards
and Richard M. Tosdal
181 pages
Retail US$45
Members US$36

“Pima Mine Story”
NOW AVAILABLE

Heinrichs GEOEXploration Company and Associates are pleased to announce publication of “The Pima Mine Story” by Walter E. Heinrichs, Jr., one of the mine’s discoverers. The book recounts the intriguing post-World War II exploration history, discovery and development of the Pima Mine, where applied geophysical techniques were used for the first time to find a major non-ferrous ore deposit under more than 200 feet of cover, where no economic mineral deposit was thought to exist. The Pima Mine is now incorporated in ASARCO’s Mission Complex—a world-class copper producer.

Ample illustrated with historical photographs and colored geological and geophysical diagrams; includes a chronology of events, production history, a selected bibliography, and a glossary of technical terms. Soft cover, 33-pages, $9.50, plus $1.00 S/H and applicable sales tax for Arizona residents. Available from Western Economic History Center, P.O. Box 637, Marana Arizona, 85653; Tel. +520.682.4121. Call WEHC for more information.

Other Publications of Interest

Patricia Sheahan • Konsult International, Inc.
44 Gemini Road, Willowsdale, Ontario, Canada M2K 2G6
Tel +1.416.223.7750 • Fax +1.416.223.4229

Volcanogenic Massive Sulphide Deposits of Latin America. Sherlock and Logan, Editors. GAC/MDD Special Paper no. 2, 650 p., 2000. Available from Geological Association of Canada, Dept. Earth Sciences, Room 4063, Alexander Murray Bldg., Memorial University of Newfoundland, St. John’s NF A1B 3X5, Canada; Fax +1.709.737.2532; e-mail: <gac@sparky2.esd.mun.ca> Cost $40.00 plus shipping and handling. Accept VISA.

**CAREER-RELATED CHANGES**

- John A.S. Dow (SEG 1998) has accepted a new assignment as executive vice president/group executive, South America, with Newmont Mining Corporation. His responsibilities include supervision of the Yanacocha mine in Peru and the newly acquired Kori Kollo mine in Bolivia, and of Newmont's other business interests in South America. He will relocate from Denver to Lima, Peru. New contact information is as follows: Minera Yanacocha SRL, Av. Camino Real 548, Torre del Pilar 1004, San Isidro, Lima, Peru 27; tel. 51.1.215.2600; fax, 51.1.215.2610; e-mail, JohnDow@corp.newmont.com.

**AWARDS & ACCOMPLISHMENTS**

- A. Frank Alsobrook (SEG 1997) was presented the SME Industrial Minerals Division Distinguished Service Award, in recognition of his contributions to SME and the Industrial Minerals Division, and for his professionalism and accomplishments. Currently president of the consulting fim, Alsobrook & Company, he previously held positions with Arthur D. Little, Energy & Minerals, and US Boxus. Alsobrook was an associate editor and a contributing author to the sixth edition of *Industrial Minerals and Rocks*.

- J. Allan Coope (SEG 1972) and Donald E. Ranta (SEG 1976) have been named SME Distinguished Members.

  Beginning in 1979, Coope worked for Newmont Mining in positions of ascending responsibility, most recently as the vice president of Newmont Mining of Canada. Organizations for which he has served as a volunteer include GAC, CMM (Toronto branch), PDAC, and the Centre for Earth Science Research at Memorial University, Newfoundland. Coope was SEG Technical Program Chair in 1993 and chaired the Finance Committee.

  Ranta is president of RRX Global, a company involved in business-to-business e-commerce for the mining industry. Previously, Ranta was employed as vice president, worldwide exploration, Echo Bay Mines, and as manager of North American exploration, Phelps Dodge Mining. Other employment was with Maxx Exploration, Climax Molybdenum, Gulf Mineral Resources, and Kennecott Copper. Recipient of several awards from SME, Ranta helped coordinate the second edition of the *SME Mining Engineering Handbook*.

- John M. Guilbert (SEG 1984) received the SME Daniel Cowan Jackling Award "for stellar life-long service to the mining community, for elucidation of porphyry copper deposit geology, for exemplary teaching of exploration geology, for development of Bajo de la Alumbrera, and for his lecture, Linkages among Hydrothermal Ore Deposit Types." A recipient of the SEG Penrose Gold Medal and former SEG International Exchange Lecturer, Guilbert is also an honorary life member of the Arizona Geological Society. In 1989, he was named the first Distinguished Lecturer of Denver Region Exploration Geologists Society. He is senior author of *The Geology of Ore Deposits*. Guilbert retired from the University of Arizona with emeritus status in 1991.

- Leo J. Miller (SEG 1960), SF, is the recipient of the SME Robert M. Dreyer Award. The award is given "in recognition of his leadership in mineral exploration and development that led to major discoveries in uranium, zinc, silver and phosphate, and for his lecture, 'The Discovery and Development of the North Carolina Phosphate Deposit.'" Miller is credited with the 1957 discovery of the Kidd zone. The result of work he did in the Canadian Shield while employed by Texas Gulf Sulfur. Active in the exploration and discovery of phosphate deposits (including Lee Creek), Miller also explored and supervised exploration for nickel, copper, uranium, lead, zinc, sulfur, and barite. He retired from Texagulf in 1981 to pursue his own programs, especially in sulfur exploration.

- William C. Peters (SEG 1958) is the recipient of the SME Ben F. Dickenson III Award, in recognition of his professionalism and contributions to the mining industry. Author of more than 50 technical papers and the textbook *Exploration and Mining Geology*, Peters also contributed to the *SME Mining Engineering Handbook*. Peters has held positions in the industry with New Jersey Zinc, FMC, and Utah Copper Division of Kennecott Copper. In 1982, Peters retired from teaching at the University of Arizona and became a consultant and author for McGraw-Hill and a senior associate with Belfire Doller. He is the 1999 recipient of the Mining Foundation of the Southwest's American Mining Hall of Fame Medal of Merit.

**DEATHS**

- Saville Cyrus Creasey (SEG 1949) died Dec. 19, 2000. He was 83. Creasey was born in Portland, OR, in 1917 and received his bachelor's and master's degrees in geology from the University of California at Los Angeles. He joined the Mineral Deposits Branch of U.S. Geological Survey in 1941, working for the Survey until he retired in 1980. In the late 1940s, he worked on the Jerome copper district and the Iron King lead-zinc mine in Arizona. He served as President of SEG in 1986 and was a Trustee of the SEG Foundation.

- Robert G. Montgomery (SEG 1978) died Jan. 6 in Eklutna, AK, at the age of 90. Born in Battleville, OK, in 1910, he was a graduate of the University of Missouri at Rolla. A mining engineer and geologist, Montgomery moved to Eklutna in 1941 and helped start Minerva Oil. He received the Williams Harding award from the AIME and was named a Distinguished Member and a Legion of Honor member of the SME.

- Charles B. Sclar (SEG 1961), SF, professor emeritus of geological sciences at Lehigh University, died January 13 at the age of 75. Born in Newark, N.J., he earned a bachelor's degree from the College of the City of New York, where he was the Ward Medalist in geology, and received M.S. and Ph.D. degrees from Yale University, where he was the James Dwight Dana Fellow. Sclar was a professor at Lehigh beginning in 1968, retiring in 1990. He specialized in mineralogy, igneous and metamorphic petrology, metallic mineral deposits, geochemistry and high-pressure petrology, and he served as chair of the geological sciences department from 1976 to 1985. The mineral sclarite was named after him in 1988, in honor of his research into the origin of the zine ores of Franklin and
Sterling Hill in Sussex Hills, N.J. In addition, Sclar was one of the principal investigators for NASA on the Lunar Sample Analysis Program of the Apollo Program from 1969 until 1978. He also worked extensively as a consultant for the mineral industry. As a teacher, he was known to be a demanding but enthusiastic leader. Sclar held two U.S. patents and was the author or co-author of more than 50 papers in scientific journals or books. He was named a Fellow of the GSA and of the Mineralogical Society of America. As a member of SEG, he served on several committees.

Richard E. Stoller (SEG 1947, SF), Dartmouth professor emeritus, died Feb. 9 at his home in Norwich. He was 90. Born in Cleveland, Ohio, in 1911, he entered Dartmouth as a freshman in 1928, beginning a commitment to the college that lasted more than 70 years. Stoller earned his B.S. from Massachusetts Institute of Technology in 1937 and returned to Dartmouth as an instructor and assistant professor until 1942, when he joined the U.S. Army Signal Corps. He returned to Dartmouth in 1946 and became a full professor two years later. Stoller was named the Frederick Hill Professor of Mineralogy in 1971. In spite of an official retirement in 1976, he continued to teach part-time until 1989. Author and co-author of more than 100 articles and a textbook on optical mineralogy, Stoller and two colleagues created "The Electronic Volcano," an Internet repository of past and current research. The volcanic mineral stollerite was named in his honor.

Warren H. Westphal (SEG 1960, SF) died Feb. 12 in Denver. He was 75. Born in 1925, in Easton, PA, he earned a bachelor's degree from Columbia University in 1947. Westphal worked for New Jersey Zinc Company, first as a junior geologist and mine surveyor, and later as a geophysical research investigator. In 1955, he took a position as senior geologist with Tidewater Associated Oil Company, exploring for uranium deposits in the Colorado Plateau area. He became senior geologist and then chief geophysicist of Utah Construction Company, organizing geophysical surveys and researching methods and interpretative procedures in his field.

Half Zantop (SEG 1977) and his wife, Suzanne, were murdered on January 27 at their home near Hanover, NH. Half was 62 years old. Born in Eckeroerde, Germany, in 1938, he received a bachelor's degree from Washington State University in 1961 and his Ph.D. degree from Stanford University in 1969. Between 1969 and 1976, Zantop worked for the industry, first as exploration geologist for Kentecott Copper Corp., and then as a senior geologist for Bethlehem Steel Corp. Following a year spent as a research fellow in microscopy at the University of Heidelberg, he joined the earth science faculty at Dartmouth College, a position he held at the time of his death. During his time at Washington State University, Zantop was among those who helped translate the prestigious German volume, The Ore Minerals and Their Intergrowths, by Paul Ramdohr. He also served as a guest lecturer at the University of Heidelberg and continued his affiliation with the economic geology industry by working as a consultant in the United States, Mexico, and Argentina. Zantop was a member of a number of professional societies, including the IAGOD, GSA, SME, Geologische Vereinigung (Germany) and Sigma Xi. He was named SEG 1992-1993 Thayer Lindley Lecturer and was chair of the Thayer Lindley committee in 1995.
SOCIETY OF ECONOMIC GEOLOGISTS

Membership Application

Membership in the Society is open to all geoscience graduates holding the bachelor's degree. Student Members must be full-time students. Annual dues are US$85 for Members and US$10.00 for Student Members. Subscriptions to Economic Geology, the quarterly SEG Newsletter and SEG Membership Directory are included in the membership. Application may be made by completing this form and submitting it with the appropriate sponsor signature to Society of Economic Geologists, Inc., 7811 Shaffer Parkway, Littleton, CO 80127, USA; phone: 720-981-7882; fax 720-981-7874; e-mail: seg@segweb.org

NOTE: PLEASE DO NOT INCLUDE ANY PAYMENT WITH THIS APPLICATION.

SECTION I
(TO BE COMPLETED BY THE APPLICANT; PLEASE USE BLACK INK.)

Personal Information:

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CITY __________ STATE/PROVINCE __________ POSTAL CODE __________ COUNTRY

PHONE (COUNTRY CODE, CITY CODE, NUMBER) __________ FAX (COUNTRY CODE, CITY CODE, NUMBER) __________ E-MAIL

Education:

UNIVERSITY AND LOCATION __________ YEARS (FROM - TO) __________ MAJOR __________ DEGREE __________ YEAR GRANTED

Undergraduates:

Graduate:

Professional Experience: (LIST IN ORDER FROM MOST RECENT AT THE TOP.)

FROM (Month/Year) --- TO (Month/Year) __________ POSITION __________ EMPLOYER

PRESENT

SIGNATURE __________________________ DATE __________________________

SECTION II
(To be completed by the sponsor who must be a Fellow of the Society; for student membership applicants, the sponsor must be either a Fellow of the Society or Head of the Earth Sciences Department.)

I sponsor the above-named individual for □ Membership, or for □ Student Membership.

To the best of my knowledge the information provided by the applicant is correct.

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□ FELLOW, SOCIETY OF ECONOMIC GEOLOGISTS, OR
□ HEAD, EARTH SCIENCE DEPARTMENT

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| GUIDEBOOK SERIES: |
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| **NOTE:** Volumes 1 through 7 are available in print. |
| **VOL. 22:** Carbonate-hosted Lead-Zinc-Fluorite-Berillium Deposits of North America: Kula C. Misra, Editor; 1985; 254p.; $US36 |
| **VOL. 28:** The Carlin-Type Gold Deposits Field Conference: Peter G. V. Elmore, et al. Editors; 1997; 294p.; 3 colored figures; $US36 |
| **VOL. 29:** Geology and Ore Deposits of the Oquirrh and Wasatch Mountains, Utah: David A. John & Geoffrey H. Battenhoffer; Editors; 1997 Revised; 1998; 308p.; 9 colored figures; 2 oversize colored plates (in pocket); $US40 |
| **VOL. 30:** Gold Deposits of Northern Sonora, Mexico: K.F. Clark, Editor; 1998; 252p.; 12 colored figures; 1 oversize figure; 2 oversize plates (in pocket); $US36 |
| **VOL. 31:** Epithermal Mineralization of the Western Carpathians: Ferenca Mohör, Jaromir Lexa, & Jürgen W. Leipold; Editors; 1999; 274p.; $US36 |
| **VOL. 32:** PART 1: Contrasting Styles of Intrusion-Associated Hydrothermal Systems: John H. Gillespie, Mark D. Barlow, David A. John, John M. Proffer, & Marco T. Ensaula; Editors; PART 2: Geology & Gold Deposits of the Gallego Region; Elizabeth Jones-Craford, Editor; 2000; 234p.; $US40 |

| SEG VIDEO SERIES: |
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Oct. 28–Nov. 1, 2001. Bullion Gold Mineralization and Modern Analogues Field Trip, Kyusyu, Japan. Sponsored by the Society of Economic Geologists, Inc. For more information, contact The Society of Economic Geologists, Inc., 7811 Shafter Parkway, Littleton, CO 80127; Tel: +1.720.981.7882; Fax: +1.720.981.7874; e-mail: < SEG@segweb.org>

OTHER EVENTS


May 9–12, 2001. 47th Annual Institute on Lake Superior Geology, Madison, Wisconsin. Contact: 47th annual Institute on Lake Superior Geology (LSG) Geoscience and Natural History Survey. 3817 Mineral Point Road, Madison, WI 53705 USA. For more information, including travel and accommodation details, contact the organizers, including proposed field excursions. Visit the website at <http://www.gsx.state.wi.us/lsg10.html>. For details and registration form, visit <http://www.geology.wisc.edu/lsg10/lsgeocenter.html>.

May 17–19, 2001. New Deposits in Metalliferous Hydrothermal Systems, Townsville, Queensland, Australia. Organized by SEG and the JCU SEG Student Chapter. Contact: Larry Chapman, Economic Geology Research Unit, School of Earth Sciences, James Cook University, Townsville, QLD 4811, Australia. Tel: +61.7.4781.4726; Fax: +61.7.4781.7202; E-mail: Larry.Chapman@jcu.edu.au. Details and registration form are available at <http://www.geol.jcu.queensland.edu.au/seminars/2001/20010517.html>.

May 23–25, 2001. 37th Forum on the Geology of Industrial Minerals 2001, Victoria, B.C., Canada. For more information, contact: George Simandl, B.C. Geologic Survey, Tel: +1.250.592.9031, Fax: +1.250.592.0381; E-mail: <george.simandl@geo.gov.bc.ca>. For information on registration, contact: Susan Dunlop, SEG, University of Victoria, Tel: +1.250.472.4347, Fax: +1.250.472.4340; E-mail: <sdunlop@seg.org).

May 27–30, 2001. Geological Association of Canada—Mineralogical Association of Canada, Joint Annual Meeting, St. John’s, Newfoundland. Contact: Dave Brown, Newfoundland Geological Survey, Dept. of Mines and Energy, P.O. Box 6740, St. John’s, Newfoundl and, A1B 4A6, Tel: +1.709.729.4016; E-mail: <dgbrown@gov.nu.ca>.

May 28–31, 2001. 6th International Symposium on Mining in the Arctic—"Divalent Minerals of the Beginning of the 21st Century," Nuuk, Greenland. Contact: Bureau of Mines and Geological Survey, Government of Greenland, P.O. Box 930, DK-3900 Nuuk, Greenland. Tel: +1.299.34.66.00; Fax: +1.299.34.66.00; E-mail: <d.gh@mig.gu.dk>. Website: <http://www.mig.gu.dk>.

June 16–19, 2001. 30th Annual Meeting of the Clay Minerals Society, Madison, Wisconsin. Contact: Technical Program—Michael Thompson, e-mail: <mthompson@uwm.edu> or David Laid, e-mail: <d.laid@geology.wisc.edu>. Meeting Coordinator—William F. Wilkins, e-mail: <wilkins@wisc.edu>.


Aug. 19–24, 2001. Gordon Research Conference "Formation, Modification and Preservation of Ore Deposits", Providence, New Hampshire, U.S.A. Co-organizers: John Thompson, John Cane and Jeff Hedrick. This conference will focus on tectonic, climatic and surface processes involved in the formation, modification and preservation of ore deposits. For more information, see website: <www.gsc.org> and click on 2001 Meetings: "Inorganic Geochemistry" for session and speaker updates.


Aug. 31–Sept. 7, 2001. Field Excursion to the Skånebba Intrusives, East Greenland. Sponsored by the Cambridge School of Mines, ICG Project 279, and GSA. Contact: Dr. John A. Fyfe, Cambridge School of Mines, University of East Anglia, Norwich, Norwich, Kingdom. Tel: +44.1603.570955; Fax: +44.1603.571595; E-mail: <j.fyfe@anu.ac.uk>. Website: <http://www.geol.anu.ac.uk/SAGA/fieldtrips/>. For more information, contact Professor Laurence Robb, Department of Geoscience, Economic Geology Research Institute, University of the Witwatersrand, P.O. Box 550, Johannesburg, South Africa. Tel: +27.11.718.8504; Fax: +27.11.393.8920; E-mail: <esther@wits.ac.za>.

Sept. 10–14, 2001. 25th Pervanov Mining Engineers Convention, Lima, Peru. Organized by Instituto de Ingenieros de Minas del Peru. For information, contact Instituto de Ingenieros de Minas del Peru, Camaruc 154, Lima 12, Peru; Tel: +51.1.239.4292; Fax: +51.1.239.4292; E-mail: <cong@minas.com.pe>. Website: <www.conm-ini.com>.

Sept. 26–30, 2001. VIII Argentine Congress of Economic Geology, Salta, Argentina. Organized by the Economic Geology Society of America (SAGA) Annual Meeting and Exhibition, Boston, Massachusetts. For more information contact GSA, 3800 Penrose Place, P.O. Box 9140, Boulder, CO 80302, Tel: +1.303.477.2028 or 1.800.477.1988; Fax: +1.303.477.0648; E-mail: <gsa@seg.org>.

Oct. 3–7, 2001. Northwest Mining Association 107th Annual Meeting and Exhibition, Spokane, WA. For more information contact: Pat Bench, INMA, 10 N. First St., Ste. 414, Spokane, WA, 99201, Tel: +1.509.624.1158; Fax: +1.509.623.1241.