Gold-only Deposits and Archean Granite

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To many geologists, the proximity of granite to an ore deposit evokes an inference that there should be some level of genetic link between the two. Early this century, Waldemar Lindgren emphasized the importance of magmatic processes during ore formation; since that time, geologists have sought further links among granites, ore-forming fluids, heat to drive fluids, and different ore deposits, with varied success. For tin, the link with granite is well understood; however, for the many other elements that also have been attributed to granites, the genetic links are still debated. In some extreme deposit models, if granites are not known to be nearby, they are inferred at depth with or without geophysical support. The tendency to link gold-only deposits to granites is exemplified in the Archean cratons where granites are so abundant.

The discovery in 1996 and mining since 1998 of significant gold mineralization in Archean granite at Woodcutters, 50 km north of Kalgoorlie in Western Australia, adds important new information to the study of gold and granite relationships. This importance arises not only from Woodcutters’ size, being greater than most other Archean granite-hosted gold deposits, but also from its position in granite, farther laterally from greenstone rock types than virtually all other gold deposits.

Figure 1. Map of the Yilgarn craton showing granite and greenstone belts, with larger gold deposits (structural background after Yeam.cambe, 1998).
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SEG names Noel C. White Technical Editor

T he SEG Newsletter is pleased to announce that Noel C. White will be the new Technical Editor beginning with the July 1999 issue. The position is a voluntary one; responsibilities include soliciting manuscripts for the lead article of each issue and shepherding those selected through the peer review and editing process.

White is Chief Geologist—Exploration, for BHP Minerals, and has been with the company since 1964. He is a native of New South Wales, Australia, and received a Ph.D. from the University of Tasmania. He has served as research associate at Monash University in Melbourne, the Natural History Museum of London, and the University of Tasmania, and has been an editorial board member of Geology and the Journal of Geochemical Exploration. White also has served on various committees for the SEG and the SGA, and currently is an SEG International Exchange Lecturer for 1998–1999.

He can be reached by email <White.Noel.NC@BHP.com.au>, fax: 1415.395.8869; BHP Minerals, 550 California St., San Francisco, CA 94104-1020.

Corrections and Amplifications

- The Quellevaco Project's mineable reserves have been officially announced at 974 million tons grading 0.65% Cu and 0.021% Mo, including 213 million tons of secondarily enriched material grading 0.94% Cu. In the Exploration Review section of the January SEG Newsletter (p. 40), the reserves were characterized as, "...despite plenty of 0.4 to 0.55% Cu, they only have 100 Mt containing 1% Cu,..." Mr. P.M.A. Esnouf, President of Empresa Minera de Mantos Blancos, S.A., has advised us that in November 1998, a decision was made to complete a Bankable Feasibility Study by the end of 1999 at an additional cost of US$115 million, and that they intend to develop the project when market conditions allow. He further stated, "It is thus not correct to suggest that Mantos Blancos seems to be pulling out."

- The SEG and Pubco are not considered private foundations and have always been able to recognize the value of gifts of appreciated securities. In the article, "Tax break for U.S. Contributors to the SEG Foundation" that appeared on page 3 of the January 1999 issue, the word "not" was inadvertently left out of the statement.


How to Write to the SEG Newsletter

Brief letters commenting on articles that have appeared in the SEG Newsletter are welcomed. The Society reserves the right to edit submissions. Please include your name, a phone/fax and email address (if available), and address your correspondence to Publications Production, Society of Economic Geologists, Inc., 5808 South Rapp Street, Suite 209, Littleton, Colorado, 80120, or to our email: segpubs@csn.net.
SEG’s Good Fortune Continued in 1998

As predicted at the GSA meeting, SEG and its affiliates—the Foundation and PUBCO—set new financial records in 1998, and all three of course continue in sound financial condition. Operations continue to improve and direct spending on programs and publications attained a record $770,000, more than $90,000 ahead of last year.

The Society’s spending on publications and programs increased 8% to a record $353,000. Administrative expenses climbed as well as the Society’s blossoming activities, but offsets from increasing revenues enabled SEG to finish the year $87,000 ahead of budget.

and the pouring of footings, and we have $2.6 million in the bank and a commitment for $1.5 million: $5.1 million total.

Foundation’s program spending and revenue growth continue to outpace expenses. Program spending increased $26,000 to $136,000—a new record—and investment income grew $17,000 to total $103,000—another record and the first time in excess of $100,000. With contributions of $26,000, SEG finished the year with a surplus of $91,000. As indicated in October, trustees for the McKinstry Estate informed SEG that it will receive a substantial bequest, possibly as early as May, that we expect will materially enhance SEG’s ability to fund student grants.

PUBCO had a record year, finishing with a surplus of $195,000 vs. a budgeted position of breakeven. The major savings is administrative; $70,000 down from last year. PUBCO took $142,000 in capital gains as it continued its move over the course of the year out of stocks and into fixed income securities. Operating revenues were $65,000 over budget, only $15,000 of which is due to increased investment income: the balance is revenue from publication sales.

The outlook for 1999 is bright. The combined budgets for direct program expenses by SEG, SEG Foundation, and PUBCO total $713,000. If we add PUBCO’s $183,600 in operating expenses, which arguably are unallocated publishing expenses, the Group is forecasting $926,600 in spending on programs—another record. The bottom line for all three entities’ combined budgets is a deficit of $26,000 but, since we have already taken $23,000 in capital gains in January, and changes in the portfolios have increased investment income by $10,000, we’re looking at a new record in program spending and a surplus year at that!
Staffing Global Exploration

The 1990s have seen an unprecedented globalization of mineral exploration, particularly with regard to gold, and few countries are now off-limits to the intrepid explorer. As my recently completed trips to the jungles of Ecuador, with Ecuadorian, South African, Australian, and British geologists; and to the high sierras of Peru, with Peruvian, Canadian, and British geologists, emphasized, it is now commonplace for international teams to work together in many parts of the world. The resulting mix of experience, local knowledge, and varied attitudes and approaches undoubtedly benefits the exploration process.

A particularly welcome aspect of the international exploration environment is the interchange of geoscientists between countries and regions, and not only North Americans, Europeans, Australians, New Zealanders and South Africans. Exploration companies have been transferring their Filipino staff to other parts of Southeast Asia for more than a decade, and Chilcan and Peruvian staff are frequently assigned throughout South America. I’m aware that companies also are currently using Bulgarian geologists on projects in the Middle East and Chilcan geologists on ventures in Greece and Russia. Greater reciprocal involvement of geoscientists from developing countries worldwide in North American and Australian exploration programs would be a most welcome change, as well.

The current downturn in the demand for metals and, hence, in exploration for them, has resulted in widespread staff retrenchment in most major and junior exploration companies. This situation is compounded, of course, by the difficulties that the junior companies are experiencing in obtaining financing. However, staff reduction in exploration offices around the world seems to have been approached differently by different companies. While some have wisely maintained the ratio of local-to-foreign geoscientists, others regretfully have preferred to increase the foreign component at the expense of local staff. And the nationalities of the foreign contingent generally reflects the country where the parent company is headquartered.

While it is understandable that companies want to remain as many of their own countries’ geoscientists as possible during the hard times, I feel that there is also an obligation to foster dedicated local exploration teams in all countries in which the companies operate. Indeed, the long-term success of their exploration efforts will likely depend on the development of corps of capable local geoscientists. This means that the local team is equipped with the work practices and corporate culture of the foreign employer and does not simply constitute “arms and legs” for fieldwork. It is anticipated that widespread failure of companies to fully employ local geoscientists will lead eventually to the introduction of restrictive visa-issuing policies on the part of host governments. This issue is believed to be already under discussion in some countries.

A widely voiced criticism among the foreign contingent is that some local geologists lack the skills and experience needed to compete on equal terms with their overseas counterparts. Perhaps this is not surprising, given the lack of mining tradition and the educational deficiencies in many of the countries where exploration is being conducted currently. And, of course, the fact that English is a second or even third language for many of them does not help, either. The lack of a proper field component to university geology courses in much of the world puts many recently graduated local geologists at a particular disadvantage. It is my view that foreign employers have a vested interest, if not a moral obligation, to try and offset these disadvantages in as many ways as possible, notwithstanding the financial restrictions imposed by the current exploration recession. Of course, this is easier for the majors than it is for junior exploration companies.

The simplest and perhaps most effective way of upgrading local geoscientists is by means of on-the-job training. This may comprise specialized in-house talks, conferences, and field courses as well as participation in national and international congresses, and field excursions. Some of the more forward-looking companies are transferring local staff to their exploration offices or mining operations in other countries for periods of several months. They gain invaluable experience in work practices and professional attitudes of other countries, and they have an opportunity to improve their geologic and linguistic skills. Loyalty to their employers is also undoubtedly increased.

Maybe companies with overseas operations also need to consider how they can influence the caliber and content of local university geology courses, perhaps by funding and even organizing student field trips. Indeed, a small consortium of progressive foreign companies operating in one South American country is understood to have pledged a substantial sum over a period of five years in order to upgrade teaching in exploration and mining geology at one of that country’s universities. Could this provide us with a model for the future? Simply mulling the obvious, that taxes and royalties paid to host governments by foreign mining companies should be used for the improvement of geoscientific education, is not enough. The host governments concerned have other overwhelming priorities.

The Society’s commitment to internationalization, perhaps symbolized by my election as its first non-North American President in 64 years, may be harnessed in the training of geoscientists in developing countries. In addition to the provision for International Exchange and Thayer Lindsey Lecturers, support for overseas geoscientists’ congresses, symposia, and field trips, and the availability of research grants to qualified nationals of any country, the Society could become involved in the organization of field training courses in selected overseas venues, in which local geoscientists are given preference. Potentially popular topics for consideration include supergene oxidation and enrichment of copper deposits in northern Chile, carbonate-hosted zinc deposits in central Peru, VMS deposits in Mexico, and porphyry copper-epithermal connections in the Philippines. Conversations with local geologists in many parts of the world have convinced me that there is a real demand for such an initiative. This is a goal that I shall be pursuing actively during my year in office.

These pages have been devoted several times in recent years to the continuing decline in the number of economic geologists graduating from universities in the developed countries, particularly in North America, and the danger that this poses for future staffing of exploration programs worldwide. While this situation is lamentable, it is probably also inevitable, and the reality is that our industry’s future supply of explorationists will depend increasingly on numerous other countries around the world, perhaps especially the mining nations of South America and Southeast Asia. So, let’s start right now by accepting this fact and treating our local geologists as a resource as valuable as the one for which we are exploring. Doing so will involve policy changes in some companies and the inevitable investment of effort and money by all concerned.
The Foundation wants SEG membership involvement. Continuing education in the form of field trips, short courses, meetings, and conferences is available to the membership. These SEG programs, which form a cornerstone of the economic geology profession, are available to us as members for increasing our personal awareness, knowledge, and skills. The Society exists for the benefit of its members, and the Foundation exists to raise the money that funds the Society’s programs. The funds provided to SEG by the Foundation are available only because of the generosity of the donors to the Foundation.

During previous fund drives, the Foundation, through strong corporate and membership support, successfully raised the money required to fund SEG’s existing programs. Membership in the Foundation’s Booster Club is increasing and these funds represent an important source of revenue for the Foundation. If you have not joined the Booster Club, please give this your consideration as a way of supporting the Foundation and SEG programs.

In addition to the Foundation’s efforts, the Society has received an anonymous gift allowing the construction of a much-needed headquarters building at the Ken Caryl Business Development Center in suburban southwest Denver. The new headquarters will facilitate SEG’s multifaceted and increasingly global activities, for which information is available on the SEG web page <http://www.segweb.org/>.

The headquarters will serve as the nerve center for distributing timely information to the international community of economic geologists. The Foundation is proud to be part of the headquarters operation.

Coincident with the construction of the SEG headquarters building, the Foundation is moving to become a Colorado corporation. The SEG Foundation Articles of Incorporation and By-Laws will be revised to conform with Colorado law. In addition to these changes, the Foundation has finalized a set of guidelines for administering the Membership Subsidy Program. Also, the 1999 Student Grant Program will be increased to $60,000, $10,000 more than in 1998. The Foundation’s total funding level for 1999 programs is over $200,000; it will only be possible to sustain and increase, this level of funding with the continued strong donation support that the Foundation has received in the past.

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**Contributions**

December 30, 1998 – March 10, 1999

- **$1,000 - $5,000**
  - CAMECO CORPORATION, CANADA
  - NEWMONT GOLD, USA

- **Up to $1,000**
  - GEORGES O. ALLARD, USA
  - RAFAEL AURELIO ARGANARAZ, ARGENTINA
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Pledge $200 per year for five consecutive years and become a key supporter of SEG’s worldwide programs. Send your check or credit card authorization to become a member of the Boosters Club to Society of Economic Geologists Foundation, Inc., 5808 South Rapp Street, Suite 209, Littleton, Colorado, USA 80120. Should you have any questions or wish further information, you may also contact the office by telephone (303) 797-0332 or by email: soccegocd@csn.net.
NWMA to Address Proposed BLM Land Management Changes

LAURA SKAER • Executive Director, NWMA

Editor’s Note: The SEG Newsletter welcomes Ms Laura Skaer, Executive Director of Northwest Mining Association (NWMA), as a guest columnist. NWMA is a strong advocate for mining and minerals exploration in the United States, but its advocacy positions are applicable worldwide. In 1998, NWMA successfully pursued legal action against U.S. Secretary of the Interior, Bruce Babbit, and the Bureau of Land Management (BLM) to invalidate the bonding regulations adopted at the direction of Secretary Babbit in 1997. The ruling judge found that Babbit and the BLM had violated federal law! Recently, NWMA adopted a “Statement of Environmental Principles.” The statement includes nine principles affirming that environmental protection is an essential element of mining and that mining and environmental protection are indeed compatible. In the following column, Ms Skaer discusses a current hot topic, “Proposed BLM Land Management Changes.”

The Northwest Mining Association (NWMA) is taking a proactive role in critiquing recently proposed changes to the federal regulations governing hard-rock mining on land managed by the U.S. Department of Interior (DOI) Bureau of Land Management (BLM). On February 9, 1999, the BLM issued proposed changes to the 43 CFR 3809 regulations. The proposal is a “solution looking for a problem.” It unnecessarily duplicates, and in many cases, supplants proven state regulatory programs. It is evident that DOI Secretary Bruce Babbit is attempting, once again, stealth and back-door mining law reform. NWMA successfully challenged the BLM in court last year on improperly issued regulations governing bonding for exploration and mining operations.

The proposed regulations will have a major adverse impact on exploration and mining activity on BLM-managed lands without any appreciable improvement in environmental protection. The current regulations were issued in 1981. They have stood the test of time and have been proven effective in protecting the environment and preventing “unnecessary or undue degradation” on the 262 million acres of land managed by BLM. After two years of rule-making activity, the BLM has yet to demonstrate a need for the wholesale changes they are proposing. The few problems which have occurred could have been effectively managed if BLM had exercised its existing authority under the regulations currently in place.

Today, all mining on federal land is subject to more than three dozen federal environmental laws and regulations. Environmental laws in each of the western mining states impose exacting controls on mining operations. Reclamation and bonding laws in every mining state mandate that mining companies clean up mining sites when their operations end. These laws, in conjunction with the existing 3809 Regulations, ensure reclamation and protection of the environment. Mining industry leaders, the Western Governors’ Association (WGA), and key Western senators and congressmen have repeatedly stated that the 3809 Regulations do not require major revisions.

In the fall of 1998, at the request of Nevada governor Bob Miller, Congress instructed the National Academy of Science (NAS) to assess the adequacy of existing state and federal regulations governing hard-rock mining on BLM-managed lands, determine if there are any gaps, and report back to Congress by July 31, 1999. The NAS panel is currently holding hearings to determine the facts upon which to formulate its report. Unfortunately, the public comment period for the BLM’s proposed changes is scheduled to close 2½ months before the NAS completes its study. Secretary Babbit has rejected two requests from a bipartisan group of 16 U.S. Senators and a request from the WGA to delay publication of proposed regulations until after the NAS study is completed. It is obvious that Secretary Babbit is not interested in having the benefit of an independent, objective, science-based study.

BLM statistics indicate exploration and mining activity currently covers 214,000 of the 262 million acres managed by the agency. Of this 214,000 acres, 65,000 have already been satisfactorily reclaimed. The yet-to-be-reclaimed acreage is less than one-twentieth of one percent of the land under BLM management—hardly a compelling reason to require the major changes BLM states are needed in the “Fact Sheet” issued with the proposed regulations.

The proposed changes in the 3809 Regulations and the accompanying Draft Environmental Impact Statement (DEIS) can be obtained from Paul McNutt by email <pmcnutt@nw.blm.gov>, or on BLM’s Internet site <http://www.blm.gov/ship/Commercial/SolidMineral/3809>. BLM plans to hold 16 public hearings on the Proposed Regulations in the western states and Washington D.C. beginning in Reno, Nevada, on March 23 and continuing through late April. Specific locations and the dates of the hearings can be obtained from any BLM office. All individuals engaged in exploration and/or mining on BLM-managed lands are encouraged to review carefully and comment on the proposed regulations and accompanying DEIS. Written comments are due May 10, 1999, unless extended. Send your comments to the BLM, Administrative Record, Nevada State Office, P.O. Box 12000, Reno, NV 89512-0006, or via email to <WOComment@wo.blm.gov>.

Additional information on the proposed regulations and DEIS can be obtained from NWMA (509-624-1158) or from any western state mining association. 
GOLD-ONLY MINERALIZATION AND GRANITSES

"Granite" here includes many felsic intrusive rocks (i.e., granite, sensu lato, or granitoid); "gold-only" deposits are those typically without economic silver and base metals (Phillips, 1996). There is considerable evidence to indicate some link between granites and gold-only systems. Most of the world's largest gold-only provinces contain widespread granite, and these include Archean granite-greenstone terranes, the Victorian slate belt, the Carlin province of Nevada, and the Mother Lode and related deposits adjacent to the Sierra Nevada batholith of California. For slate-belt provinces, there may even be a positive correlation between granite abundance and gold production (Phillips and Zhou, 1998). In Archean granite-greenstone terranes, some gold-only deposits, including some large ones, are situated within 2 km of granite contacts. But closer inspection of the distribution of gold deposits in Archean granite-greenstone terranes reveals three important limitations to any universal granite link. First, some of the largest and most important gold systems are near the center of greenstone belts, well removed from known granites (Figure 1). For example, Kalgoorlie, which has production and reserves of 60 million ounces (Moz) of gold, is as far from any surface or subsurface granite as possible in the entire Proterozoic, and is more than 10 km from the nearest granite. In the past, spatial correlations have been noted between gold deposits and ultramafic rocks, basalt, and differentiated dacite sills, porphyry dikes, lamprophyre dikes, and banded iron formations. On this basis, many of the rocks have been linked genetically to gold formation at one time or another. However, it has long been appreciated that many magmatic processes are ineffective at concentrating gold. This has been demonstrated by the lack of gold enrichment in differentiated mafic sills. Layered mafic sills, and a variety of Archean rock types, including mafic, felsic, and ultramafic volcanic rocks, felsic intrusions, and sedimentary rocks (Kwon et al., 1978). Within the broad category of Archean granites, sensu lato, there is no significant gold enrichment in any particular granite type, and elevated gold values are typically associated with signs of alteration rather than specialized granite.

GOLD IN ARCHEAN GRANITES

The dominant lithology in all Archean cratons is granite, and this rock type tends to form large areas interspersed with linear greenstone belts and gneissic domains. For the Yilgarn craton of Western Australia and the Zimbabwe craton, mapping shows that granite makes up over 50 percent of these cratons. Many rock types have been spatially correlated with Archean greenstone gold deposits, and granite is no exception. This comes as little surprise, given the vast amount of granite in each craton, and the narrowness of many greenstone belts. Making the correlation between granite and gold deposits has often been difficult to find locations in Archean cratons much more than 10 km from the nearest granite. In the past, spatial correlations have been noted between gold deposits and ultramafic rocks, basalt, differentiated dacite sills, porphyry dikes, lamprophyre dikes, and banded iron formations. On this basis, many of these rocks have been linked genetically to gold formation at one time or another. However, it has long been appreciated that many magmatic processes are ineffective at concentrating gold. This has been demonstrated by the lack of gold enrichment in differentiated mafic sills. Layered mafic sills, and a variety of Archean rock types, including mafic, felsic, and ultramafic volcanic rocks, felsic intrusions, and sedimentary rocks (Kwon et al., 1978). Within the broad category of Archean granites, sensu lato, there is no significant gold enrichment in any particular granite type, and elevated gold values are typically associated with signs of alteration rather than specialized granite.

Table 1. The Volume of Granite, Gold Production from Granite and the Prospective of Granite Compared to the Rest of the Province: Yilgarn, Zimbabwe, Victoria

<table>
<thead>
<tr>
<th>Granite</th>
<th>Gold in granite</th>
<th>Relative prospectivity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yilgarn</td>
<td>70%</td>
<td>3%</td>
</tr>
<tr>
<td>Zimbabwe</td>
<td>80%</td>
<td>10%</td>
</tr>
<tr>
<td>Victoria</td>
<td>20%</td>
<td>0.50%</td>
</tr>
</tbody>
</table>

The potential link between gold-only deposits and granite involves, at one extreme, the granite as the source of fluids and gold to form the deposit (magmatic model). Alternatively, the granite may introduce heat and generate a structural environment favorable for fluid migration; or granite may be a product of the same tectono-thermal event that generated the anisothermal hydrothermal fluids. At the other extreme, granite may be clearly older than mineralization and act as a rheological heterogeneity during deformation, or be significantly younger than mineralization and cause contact metamorphism and ore remobilization.

Gold in Zimbabwe granites

As a result of long-term regional mapping and well-exposed granite batholiths, Zimbabwe is one of the better-documented Archean cratons for gold deposits in granite. As shown in Figure 2, there are at least 650 gold deposits in Archean granite in Zimbabwe alone (Mann, 1984; Nutt et al., 1988). Over 80 percent of exposed Zimbabwe craton is granite; the combined gold production from granite, gneiss, and greenstone is 55 Moz. Three million ounces, or less than 10 percent of the Zimbabwe production, has come from granite (Table 2).

Table 2. Number of Gold Deposits, and Gold Production, from the Zimbabwe Craton and from Granite (Data from Mann, 1984)

<table>
<thead>
<tr>
<th>Total number of gold deposits</th>
<th>6000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of deposits in granite</td>
<td>600</td>
</tr>
<tr>
<td>Total gold for Zimbabwe</td>
<td>55Moz</td>
</tr>
<tr>
<td>Gold from granite</td>
<td>3Moz</td>
</tr>
</tbody>
</table>

Among the 650 mines in granite in Zimbabwe, most are in pre-2700 Ma, older tonalite gneiss (Table 3). The 2700 Ma Sesomhi suite of hornblende-biotite tonalite hosts nearly 30 percent by number of the gold deposits in granite and yields around 15 percent of the gold mined from granites (Mann, 1984), although recent Freda Rebecca production would increase this. The Chilimana suite of granite and adamellite is far more extensive than the Sesomhi suite but produces
negligible gold. The greater favorability of the Sesombi suite (tonalite) over the Chilimanzi suite (adamellite) would be predicted by some gold genetic models in which iron is one of the critical precipitants of gold. Another factor may be the later emplacement age of some Chilimanzi granite.

Table 3. Subdivision of Zimbabwe Gold Production on the Basis of Different Granite Host-Rock Types

<table>
<thead>
<tr>
<th>Percentage of deposits</th>
<th>Gold production</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ancient gneiss (3500 Ma, common tonalite)</td>
<td>65%</td>
</tr>
<tr>
<td>Sesombi suite (internal) (2700 Ma, hb-bi tonalite)</td>
<td>30%</td>
</tr>
<tr>
<td>Chilimanzi suite (external) (adamellite)</td>
<td>5%</td>
</tr>
</tbody>
</table>

With respect to distance from the nearest greenstone belt, there is an exponential decrease in the number of gold deposits in granite going away from greenstone (Mann, 1984), and very few deposits are more than 3 km horizontally from greenstone. Most gold deposits in granite are actually in or adjacent to greenstone contacts or mafic xenoliths (50 percent), and this is obvious for the largest 6 percent of deposits in granite (>0.03 Moz) for which 80 percent are next to mafic rocks (Figure 3). A subordinate number of deposits in granite are in massive granite (20 percent) and all of these are small (<0.03 Moz).

The Zimbabwe data clearly indicate that gold deposits in Archean granite are close to greenstone contacts and concentrated in more Fe-rich granite types. Similar structural controls appear to influence gold deposits in both the greenstone belts and granites (Nutt et al., 1988).

Gold in Canadian granites

The most significant Canadian Archean gold deposit in granite is the Renabie mine in the western Abitibi province near Lake Superior. This deposit is globally significant, as it appears to be the only granite-hosted Archean gold deposit that has produced over 1 Moz. Renabie is within 0 to 600 m of a greenstone contact with mafic volcanic rocks, is structurally controlled by brittle-ductile shear zones, steeply plunging, and continues to 900 m depth. Mineralization trends away from the greenstone through tondjimeite and into tonalite, thus crossing the different granite units (Callan and Spooner.)
1989). The gold/silver ratio is 3:1 and base metals are uneconomic, suggesting close affinity with other Canadian greenstone gold deposits, rather than being a new magmatic gold deposit type. Fluid inclusions from mineralized quartz veins from Renabie contain H₂O-CO₂ and are 4 to 8 wt percent NaCl equiv, similar to those found in many other Archean gold deposits (Studemeister and Kilias, 1987).

The example of Renabie is compatible with the Zimbabwe data, and similarly, indicates that better gold in granite is structurally controlled and occurs near greenstone belt margins.

**Gold in Yilgarn granites, Australia**

Although granites are the most abundant rock type in the Yilgarn craton, they host 7 percent of the gold deposits by number, and have yielded only 3 percent of mined gold (Table 1). The three largest cited examples are Tamaroo (Fairclough and Brown, 1988), Granny Smith (Ojala et al., 1995; Hall and Holyland, 1986), and Woodcutters, although these are not at all clearly "in granite" (Table 4), so the importance of granite as a host rock is overstated. This point is further illustrated at Tamaroo, 30 km north of Leonora. Here, shallow-dipping splays off a major structure control the gold mineralization that is in both schistose mafic rock and granite gneiss (3 Moz at 1.7 g/t resource). Despite these significant deposits of gold in granite, Yilgarn granites are two orders of magnitude less prospective than greenstone belts.

The Australian examples support conclusions from Zimbabwe and Canada that proximity to greenstone is important and that gold deposits in granite tend to be substantially smaller than the largest gold deposits in greenstone belts.

**Some other gold-only deposits in granite**

Gold-only deposits are well known in and near Phanerozoic granites, particularly in the major gold provinces. One of the largest such deposits is the Charters Towers deposit of northeastern Australia, from which 7 Moz of gold have been mined since 1871, from quartz veins in shear zones in Early Devonian granite (Peters and Golding, 1988). Some of these veins extend to 1,000 m depth, and contain higher-grade shoots within the plane of the veins. Gold mineralization post-dated intrusion of the granite and preceded Carboniferous dikes, but no direct relationship between any of the granite phases and the mineralization has been established.

The relationship of gold deposits to granite has been well documented for Victoria, and many similarities between this province and Archean greenstone belts have already been highlighted in the literature (Coney, 1992). Although granite makes up 20 percent of the Lachlan fold belt in the Victorian gold province of southeastern Australia, gold deposits in granite have yielded approximately 0.3 Moz of gold out of Victoria's 80 Moz: this is despite the observation that many granites crop out especially well. Thus, granites are two orders of magnitude less prospective than surrounding Paleozoic metasedimentary rocks. Critical to understanding the lack of importance of any special magmatic process, Victorian granites that host small gold deposits include I- and S-type, fractionated and unfractuated, and mafic and felsic granites, and those crystallizing at both very shallow and at great depths. In other words, almost all possible variants of granite can host small gold deposits (Hughes et al., 1997).

**WOODCUTTERS GOLDFIELD, KALGOORLIE, AUSTRALIA**

Gold was discovered in the Woodcutters granite in 1996, during drilling of a gold anomaly by AMX Resource NL. Centaur Mining and Exploration Ltd in 1996–1997 discovered additional gold in this granite, and now a number of areas of mineralization are known that together represent over 1 Moz of contained gold. Total reserves and resources on the AMX tenement is about 1.05 Moz with a 0.5 g/t cutoff (AMX, 1996) and a further 0.3 Moz endowment at Centaur's Federal open pit. Centaur commenced mining of the Federal orebody in July 1998, and ore is trucked to existing treatment facilities at the nearby Mt Pleasant mine. The potential mining of the other deposits is still being evaluated by AMX and Centaur. The Woodcutters gold field is unusual given its position so far removed laterally from the nearest greenstone belt (Figure 4). All the deposits that make up the gold field are several kilometers from the nearest greenstone, and for the Federal open pit, this distance is 5 km. If Woodcutters were analogous with other known deposits, its gold field should be of negligible size, given the large distance from adjacent greenstone (e.g., Mann, 1988). Instead, the contained gold makes it one of the largest Archean gold systems in granite (cf. Renabie production of 1 Moz Au).
The host granite at Woodcutters is a hornblende-biotite granodiorite similar to several other granite bodies in or adjacent to the greenstone belts (Witt and Davy, 1997). At the Federal open pit, gold mineralization is aligned on a northwest trend (Figure 5) that extends to Kanowna Belle, with higher-grade shoots where transected by north-northeast-trending brittle-ductile shear zones (that extend to Paddington; Vearncombe, pers. commun., 1993). The northwest-north-northeast direction is common in the greenstone succession and typically defined by early ductile and brittle-ductile shear zones. The 020° direction is a subset of the northeast-striking dextral faults defined on aeromagnetic imagery and by later magnetic dikes, along with conjugate east-southeast-striking sinistral faults. These directions prevail as mineralized structures in the greenstone succession within the Mt Pleasant gold field (Vearncombe and Vearncombe, in press; Figure 6).

The broader alteration halo at the Federal open pit is dominated by epidote from the breakdown of plagioclase, and this can be over 100 m wide (Figure 5). The proximal alteration involves hornblende and biotite destruction and the stabilization of muscovite, secondary biotite, and quartz veins with gold and pyrite. Hematite is locally abundant, although its paragenesis remains uncertain. The lack of strong carbonate alteration or K addition is predicted from the felsic host-rock composition. Fluid inclusions from numerous quartz veins are H2O-CO2-dominant, of low salinity, with homogenization temperatures around 250° to 300°C (G. Dong, writ. commun., 1998); this is very similar to fluid inclusions recorded from many greenstone gold deposits (Ho et al., 1990). With respect to structural setting, fluid type, and ore mineralization, Federal appears very similar to surrounding gold deposits in the greenstone belt, the main difference being the different host rock.

**Figure 4.** Map of Kalgoorlie—Mt Pleasant district of the Yilgarn craton in Western Australia (granite distribution from Witt and Davy, 1997). This highlights the number of major gold deposits in greenstone belts in this area, and the location of the Woodcutters goldfield.

**Figure 5.** Geological map of the Federal open pit, and inset map of the Woodcutters goldfield showing several granite-hosted deposits discovered by AMX and Centaur since 1996. Broad epidote alteration surrounds proximal muscovite-pyrite alteration with gold. Mineralization is elongate northwest, but high-grade shoots occur at the intersection of this direction and 20° structures.

**Figure 6.** Summary of structural directions at the Golden Mile—Kalgoorlie, Mt Pleasant and Woodcutters goldfields.

**Interpretations of the Woodcutters gold mineralization**

At the time of discovery of gold at Woodcutters, two models for mineralization were considered. The position of the mineralization in the middle of a major batholith suggested Woodcutters may be a new type of Archean gold deposit, or alternatively, a better quality example of the many smaller mineralized occurrences known in granite.

The host granite batholith is typical of one of the main granite types in the Eastern Goldfield region (Witt and Davy, 1997), although the gravity signature indicates somewhat more dense rock than typical granite (Whittaker, 1992; Trench et al., 1993). This elevated gravity has been explained by greenstone underlying the granite, consistent...
with seismic data through the Mt Pleasant area (Dentith et al., 1992; Golby et al. 1993; Drummond and Golby, 1998). The nature of the gold-bearing fluid (low salinity, H₂O-CO₂), the alteration of the felsic host rock (broad epilite, proximal mica, and pyrite), the structural setting (similar fault network of brittle-ductile shear zone sets to Mt Pleasant), and the relatively Fe-Mg-rich nature of the granite suggest that Woodcutters formed by the same basic process as that which formed greenstone-hosted gold deposits. The available evidence favors neither a unique nor different fluid type, a significantly different time of gold introduction, nor any particular genetic link to the hosting granite.

**Genesis of Woodcutters gold deposits**

As mining proceeds at the Federal open pit, and as other mines begin in the Woodcutters goldfield, more geological detail will become available to constrain genetic models for the gold. However, it is already possible to evaluate the relative merits of two models: a new magmatic model for gold in Archean granites and a conventional greenstone metamorphic model (Phillips and Groves, 1983; Phillips and Powell, 1993). The conventional greenstone “continuum” model (Colvin, 1989) is not discussed because of its difficulties with explaining the source of the H₂O-CO₂ fluid, and its inability to address the issue of partial melting and aqueous hydrothermal fluids in conditions above 700°C elsewhere in Archean gold provinces.

**Magmatic model:** A new magmatic model for Archean gold appears unlikely for Woodcutters, given that the ore fluid is similar to that in other Archean gold deposits and that an H₂O-CO₂ composition is very difficult to generate by ordinary magmatic processes. The simple mineralogy of the phases during granite crystallization (feldspars, quartz, biotite, hornblende) does not lead to CO₂-rich fluids. These granite magmas and resulting fluids have low solubility of sulfur, which precludes widespread gold-sulfur complexing and the formation of “gold-only” deposits. The elevated salinity of ore fluids associated with some other granites favors gold and base metal accumulation rather than gold-only deposits, and hence is inconsistent with Woodcutters.

**Metamorphic model:** One of the strengths of the metamorphic model is that it predicts the composition of the gold-bearing fluid from possible metamorphic processes within greenstone belt successions (Powell et al., 1991). In a metamorphic model of gold-bearing fluids infiltrating granite-greenstone belts, mineralization is expected in greenstone or granite-greenstone margins. Woodcutters does not fit this criterion in plan view, but gravity and seismic data are consistent with greenstone lithologies at 1 to 3 km depth beneath Woodcutters (Drummond and Golby, 1998). The metamorphic model predicts granite to be less favorable for major gold deposits than many greenstone rock types for two reasons—the paucity of large-scale dilational sites in granite, and its less favorable chemical composition because of low iron and carbon contents. The metamorphic model predicts that higher-Fe granites are better host rocks than lower-Fe granites, all other factors being equal. Accordingly, tonalite and hornblende-bearing granodiorite should provide better environments for major gold deposits compared to adamellite and granite. The position of the Woodcutters goldfield above greenstone within a thin veneer of granite most probably allowed greenstone structures to propagate upward into the granite. Such a setting provided unusually effective fluid infiltration into the granite. Furthermore, Woodcutters is compatible with the host-rock predictions favoring hornblende-homblende granodiorite.

In the proposed model, the gold-bearing fluids are generated by metamorphic devolatilization in the greenstone belt succession (Powell et al., 1991). The overlying granite is simply another host rock that is mineralized on the merit of relatively favorable chemical and structural characteristics.

**Exploration for gold in Archean granites**

In several gold provinces, the granites are one to two orders of magnitude less prospective than other rock types (Table 1). This means that a randomly drilled hole in these gold provinces will, on average, discover 50 times as much gold if it is sited outside granite. However, the Woodcutters gold field illustrates the significant opportunity for discovery in specific sites within granite. The known distribution of mineralization favors Woodcutters being a variant on known Archean greenstone-related gold styles. If this is the case, then conventional greenstone search criteria will be valid, and “granite” becomes just another host rock in addition to basalt, banded iron-formation, and metasedimentary rock. Given the vast areas of granite in Archean cratons, however, exploration needs to be selective and well focused. Combining knowledge from Woodcutters with published information about gold in Archean granites provides a set of criteria that can guide cost-effective exploration. These include:

1. A district-scale structural analysis utilizing first vertical derivative gray-scale aeromagnetic data has provided several new targets (Vearncombe, written communication, 1999).
2. Proximity laterally and vertically to greenstone belts favors more and larger gold occurrences in granite.
3. Tonalite-trondhjemite series rather than granite; and adamellite (the late potassic granites are less favorable). The less favorable granite types are likely to crop out more strongly in many terranes compared to the chemically favorable granite types, owing to plagioclase and Fe-Mg mineral abundances.
4. The more favorable granite types are likely to be weakly to moderately magnetic (biotite-hornblende granodiorite).
5. Granite underlain by greenstone belt, as indicated by higher gravity response, should be considered favorably, especially if situated on the continuation of gold mineralized trends extending from adjacent greenstone belts, or adjacent to gold mineralized districts.
6. Quartz veining and sulfides associated with anomalous gold should be highly regarded. The absence of carbonate and/or strong K additions need not be detrimental.
7. Special geochemical pathfinders (Mo, Sn, Bi, Zn, Te, Cu, Pb, Zn, Ag, W) are unlikely, and may be a hindrance as they will tend to lead to granite rather than to gold. A better element suite based on greenstone-hosted gold analogies might include Au, S, possibly As, but not much else.
8. Epidote alteration may be an important indicator of gold-related alteration, though epidote alteration unrelated to gold may be quite widespread.
9. Direct targeting of this type of mineralization from geophysics is rarely successful on its own.
OVERVIEW

Gold deposits in Archean granite appear to be a modest exploration proposition at best. Most have produced less than 0.03 Moz of gold, with the largest deposits capable of producing slightly over 1 Moz. Evidence to date does not suggest that the Woodcutters goldfield represents a new deposit type, but it may represent an unusual set of geological features, including an underlying segment of greenstone belt. Understanding these unusual features does create some selective opportunities for economic gold deposits in granite.

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Figure 1. The outline of the building begins to take shape. The concrete footings for the east half of the front (north side) of the building have been poured (left middle ground) and forms are being placed for the remainder (left foreground). The foundation for the rear (south side) of the building has been completed (right foreground). (February 6, 1999)

Figure 2. Grading and excavation of the building site commenced shortly after the groundbreaking ceremony in December. In this photo, grading of the building site is almost complete. The cutout at the left side marks the position of the front entry for the building. (January 9, 1999)

Figure 3. Pouring the east half of the foundation for the front of the building. The concrete pumper truck is positioned opposite to where the front entry of the building will be. (March 6, 1999)
Figure 4. Pouring the footings for the west end of the front of the building. The transformer (dark cabinet, left of center), which will provide electrical service for the building, is in place. The gray electrical panel (to the left of the transformer) is connected to the transformer and will be used during construction of the building. (March 6, 1999)

Figure 5. "Topping-off" the foundation wall. Because of the height of the foundation wall, the concrete was poured in three "lifts" over a period of about three hours. Altogether, approximately 120 cubic yards of concrete were poured to complete this part of the foundation and the footings for the west half of the front of the building. (March 6, 1999)

Figure 6. Forms are in place for the east half of the foundation wall for the front of the building. The forms for the foundation wall here are almost 15 feet high. The foundation wall for the rear of the building (the walk-out level) appears in the foreground. (March 5, 1999)
Council Actions

The SEG Council held a regularly scheduled meeting at the Hyatt Regency Hotel in Denver, Colorado, on March 1, 1999. Members of the Council present were: PM Bethke, RG Blair, DI Groves, JW Hedenquist, SE Kesler, TA Loucks, RA Newell, FR Robert, F Seckloff, RH Sillitoe, HJ Stein, TB Thompson, and JA Thomas. MW Hitzmann and AR Wallace were unable to attend due to illness. Others present were: FM Beck, JM Franklin, LB Gustafson, and LA Landefeld. President Kesler called the meeting to order at 7:15 pm. The following actions were taken at the meeting:

- Approved the minutes of the Council meeting held at the Sheraton Centre Hotel in Toronto, Ontario, on October 26, 1998, in conjunction with the GSA 1998 Annual Meeting.
- Received the report of the President as Chair of the Executive Committee, and ratified the following actions taken by the Executive Committee during the period October 27, 1998 - February 28, 1999:
  - Accepted the "Permanently Restricted Endowment Fund" agreement that sets forth the terms and conditions under which the Society will be obligated to administer the Fund, the income from which will be used to offset operating and maintenance expenses for the Headquarters Building and to defray the cost of future replacement items. (A separate "gifting" letter from the Anonymous Donor pledges that a contribution of $1.5 million will be made to establish the fund by the time construction of the Headquarters Building is completed.) (2/23/99)
  - Approved a resolution authorizing Thomas A. Loucks to "...sell, assign and endorse for transfer, certificates representing stocks, bonds or other securities ...registered in the name of (1) Society of Economic Geologists-Headquarters Fund, (2) The Society of Economic Geologists, Inc., and (3) Society of Economic Geologists-Penrose Fund." (2/28/99)
  - Approved a motion to reimburse reasonable expenses for SEG officers and Councilors traveling from overseas to attend regularly scheduled business meetings of the Society. (2/28/99)
  - Approved Fellowship List F-75 (5 candidates). (2/28/99)
  - Approved the establishment of full-time "Membership Services" and "Mail Room" positions at SEG Headquarters, and authorized the Executive Director to hire suitably qualified candidates to fill the positions. (2/28/99)
  - Authorized the President to appoint a committee to (1) initiate a search for, and evaluate candidates for a full-time "Business Manager" position with a salary in the $40,000-50,000 per year range; (2) initiate a search for an Executive Director, with remuneration to be discussed; and (3) to recommend appropriate candidates to the Executive Committee for consideration and selection. Recommendations are to be provided to the Executive Committee by July 31, 1999. (2/28/99)
  - Approved a motion to increase the SEG Annual Budget for 1999 by an amount equal to the IRA contributions that SEG will make on behalf of its employees during the year. (2/28/99)
  - Accepted the Treasurer's Report for the year 1998, and the Finance Committee's report, as presented by the Treasurer.
  - Accepted the Executive Director's Report.

- Approved the slate of candidates recommended by the Committee on Committees for the various committee positions coming open on April 1, 1999.
- Approved the nomination by the Lindgren Award Committee of D. Graham Pearson, University of Durham, for the 1999 Lindgren Award.
- Approved the following slate of candidates recommended by the Nominating Committee for the various officer and Councilor positions coming open on April 1, 2000: For President-Elect—David L. Groves, Vice President-Elect—Murray W. Hitzman, and for Councilors—Mark D. Hannington, Christoph A. Heinreich and Noel C. White. These candidates will be submitted to the SEG membership for election on the ballot that will be distributed in August 1999.
- Approved the applications to form SEG Student Chapters at Laurentian University, Ontario, and at the University of Victoria, British Columbia.
- Voted to eliminate the word "scientific" from the Bylaws, Article IX, Sections 6. Thayer Lindsley Visiting Lecturer: "...qualifications...are proven scientific expertise in the field of economic geology..." This will be an amendment to the Bylaws and will require approval by a 2/3 majority of the Council. An appropriate ballot will be circulated to the full Council requesting such approval.
- Approved a grant of US$1,500.00 as seed money to support the Member-at-Large field conference being organized by Krister Sunblad and which will be held in northern Sweden sometime between April 2000 and April 2001.
- Voted to reimburse travel expenses up to US$1,500.00 for Holly Stein, who is the keynote speaker for the "Gold '99" conference being held in May '99 in Tromsø, Norway.
- Approved a recommendation to establish an SEG stand-alone meeting schedule beginning in the year 2002 in Denver, to be followed in 2004 outside North America, then 2006 back in North America, etc. (President Kesler will appoint an organizing committee for the 2002 conference. David Groves suggested that the 2004 conference be held in Perth, Australia, and offered to take the initiative in organizing the meeting.)
- Voted to transfer the responsibility for selecting nominees for Society medals and awards from the Medals Committee to the SEG Council. First year Councilors will be responsible for nominating candidates for the Silver Medal; second year Councilors will nominate candidates for the Penrose Medal; and third-year Councilors will nominate candidates for the Menden Award. The medalists and awardees will continue to be selected by vote of the Council. This change in procedure to select nominees for medals and awardees will involve dissolving the Medals Committee and necessitate a Bylaws amendment that will require approval by a 3/4 majority of the full Council. An appropriate ballot will be circulated to the Council requesting such approval.
- Voted to hold the next SEG Council meeting in Denver, Colorado, on Monday, October 25, 1999, in conjunction with the annual meeting of the Geological Society of America.
Thayer Lindsley Visiting Lecturers for Academic Year 1999–2000

The Society of Economic Geologists announces the appointment of Murray W. Hitzman and John F.H. Thompson as the Thayer Lindsley Visiting Lecturers for 1999–2000. Dr. Hitzman is a professor in the Department of Geology and Geographical Engineering, Colorado School of Mines. Dr. Thompson is chief geoscientist, Teck Corporation, Vancouver, British Columbia.

MURRAY W. HITZMAN received B.A. degrees in Earth Science and Anthropology from Dartmouth College in 1976, an M.S. degree in geology from the University of Washington, Seattle, in 1978, and a Ph.D. from Stanford University in 1983. He began work in the mining industry with Anaconda Company in 1976 at the Yerington porphyry copper mine in Nevada and subsequently worked in Alaska from 1977 through 1982. The Alaska work provided the basis for both his master's thesis (Volcanogenic Massive Sulphide Mineralization in the Ambler District) and his doctoral dissertation (The Ruby Creek Copper-Chalcopyrite Deposit in the Brooks Range). After completing his Ph.D. degree, he worked for Chevron Resources Company, initiating and managing base and precious metal exploration projects in Papua New Guinea, Brazil, Spain, Ireland, France, Germany, Italy, Tanzania, Canada, and the United States. In 1990, he was instrumental in the exploration for and the discovery of the Lisheen zinc-lead-silver deposit in Ireland, and from 1990 through 1993, managed the Lisheen project, guiding it through exploration and pre-feasibility, including engineering and environmental studies. Dr. Hitzman was named a Geological Society of America Congressional Fellow in 1993 and served on the staff of U.S. Senator Joseph Lieberman (D-CT), working on natural resource and environmental issues. He was named Executive Branch Fellow by the AAAS/Sloan Foundation in 1994 and served as a senior policy analyst in the White House Office of Science and Technology Policy from September 1994 through March 1996, specializing in natural resource, environmental, and geoscience issues. In June 1996, he was appointed the Charles F. Fugerty Professor of Economic Geology at the Colorado School of Mines, a position he holds at present. Current research interests include carbonate-hosted Zn-Pb deposits, the Zambian copper belt, Olympic Dam-type iron oxide Cu-Au-U deposits, and the role of microbes in ore formation. He has authored more than 50 technical and popular articles on ore deposits, mineral exploration, and geoscience policy. His is a director of Mansfield Minerals Ltd. (Vancouver) and consults on mineral properties worldwide. Dr. Hitzman offers three talks: "The Zambian Copper Belt—A New Look at a Classic World-Class District," "Geology and Genesis of the Irish Zn-Pb Orefield," and "Olympic Dam-type Iron Oxide Cu-Au-U Deposits." The first is designed for general audiences, while the latter two are for upper division and graduate students.

JOHN F.H. THOMPSON was born in England and received a undergraduate degree in geology from Oxford University in 1976, followed by M.Sc (1978) and Ph.D. (1982) degrees from the University of Toronto. His research focused on magnetic Ni-Cu-Cu-PGE sulfides in Norway for the master's degree, with similar research in Maine for doctoral work. After receiving his Ph.D. degree, he joined Selhurst/BP Minerals in Australia and began working on exploration for Ni and Cu-Zn in western Australia. He was transferred to eastern Australia in 1984 to do regional exploration for gold. In 1986, he moved to the Area Selection Group for BP Minerals International in the United Kingdom, working in southeast Asia, Australasia, Brazil, the United States, Canada, and Spain. He then moved to Salt Lake City in 1988 to work for Kennecott, doing regional exploration/evaluation in Nevada, Arizona, and British Columbia. Dr. Thompson accepted a position at the University of British Columbia in 1991, serving as director of the Mineral Deposit Research Unit (MDRU), a joint industry-university research effort. While there, he directed eight collaborative research projects funded by industry-government and involving faculty, postdoctoral and graduate students. These projects included regional metallogenic studies, deposit studies, and research into exploration techniques. In addition, he organized MDRU short courses for industry, and short courses and symposia for conferences. In 1998, he accepted his current position with Teck Corporation, becoming involved in worldwide exploration and exploration technology. Dr. Thompson offers three talks for his lecture series: "Research and Mineral Exploration," "Cordilleran Metallogeny of Western Canada," and "Intrusive-related Mineral Deposits; Tectonics, Magmas, and Fluids." The first talk can be adapted to general audiences, whereas the latter two are for upper division and graduate students.

Collegiate institutions offering degrees in geology are eligible to request Thayer Lindsley lecturers. The Society of Economic Geologists Foundation provides funds for the lecturers and the only cost to institutions is for local transportation and/or special activities such as receptions or local dinners. Requests for visits are processed in order of receipt and priority is given to institutions that have never had a lecturer or to those that have not had a visit within the last two or three years. Inquiries and/or requests for visits by either Dr. Hitzman or Dr. Thompson should be addressed to: Dr. Clay T. Smith, Secretary, Thayer Lindsley Visiting Lecturer Committee, Department of Earth and Environmental Science, New Mexico Institute of Mining and Technology, Socorro, New Mexico 87801. Phone: (505) 835-6553 or (505) 835-6538. FAX (505) 835-6538.
SEG STUDENT CHAPTER NEWS

NEW MEXICO TECH

The SEG student chapter at the New Mexico Institute of Mining and Technology (NMIMT) had an active 1998. Seven members participated in a field trip to Ghana in May, visiting gold, manganese, bauxite and diamond mines. In June, 10 students toured the Harding pegmatite mine in northern New Mexico. Chilean copper mines were the object of an early-January 1999 field trip that included four chapter members in a joint SEG venture with the University of Utah. The Ghana and Chilean field trips are described following this report. Aside from these excursions, the newly active chapter found time to carpool to monthly SME meetings in Albuquerque, organize a bulletin board describing group activities, design a logo and T-shirts, and begin construction of a web page at http://zippy.nmt.edu/Geol/SEG.

The spring 1998 fund-raiser was a mineral raffle held during the annual New Mexico Geological Society meeting. Many SEG student members contributed minerals and a large selection of specimens was donated by the New Mexico Bureau of Mines and Mineral Resources Mineral Museum. The raffle was a huge success, bringing in nearly $600, and is bound to become an annual chapter event. The focus of activity in the fall semester was fund-raising work for the Minerals Education Coalition, whose goal was to hand out over 20,000 mineral specimens to science teachers at the National Science Teachers Association convention in Albuquerque. In October, visits were made to local mining operations to collect baskets of industrial minerals such as gypsum and mica. November was spent washing, sizing, and bagging the minerals with informative labels, just in time for the early December convention. For three days, members had fun distributing samples and talking with science teachers about New Mexico mines and minerals. For its efforts, the chapter was awarded $700 by BHP Minerals.

A number of speakers came to Socorro to address the chapter. Ralph Stegen, chief geologist for Phelps Dodge Tyrone, Inc., explained aspects of the copper mineralization at Tyrone, New Mexico, and Paul Eimon, President of Commonwealth International Inc., delivered some very useful advice on employment strategies in the mining industry. On a historical note, Robert Enevoldsen, senior mining engineer at the New Mexico Bureau of Mines and Mineral Resources, spoke on “How Socorro Became the Mining Center of the Southwest,” and Clay Smith, professor emeritus at NMIMT, spoke about the Mockingbird Gap claim on the White Sands Missile Range.

Plans for spring 1999 include a trip to the Hamburger mining district of New Mexico and a mineral auction to be held at Socorro County’s annual “Rockhounding Days,” a family-oriented event. In March, Ghanaian students from the UST School of Mines in Tarkwa will join us on a field trip to copper mines in Arizona and southern New Mexico. Finally, field trips to Quebec in May, New Zealand in December, and Hawaii in 2000 are at the planning stages.

— the Executive Committee

FIELD TRIP TO GHANA

May 10–23, 1998

The NMIMT Student Chapter participated in a field trip to Ghana in May 1998. Drs. David Norman and Henry Appiah coordinated the trip, which was sponsored in part by SEG. Of the 11 participants, seven were students and four were professionals. The trip, a final activity of a course class on the ore deposits of Ghana, included visits to paleoplacer and lode gold deposits, and manganese, bauxite, and diamond mines. The first week was spent in the Tarkwa region, where the students were guests at the U.S.T. School of Mines. The second week was spent in the area of Kumasi, and the final leg brought us to Korforidzu, near the Akwaria diamond mine. The lack of rains, and consequent hydroelectric power rationing (12 hours on, 24 off), made lodging and dining an adventure akin to impromptu camping.

Ore deposits are located predominantly in three proterozoic-aged Birimian and Tarkwaian Group formations exposed in western and far northern Ghana. The Tarkwaian conglomerates lie unconformably over the Birimian metavolcanic and metavolcaniclastic schists. Conglomeratic and syndeformational “Cape Coast” granitoids intrude the Birimian units. Metamorphism of both rock groups reached greenschist grade at about 2.1 Ga, in a single event. Regionally, the mineralization is controlled by a northeast-southwest-oriented megashear extending through both the Tarkwa-Prestea and Obuasi areas. The region is host to many gold paleoplacers and shear-zone lode gold deposits. Diamonds are found dominantly in kimberlite-derived recent and paleoplacers.

The Tarkwaian rocks form prominent hills, and in the Tarkwa area the paleoplacers at the base of the unit occupy one or two principal strata. At each of the paleoplacer deposits (the Teberebie, Ghana Australian Goldfields-Idealplacid and the Ghana Goldfields-Tarkwa mines), the gold grades were highest in the coarsest, matrix-supported, quartz pebble conglomerates. Underground operations produce 7 to 8 g/t gold at the headframe, and open pit operation grades average about 1.5 g/t gold. The Tarkwa underground mine has just restarted production after a $120 million development and major maintenance project.

Gold mineralization in the Birimian schist is typically in quartz-sulfide veins with locally intense graphitization. At some of the lode gold mines (the Ahosso Goldmines-Damang, the Barex-Tresta, and the Bogoso Gold-Bogoso mines), there are some ongoing efforts to understand the complex structures controlling mineralization. On a regional scale, the mines occur near the Birimian-Tarkwaian contact. In the Ashanti Goldfields-Obuasi mine, current operations are focused on the disseminated oxide and sulfide deposits that accompany the lode gold. A visit to the new Box Plant, which has total recovery exceeding 80%, was particularly interesting.

Other highlights of the trip were visits to the Ghana Manganese Company Nuna mine, the Akwaria diamond mine, the Ghana Bauxite Company Awaso mine, and the Bonite Goldmines Bonti-
mine. Dredging at the Bonte mine turns up archeological finds—small pieces of jewelry and weight standards from the Ashanti gold trade—as well as placer gold. The conveyor belt at the Awaso mine brings down ore from so high up on the hill that it actually generates electricity for the mine.

We would like to thank the many mine employees who made this trip a success, and we are indebted to the Ghana Bauxite Company for the kindness extended to us upon the breakdown of our vehicle. Thank you, also, to the folks at the Ghana Manganese Company and Ghana Goldfields for the use of their swimming pools and for after-hours hospitality. We especially appreciate the cooperation of the U.S.T. School of Mines and the efforts of Dr. Henry Appiah. This trip would not have been possible without the financial support of SEG, to whom we extend also our gratitude.

— Beverly A. Chominick and Gregory P. Miller

ORE DEPOSITS OF NORTHERN CHILE

January 3–14, 1999

Students from the combined Society of Economic Geology Student Chapters of the University of Utah and the NMMIT, with representatives of mineral exploration companies, took part in an 11-day trip to visit ore deposits of northern Chile, January 3–14, 1999. The trip was supported by exploration company contributions, host mines, and a grant from the Society of Economic Geologists Foundation. The mines visited are shown on the accompanying map.

Chile ranks number one in copper production, providing nearly 20% of the world’s copper. Hence, our focus was on the red metal. Mine visits started at the Paleocene-age Cerro Colorado porphyry copper deposit near Iquique. Supergene mineralization at Cerro Colorado is characterized by a chrysocolla-chalcocite assemblage and reserves of more than 200 million tonnes (Mt) of ore grading 1.0% Cu. A sulfide resource approximately twice as large with a grade of about 0.5% Cu represents potential future ore. This mine-leach operation produces slightly more than 60,000 t/yr of fine copper.

The early Tertiary-age Quebrada Blanca porphyry system, at an elevation of 4,200 m, was our next stop. This mine, part of the Collahuasi district (see Newsletter, October, 1991), produces 75,000 t/yr copper from a heap leach operation. Initial reserves were more than 150 Mt of ore at 1.1% Cu as chalcocite derived from a pyrite + chalcopyrite protolith.

The giant Chuquicamata mine provided a chance for participants to see the structural complications associated with emplacement of one of the world’s largest metal repositories: tout contained copper metal at Chuquicamata is greater than 87 Mt, and the mine produces Mo, Re, Au, Ag, Se, As, and Li, in addition to more than 550,000 t/yr of copper per year. The more than 800-km-long Domeyko fault system apparently has served as a synmineral and postmineral suture, and adjacent to which many porphyry-style ore deposits are located.

In addition to the complex of intrusions at Chuquicamata and Radomiro Tomic, the El Abra porphyry system and adjacent Maria Vein system appear to be part of the development of this metallogenic feature. Our visit to El Abra gave participants the opportunity to see how the weathering of a K silicate-altered intrusive complex results in the in situ formation of copper oxides from a low pyrite, chalcopyrite + bornite protore. El Abra produces about 220,000 t/yr of copper cathodes, derived from the world’s largest heap leach operation. Crossing the central Atacama Desert and the historic nitrate fields, now being remined to make Chile the world’s leading producer of iodine, we visited the newly commissioned Lomas Bayas mine and the adjacent Fortuna de Cobre prospect, both owned by Boliden. At Lomas Bayas, heap and dump leach operations produce copper from a mixed copper oxide assemblage of brochantite, antlerite, atacamite, and chalcocite, hosted by a Paleocene-age intrusion and associated breccia bodies. The Fortuna de Cobre prospect is also of Paleocene age and represents an oxidized pyritic protolith consisting of copper sulfates, iron sulfates, and relic pyrite ± chalcopyrite. Andesites and rhyolites host the Triassic(?)-Mantos Blancos Cu-Ag deposit with mineralization consisting of digenite, chalcocite, bornite, chalcopyrite, and idaite ores, whereas pyrite and chalcopyrite constitute low-grade mineralization adjacent to the high-grade
orebodies. The mine produces about 85,000 t/yr copper as cathode and in concentrate. The former series of multiple open pits is being turned into a single "super pit" to accommodate production of leachable copper ores.

A quick visit to some prospects in the coastal cordillera near Antofagasta showed that copper oxides are developed in many of the andesitic volcanic rocks of Mesozoic age, probably as a result of low temperature metamorphic remobilization of copper from those same andesites.

Our final mine visit was to the La Escondida district, where we saw the well-developed chalcocite-hydrohemimite enrichment zone at Zaldívar. Producing 120,000 t/yr of copper cathode, this leach operation is adjacent to the La Escondida and Escondida Norte properties, and is located astride the Domeyko fault system. Total contained copper in the La Escondida district now amounts to more than 65 Mt, and will probably increase as exploration continues.

We are very grateful to all our supporters for the financial and logistical assistance they provided to make this trip possible for students from the United States, Papua New Guinea, and the Dominican Republic. In addition, the opportunity for students (and Drs. Petersen and Chávez) to learn from mineral exploration professionals was invaluable. We encourage other student chapters to take advantage of the support provided by the Society of Economic Geologists, and we acknowledge the continued motivation of SEG leadership to promote student field trips in association with economic geology professionals. The trip was led by Dr. William X. Chávez, Jr. of NMIMT and Dr. Erich U. Petersen of the University of Utah.

The McGill SEG student chapter had a busy and successful 1998. Membership remained constant at 50 students, with equal representation of undergraduate and graduate students. Corporate membership of the chapter increased considerably, and this generous and much appreciated financial assistance allowed us to organize more mine visits, field trips, and guest lecturers than in the previous year. A new committee was chosen for the 1998–1999 session. New officers are: Martin Hellinghann—President, Nicholas Barnes—Vice President, Alex Wilks—Treasurer, and Sandy Archibald—Secretary.

The highlight of last year's activities was an Easter field trip to Nicaragua by 15 chapter members, led by faculty sponsor Prof. Williams-Jones. The itinerary included visits to several volcanoes (Masaya, Concepción, and Momotombo), geothermal fields (including a geothermal power plant), numerous stops to examine the volcanic stratigraphy in western Nicaragua, and two mines. The first mine was the El Limón-La India gold mine operated by Triton Corporation. The mine, a high-sulfidation epithermal type, is estimated to have produced more than 2 Moz of gold. We were able to observe advanced argillic alteration and vuggy silica within the open pit workings, although alas, we saw no visible gold. After lunch, the mine staff conducted an underground tour of the sub-surface expression of the system. To complete the visit, we were given a tour of the mill and the cyanide recovery circuit for gold. The second mine visit was to Greenstone Resources' La Libertad heap-leach gold deposit. The mine uses cyanide heap leaching of the highly altered auriferous quartz veins and surrounding alteration halos to extract the 3 to 4 tppm gold present in the ore. We were also introduced to the technical challenges Greenstone Resources faces to make its mine an environmentally safe operation. It was an impressive sight, to see the five 100,000-ton heap leach pads in the central Nicaraguan landscape. Special thanks are extended to both the Triton Corporation and Greenstone Resources for facilitating the mine visits, and to Cominco Ltd., Glamis Gold Ltd., and Kinross Gold Corporation for their generous donations toward this educational field trip.
Other chapter events included conference visits, guest lectures, and a fall field trip to eastern Québec. Several chapter members were in attendance at the Prospectors and Developers Association of Canada (PDAC) conference held in Toronto in March 1998. This year, we are hoping to include a McGill University student chapter display within the Earth and Planetary Sciences alumni hospitality suite.

Talks by both chapter members and invited speakers increased last year. For the winter (98) semester, guest speakers included Gary de Schutter of Falconbridge Ltd., who presented a talk entitled “Anatomy of a Giant Kidd,” which focused on the geology of the Kidd Creek VMS deposit in Ontario; and Anne Charland, also of Falconbridge Ltd., who gave a very informative presentation on “Baglan, an Example of a Proterozoic Komatiite-Hosted Nickel Deposit.” During the fall, François Robert, of Barrick Gold Corp., gave a presentation on “Greenstone Gold Deposits and their Diversity,” followed by Alex Brown from École Polytechnique, who presented, “Geology and Genesis of the White Pine Sediment-Hosted Stratiform Copper Deposit.”

Our fall field trip, held in mid-November, was a visit to Noranda’s Mines Gaspé classic copper skarn deposit at Murdochville, Québec. Sixteen chapter members were in attendance for the 1,800-km round-trip visit to the Gaspé area. Thanks are extended to chief geologist Jeff Hussey, who organized the mine tour, as well as to Peter Marenghi, Pat Element, Denis Sylvain, Serge St-Pierre, and Gilles Fortin, who all helped with the mine, mill, and smelter tours. There was general agreement among the graduate and undergraduate students alike that this tour was one of the best that they had experienced.

Twenty-two chapter members will be visiting Ecuador as part of this year’s Latin America field trip (February 21–March 9). A report will be presented in the next SEG Newsletter and on our website (http://www.egxmcgill.ca/~seg).

— Sandy Archibald, Secretary
Call for Nominations for Penrose and SEG Silver Medals, and Marsden Award

Nominations for the Society’s Penrose and SEG Silver Medals, and the Marsden Award are due by September 1, 1999, for review by the SEG Council. Members and Fellows of the Society are urged to participate in this important process by nominating outstanding candidates for these prestigious honors.

**PENROSE MEDAL**—The Penrose Medal was established in 1923 to be awarded primarily in recognition of a full career in the performance of “unusually original work in the earth sciences,” which is broadly interpreted to encompass major contributions to: (1) the science through research; (2) the profession through teaching, program administration, and development of exploration technology; and (3) the development of mineral resources through mine geology, exploration, and discovery. The recipient need not be a member of the Society.

**SEG SILVER MEDAL**—The SEG Silver Medal was established in 1980 to be awarded annually for “excellence in original work in the geology of mineral deposits.” The general criteria and their interpretation for determining qualification for the award shall be the same as for the Penrose Medal, except that it will be considered primarily in recognition of excellence by or during the awardee’s “mid-career.” The recipient need not be a member of the Society.

**MARSDEN AWARD**—The Marsden Award, established in 1987, is awarded annually for “outstanding service to the Society.” Guidelines for qualifying for the award are based largely on the nominee’s record of exceptional stewardship and contributions to Society affairs. The recipient must be a person living at the time the nomination is submitted to the Council for approval.

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**HOW TO NOMINATE**

Please use the accompanying “Award Nomination Form.” The nomination should include a brief biographical summary, a short summary of the contributions that qualify the candidate for the award, and if appropriate, a selected bibliography of no more than five titles; the total number of additional titles may be indicated. Publication lists are considered to be only one measure of contributions to economic geology; many industry-associated individuals are not in a position to publish because of the proprietary nature of their work. Publications are not of significance in considering candidates for the Marsden Award. Candidates representing each of the three components of SEG membership—industry, government, and academia—are solicited.

A nomination for each of these awards must be supported by signed letters from three SEG Fellows or Members. Supporting letters may be attached to the nomination form, which is also available on the SEG website: <http://www.segweb.org>, or sent separately. Nominations and supporting letters should be sent to:

Executive Director • Society of Economic Geologists, Inc.
5808 South Rapp Street, Suite 209 • Littleton, Colorado 80120 • USA
Fax (303) 797-0417 • Email: <sgeo@segweb.org>

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DEADLINE: September 1, 1999
SIGNIFICANT ACCOMPLISHMENTS/PUBLICATIONS: (for accomplishments, give specific examples; for publications, list no more than 5 titles.)

Individual nominations for any of these awards MUST BE SUPPORTED by three signed letters from SEG Fellows or Members. The letters may be attached to this form or sent separately. Supporting letters should emphasize the significance of the nominee’s contributions. All information must be verifiable.

NAME OF PERSON MAKING NOMINATION: 

ADDRESS: 

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LETTERS OF SUPPORT WILL BE SUBMITTED BY:
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Society of Economic Geologists, Inc.
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Littleton, CO 80120, USA
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DEADLINE: September 1, 1999
Special Publication 7

Introducing *Society of Economic Geologists Special Publication Number 7, Geology and Ore Deposits of the Central Andes.*

This 368-page volume, edited by Brian J. Skinner, is dedicated to Professor Ulrich Petersen, a foremost scientific investigator of mineralization in the Peruvian Andes, in recognition of his lifetime and seminal contributions to economic geology. The papers comprising this volume, including several added for balance, derive from a two-day conference held at the Department of Earth and Planetary Sciences, Harvard University, May 10–11, 1996, on the occasion of the retirement of Professor Petersen. The central Andes of Peru, Bolivia, and northern Chile, in particular, are the site of a remarkable range of deposit types. Nowhere else in the world can the genetic connection between tectonics, magmatism, and widespread mineralization be made more clearly, or more definitively, than in the Andes. These relationships are discussed in-depth in this volume, which also provides invaluable historical information, descriptive material, and current research on the ore deposits of the Central Andes. Available May 1999; estimated price—US$38.00.

Reviews Volume 8

The Society of Economic Geologists, in cooperation with the Mineral Deposits Division of the Geological Association of Canada, presents *Reviews in Economic Geology Volume 8, Volcanic-Associated Massive Sulfide Deposits: Processes and Examples in Modern and Ancient Settings,* edited by C. Tucker Barrie and M. D. Hammingston. The papers in this simply illustrated, 416-page volume stem from a short course held May 17–18, 1997, at Carleton University, Ottawa, Canada. The volume provides descriptions of the processes involved in VMS formation, includes important examples representing a variety of VMS deposits and districts, and reflects a spectrum of current ideas based on research over the last 20 years. It will be a valuable reference for research investigators and should be particularly useful to minerals exploration and mining geologists. Available May 1999; estimated price—US$40.00.
Diamonds and Metals: Recent Contributions of Commercial Activities and Marine Research to the Development of High Value Terrestrial and Marine Deposits

The 29th Annual Conference of the Underwater Mining Institute

TREVOR BOYD • RICHARD HUTCHINSON (SEG 1960)

The conference was held October 22-23, 1998 at the Days Inn, Toronto, Ontario, attracting nearly 100 registrants from 14 countries, including a significant contingent from South Africa.

Charles Morgan, of the Marine Minerals Technology Center, University of Hawaii, and Steven Scott, of the University of Toronto, opened the conference. Thirty presentations spread over two days focused on the technical and economic aspects of the development of mineral deposits on the seabed, with comparisons made to analogous deposits on land.

Richard Garnett of Vallok Enterprises Inc., Oakville, Ontario, organized and chaired the first day technical session, mostly on diamonds, while Steven Scott and Richard Moore of Falconbridge Limited, Toronto, organized and co-chaired the second day technical session on base and precious metals.

The conference was the first time that the Underwater Mining Institute had focused on the mining of alluvial diamonds on the seabed. Talks and subsequent discussions made it clear that the presenters from this established industry, mostly engineers and businesspersons brought a needed “hardheaded” perspective of underwater mining to the rest of the participants. In contrast, presentations on the mineability of sea-floor sulfide deposits showed that, technically and economically, these types of ventures are still very much in their infancy. Studying these deposits, however, has provided lessons for geologists involved in the exploration and mining of base and precious metal orebodies on land.

DIAMONDS

Richard Garnett opened the diamond session. He provided an up-to-date summary of the offshore diamond mining industry, focusing on the activities off the coast of southwestern Africa, where there are presently 800 km of continuous mining. This introduction set the rigorous technical and economic tone of the day. The high level of technical focus was echoed in specific talks by Stefan Schwank of Bayer Spezialklebetechnik GmbH, Germany, on the use of underwater trench cutting for sampling, and by Anthony Wakefield, Consulting Engineer, England, on jet pumps used for the transportation of rock slurries. Tony van der Steen of Paragon International, Netherlands, outlined the factors that determine the design and choice of different seabed mining systems.

Luc Rombouts of Terraconsult BVB.A, Belgium, discussed sampling methods used for the estimation of alluvial diamond reserves. Areas of high-grade material tend to be underestimated while those of low-grade material tend to be overestimated; a problem not unknown to land-based mine geologists. An update of the status of the diamond market was provided at this time. It was noted that prices of good quality diamonds, especially between 0.1 and 1.0 carat, have dropped considerably since June, and that most offshore production is of gem quality within that size fraction.

The majority of talks given the first day were by operators of sea-floor exploration and mining ventures varying in scale from the use of a dought canoe to multimillion-dollar-scale mechanized programs. Michael Gibb of Marine Mining Inc., Toronto, provided an example of the former in outlining their grassroots exploration program for alluvial gold and diamonds off the coast of Ghana. Recovery of samples of crystalline gold coated on detrital particles was reported. This disputes the interpretation that crystalline gold in paleo-placer deposits indicates a late epithermal mineralizing process. Ian Corbett of DeBeers Marine, South Africa, presented the example of the latter. He provided a rare glimpse into the massive exploration and mining effort, off the Namibian coast, which is maintaining DeBeers as the technical and economic leader in the industry. Presently, the mining of diamonds is at a maximum depth of 140 m, with stripping off of up to 4 m of overburden. Exploration is occurring to a maximum depth of 400 m.

Dan Johnson of Diamond Fields International, Vancouver, British Columbia, outlined the company’s aggressive exploration program offshore of the Namibian coast. The program has progressed to the mine development stage, with an envisioned potential production of 500,000 carats a year. Ian Selby of Coastal Geosciences, United Kingdom, discussed the preliminary exploration program conducted by RTZ/CRA off the northern coast of Australia during the early 1990s. The program met with limited success and no follow-up exploration has been conducted since 1993.

Two talks on alluvial diamond production were of particular interest to the participants. John Gurney of Benguela Concessions, South Africa, outlined some of the geological factors controlling the grade and size of the deposits along the turbulent seaward border of southwestern Africa. It was stated that the best diamond deposits are in gravel situated on the continental slope. The differences between sampling and production grades of deposits were discussed, noting that the actual grade can be higher than the estimated grade because the diamonds tend to concentrate more toward the bottom of gravel pockets. The economic benefits of this discovery can only be achieved with a well thought-out mining program maximizing ore recovery rather than the rate of production. Some information on the economics of ocean diamond mining was shared. A high-grade deposit with a grade of 11 carat/m3 can provide...
a good profit, however, an economic cutoff grade of 0.1 carat/m³ is needed for a mining operation to be truly successful in the long term. Generally, a production of 5,000 carats/month is required by a mining vessel in order to maintain a profitable operation. Andre Louw of Ocean Diamond Mining Holdings, South Africa, also emphasized the importance of maximizing diamond recovery by “surgically removing payable ore from waste” on the sea floor. A detailed understanding of the geology of the gravel beds and sea-floor bedrock is an important tool for defining mineable reserves, he believes, and a knowledge of the geology of the alluvial orehedrites on the adjacent shorelines has been very helpful in achieving this. Side-scan sonar and remotely operated vehicles are tools for increasing mining efficiency to be more commonly used in the future. Although successful low-grade mining operations are needed for long-term success, the initial profitable recovery of high-grade pockets is crucial to small companies in order to quickly pay back capital costs and to maintain investor confidence.

Richard Garnett closed the session with an excellent summary of sea-floor mining that recapitulated the long and steep learning curve underwater alluvial mining has undergone to reach this point of success. The factors controlling exploration and production were reviewed, with comparisons made to alluvial gold mining operations off the coast of Alaska. No need to economically recover the lowest possible grade was emphasized, because as the cutoff grade increases, the ore reserves become more fragmented. In addition, the difference between resources and reserves was noted, with the point made that the presence of resources has no relation to economic feasibility. Many of the comments and conclusions by Richard Garnett, Andre Louw, and John Gurney, perhaps not surprisingly, are consistent with the experiences of land-based mining geologists and engineers, but they now represent a new perspective to the ocean scientists present in the room. The session concluded with a cautionary warning of the expected technical and economic challenges to these proposing sea-floor sulfide and manganese nodule mining ventures. However, what was perhaps left unsaid was that the success of the underwater diamond mining industry today shows that these hurdles can be overcome and that fact bodes well for the future economic recovery of other resources from the sea floor.

METALS

The technical session was mostly an update to the 1993 UMI meeting held in Eses Park, Colorado, entitled “Gold and Massive Sulphides in the Oceanic Lessons for Land and Sea Exploration.” The participants, as in 1993, consisted of a mixture of marine scientists and exploration and mining industry types. Steve Scott opened the session with an update on sea-floor sulfide deposits and their similarities to and differences from the volcanicogenic and sedex-type massive sulfide deposits being mined on land.

Marine geologists, many of whom had participated in the ’93 meeting, provided new information on their exploration projects on the ocean floor. Yves Fouquet of IFREMER, France, reported on the recent activities of the Ocean Drilling Program (ODP) on the Trans Atlantic Geothermal (TAG) deposit on the Mid-Atlantic Ridge and Middle Valley deposit in the northeastern Pacific Ocean. The results allowed for the first time a three-dimensional view of these deposits. What was clear was the first-order importance of zone refining and other subsurface hydrothermal processes resulting in the considerable leaching or enriching of base metals in relation to pyrite-rich bodies, and thus, the formation or obliteration of an orebody. At the sedimented Middle Valley, stacked zones of mineralization including a deep copper-rich body were intersected by drilling. The site may represent an actively forming modern analogue to sedges and possibly Besshi-type deposits. Raymond Binks of CSIRO, Australia, reported on the felsic volcanic-hosted gold and base metal-rich sea-floor sulfide deposits in the eastern Manus basin, Papua New Guinea. Sixty samples analyzed to date average 15 g/t Au. It was suggested that these sulfides may be underlain by subhalite or intrusive-related deposits. Deep drilling of the area by the ODP will be undertaken in the year 2000. The area has recently been covered by an exploration lease operated by Nautillus Mining Inc., Australia. Roger Moss of the University of Toronto reported on precious metal content in sea-floor hydrothermal deposits, noting the importance of silver- and gold-enriched zinc sulfides within both fore- and back-arc environments.

Mark Hannington of the Geological Survey of Canada, Ottawa, reported on the exploration for shallow gold-rich sea-floor deposits associated with spreading ridges around Iceland and along the Bonin Arc in the South Pacific. These areas range in depth from approximately 200 to 1,000 m, shallower than most sea-floor sulfide deposits (2,000-3,500 m) but deeper than the sea-floor diamond orebodies. It was suggested that the area around White Island, north of the North Island of New Zealand, is a center of considerable shallow-water, magmatic, hydrothermal activity containing significant gold occurrences. Peter Herzig of the Institut fur Mineralogie, Freiberg, Germany, discussed the recent discovery of shallow-marine gold mineralization on a seamount 30 km south of the giant Lihir orebody (40 million ounces). The geology and mineralization at this site are similar to that in the Lihir mine with recovered samples to date averaging 18 g/t Au, but the top of the seamount is at 1,100 m depth. The orebody is located within a volcanic caldera at the waterline of Lihir Island, so the challenges encountered in the mine’s development serve as an important guide to those ready to venture further out into the marine environment. Alexander Malakhoff of the University of Hawaii, Honolulu, described a spectacular caldera collapse in the Loihi submarine volcano and the formation of voluminous hydrothermal bacterial matts and copper and zinc mineralization. He noted that the bacteria may have industrial applications and may thus be considered a potential economic resource. It was interesting that the volcanic activity resulted in the release of a considerable discharge of metals contaminants into the marine environment which did not seem to be a concern to either the scientists or the local sea-floor inhabitants.

Some geologists with both ocean- and land-based experience presented talks with a land-based focus. Jan Peter of the Geological Survey of Canada, Ottawa, discussed the possibility that iron-silica exhalites and their anomalous Pb, Zn, Cu, As, Hg, Sn, and Bi signatures in the Pb-Zn-Cu Bathurst Mining Camp are the result of a paleo-plume fallout. This is possible if the plume is heavier than the surrounding seawater, which would minimize dilution of the metal signatures. It was noted that the spuriousness of these anomalies as vectors to ore may be a function of variable hydrothermal activity and changeable ocean currents resulting in a “smearing” of the metal anomalies over a large area. However, the multiple-origin of silica in the exhalites, both as a hydrothermal constituent and detrital and biogenic diluant, may also have a role in blurring the impact of the anomalies. Kailui Yang and Steven Scott of the University of Toronto presented a poster on the discovery of high concentrations...
of metals in CO2-rich fluids trapped in felsic volcanic rocks hosting sulfide deposits in the eastern Manus basin and in footwall rocks to the 120+ million tonne Brunswick #12 massive sulfide orebody. Jim Franklin of Franklin Geosciences, Ottawa, reviewed the knowledge obtained from sea-floor deposits with respect to the better understanding of their land-based analogs. It was pointed out that the study of sea-floor sulfides has demonstrated the importance to the formation of massive sulfide orebodies of subvolcanic intrusions, a high permeability of subsurface rocks, and a magnetic source of the mineralizing fluids.

A number of representatives from the mining industry gave presentations. David Burrows of Inco Technical Services Ltd., Toronto, and Gerald Riverin of Inmet Mining Corporation, Rouyn-Noranda, Quebec, each gave the industry perspective on the contribution of sea-floor deposit research to land-based mining and exploration. Both representatives and to a lesser extent, Jim Franklin, expressed some disappointment that we have learned little from the sea floor with respect to generating new tools for the exploration and development of new orebodies. Indeed, in many ways the benefit has been mostly in the other direction; for example, the study of land-based deposits, especially in the third dimension, has provided considerable aid in understanding the sea-floor analogs. Gerald Riverin emphasized the importance of being able to plot features on a map for data to be useful in exploration. David Burrows suggested that perhaps the greatest contribution of sea-floor research may be the eventual direct exploitation of the resources, especially as larger and higher-grade deposits are located. Stephen Juras of MRDI Canada, Vancouver, discussed the successful use of stratigraphic models in the exploration for ore while he was senior geologist for the Boliden-Westmin Myra Falls massive sulfide mine. The description of the preservation of the stacked deposits at Myra Falls, including the deep copper-rich HW orebody, not dissimilar to that described at Middle Valley by Yves Fouquet, is an important lesson for both land- and sea-based explorers. At the end of the day, Richard Hutchinson of Golden, Colorado, summarized the two days of presentations; many of the comments are included in this report.

OTHER TOPICS

In addition to the talks given on diamonds and metals, Charity Lee of the Deepsea Resources Research Center, Korea, gave an overview of their deep sea mining exploration programs, including Korea's continuing examination of the Chirion-Clipper zone in the central Pacific Ocean as a prospective mining area for manganese nodules. S. Rajendran of the Cochin University of Science and Technology, India, provided information on placer deposits of India. Steven Scott in his capacity as the President of the Canadian Scientific Submersible Facility, Sydney, B.C., made a presentation on the ROPOS remotely operated vehicle as a tool for sea-floor exploration.

CONCLUSIONS

The conference organization was excellent, thanks to workers in both Hawaii and Toronto, especially Karynne Chong Morgan, Administrative Officer of the Marine Minerals Technology Center, and Helen Lasthiotakis of the Canadian ODP Secretariat at the University of Toronto. The chosen topics were a great success because they brought not only representatives of academia and industry together, but also workers at different timelines in the pursuits of their underwater endeavors. Those studying sea-floor sulfide deposits are working in a fundamentally different environment in comparison to those working on the diamondiferous seamounts, considerably deeper and more thermally active; nevertheless, the experiences in the latter will be invaluable in the future exploration of precious and base metals on the sea floor.

It appears that every type of modern massive sulfide deposit has now been discovered either formed or being formed on the sea floor, including both sedex and volcanogenic types. One possible exception is the more distal Irish-type Pb-Zn-Ag carbonate-hosted sulfide deposits. Their discovery will probably require drilling because, based on the results of land-based research to date, these deposits form by diagenetic replacement beneath the seabed surface. Future efforts in sea-floor research should encourage the participation of the mining industry and investors by focusing on the direct exploitation of resources rather than on gathering information applicable to the land-based exploration. This can be done in the following areas:

- Study and delineation of precious metal deposits hosted in shallow water (<100 m depth) with the purpose of testing their viability for commercial exploitation. Gold-bearing, hydrothermally active areas discussed during the conference include offshore to White Island, New Zealand and Lihir Island, Papua New Guinea. Also of interest are the extensions into the water of known ancient lode gold camps such as along strike southwest of the Ashanti gold belt offshore Ghana, West Africa.
- Exploration by drilling of favorable shallow, sediment-hosted, "mintry" basins in order to search for giant polymetallic deposits. The Red Sea has been shown to host such an environment and to contain voluminous sulfides. Other candidates for additional exploration are the Black and Caspian Seas, or possibly the shallow northern end of the Gulf of California, Mexico, in the area of the Salton Sea. The well-documented Pb-Zn-Cu-Ag sulfide deposits of Guaymas basin at the central part of the Gulf are associated with carbonate-hosted deposits.

The conference was a great success because the participants clearly benefited from the interaction with those in different fields of enterprise, individuals whom they would normally never meet. If in the next 20 years the sulfide ventures can progress with success similar to that of the diamonds, the title of the 49th Annual Conference of the Underwater Mining Institute will be "Marine Mining of Hydrothermal Polymetallic Ores: Now an Established Industry."
EXPLORATION REVIEWS

MEXICO

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At the start of last year, I reported on the land rush created by Teck and Western Copper’s big VMS discovery at San Nicolas in the state of Zacatecas. I boldly forecast that major exploration programs would be carried out by a multitude of major and junior companies, which would produce at least one big new discovery. Apparently, I was carried away by the excitement of the moment. Two things have derailed the prediction: a depressing lack of exploration funding and the existence of a tremendous number of false geophysical anomalies. There is not much anyone can do about the funding problem. Low metal prices are killing the exploration budgets of the majors, and the juniors practically have to give away the company to raise money.

There has not been a tenth of the drilling in Zacatecas that was anticipated, but there has been enough to demonstrate that success will not come easily in this belt. Teck, Western Copper, Aurado, Noranda, Peñoles, and several other companies have drilled good anomalies in 1998. Yet, as far as I know, there are no discovery holes, and I think, with the thirst for good news, it would be impossible to keep a truly exciting hole secret. Everyone is confronting the problem of targeting in this covered terrain with what they think worked best at San Nicolas. This could be L.P., Real Section L.P., gradient L.P., ground EM, airborne EM, analag, gravity, or some selective leach on soils. Based on personal experience, I guarantee that if you apply any of these targeting tools on enough ground (and remember, in the heat of the land rush you picked up 300,000 hectares of prime ground) you will get stunning anomalies. I know we did. Now as we move the drill rig through the anomalies we, and I suspect others, are doing a good job of mapping out the distribution of clay beds in the state of Zacatecas. I still believe the discoveries are there to be made, but either a lot more drilling or a breakthrough in targeting is needed.

The big news during the last year was supposed to be in VMS exploration, but in the end, the year was saved by base metal exploration in skarns and mantos. Apex Silver and Excellon have had the most recent success with an impressive manto intercept at La Platosa, located north of Torreon. It’s always nice to get a sulfide intercept where there is no gange and where you need a lab to find the pyrite. Apex plans to track this 7.5-m-thick manto by using L.P. to follow the galena and then go to the next drill phase. However, with another intercept like the first, it will be tempting to go underground and drift on the body to see where it goes. If you could keep the shaft in this well-mineralized manto, its $350/ton value would more than pay for the work.

Possibly the biggest news of 1998, but something I have not yet confirmed, is that Grupo Mexico has drilled into a major skarn below the vein system at Santa Barbara, Chihuahua. Once again we may be confronted with a case where what we thought was an ore deposit was really just a geochemical halo above the real deposit.

Grupo Mexico is also active in the Chihuahua district of Zacatecas, where they have been quietly working for over a decade acquiring ground cheaply and exploring the Cronos prospect. Last year the quiet was severely disrupted by the intrusion of Panamerican Silver, Penoles, and Noranda into the district. While a new mine was not found, there was progress in the right direction. The skarn discovery by Panamerican under the La Colorado bonanza silver veins produced intercepts of mineable grade, and there is clear potential for a big deposit. At Cronos, Noranda and Grupo Mexico pummeled a blind skarn with 10 drills. A marble front skarn at 200 to 300 m hosts ore-grade Zn-Ag mineralization over widths of 15 to 50 m. Noranda has now abandoned its small holding at Cronos while Grupo Mexico carries on toward feasibility.

Last semester I reported that the annual labor requirements had been tripled in mid-year, causing a major uproar in the industry. Individuals, companies, and every industry group, it seems, responded strongly to the change. Impressively, SECOFI listened to reason and rolled back the investment requirements. The environmental permitting bureaucracy has also responded favorably to widespread complaints about permitting delays. For initial exploration drill campaigns, where disturbance is less than 10% per hectare, work can proceed after five days of filing for a permit if there is no response from SEMARNAP. This is not a carte blanche for exploration programs to run roughshod over the countryside; in fact, to the contrary, we will likely be watched more closely.

For the first time in eight years, we now have had post-reclamation field reviews of projects by PROFEPA, the agency charged with permitting compliance. We view this as a positive development, as it will allow for closure on projects that we have abandoned.

Now that the industry has successfully addressed annual labor and permitting issues, the lobbying focus will shift solidly to surface access issues. On paper, with few exceptions, the right to access and develop mineral concessions is legally the highest priority land use in Mexico. In practice, the principle does not apply and surface rights holders can keep you at bay for years. There has always been concern that once you found something it might be difficult to get the surface rights permanently tied up, but at least once you had found something, you had the funding and the staying power to address the access issue. Peñoles has now successfully done this at Francisco Madero, and while Cambior is having a hard time at Cerro San Pedro, they too will probably get what they need. Just as bad, or worse in my opinion, is that we are now seeing cases where the access issue comes up at the drilling stage or earlier. At this stage, a surface owner who wants to put you off is almost sure to win. Most companies will not face steep payments or years of legal wrangling just to test that great EM anomaly. Heck, it’s probably just a clay bed, anyway. If the government really believes mining is the highest value use of the land, and that’s what the law says, something like binding arbitration is needed to expeditiously resolve surface access.
PERÚ

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Exploration in southern Peru continues to focus on copper, with porphyry and skarn targets receiving much attention despite the depressing low current price of the red metal. Even some gold mines, reeling from low gold prices, are considering re-treatment of their tailings as a means of boosting an output.

The Southern Peru Copper Corporation (SPCC), bolstered largely by U.S.-based ASARCO as the major corporate partner, operates two open pit mines at Cuajone and Toquepala, near the city of Moquegua. The Toquepala mine produces more than 130,000 tonnes per year of copper and 0.8% Cu and 0.06% Mo. Mining is at the rate of 180,000 tons per day of material, including 55,000 tons per day of mill ore, with a copper grade of 0.4% Cu lower-grade supergene material having a grade of about 0.2% Cu and a 0.1% Cu cutoff grade is sent to dump leach. Mining currently consists of approximately 20% supergene chalcocite ore and 80% hypogene ore characterized by chalcopyrite + pyrite. Ore reserves at Toquepala are enormous, where more than 1 billion tons of mineralized material comprise the geologic resource. At a 0.4% Cu cutoff, more than 300 million tons are mineable, and more than 600 million tons of ore with a grade of just over 1% Cu have been mined to date.

Porphyry at Toquepala comprises several porphyry rock units and economically important hydrothermal breccias containing pyrite + chalcopyrite, with py/cu ratios varying from 2.1 to as great as 15:1. Molybdenite occurs in paragenetically early “B vein” quartz structures (“blue veins”); molybdenite is produced as concentrate and makes up a substantial by-product.

The complex geologic and chronologic settings of Toquepala, a late Paleocene porphyry system and breccia complex located within a structural block adjacent to the regional northwest-trending Inca puquio fault, are being unraveled by Jefe de Geología Rubén Mattos P. and geólogo Julio Rojas G.

Northwest of Toquepala, evaluation of the late Paleocene-age Quellaveco porphyry copper system by Minorco Perú S.A. continues. The project's mineable reserves have been reduced at 974 Mt grading 0.65% Cu and 0.021% Mo, including 213 Mt of secondarily enriched material with an average grade of 0.94% Cu. These reserves are contained in a series of monzonic porphyries and a late hydrothermal breccia. Copper cutoff grade is 0.5% Cu—the average ore grade at many southwest U.S. porphyry copper mines. Because poroliths at Quellaveco contains sulfide mineralization with relatively low py/cu ratios, a copper oxide resource occurs within the “leached” capping and subjacent weathered rock units. Fracture-filling and disseminated chalcopyrite, brochantite, and phosphates (including turquoise) are the most volumetrically significant copper oxide minerals, with copper also contained in Fe and Mn oxides. The leached capping at Quellaveco appears to have developed in such a fashion that the base of oxidation follows topography, and overlies a supergene-derived enrichment volume having chalcocite in the upper, more enriched portions of the enrichment horizon, and covellite + chalcocite in the lower, weakly developed portions.

Hypogene sulfides are dominated by veinlet-controlled chalcopyrite + pyrite, with disseminated sulfides occurring as replacements of native minerals. Deep (>500 m) drill holes indicate that ore mineralization is open at depth.

Jefe de Geología John Romero V. and geólogo Joseph Salas T. have defined at least three distinct alteration-mineralization periods at Quellaveco, along with a late, locally well-mineralized hydrothermal breccia complex. Because of the strong structural control of mineralization, mapping has demonstrated that higher copper grades are correlated with increased sulfide veinlet densities. Romero and Salas also report that an alteration halo comprising the propylitic-style assemblage epidote + chlorite + calcite ± pyrite occurs in an area 2.5 x 1.5 km, around the Quellaveco system; they continue to refine their chronology of intrusion-alteration-mineralization with additional field mapping and in-progress geochronologic studies.

With billion-tonne systems having high-grade porphyries such as Toquepala, Cuajone, Quellaveco, and Cerro Verde occurring in southern Peru (to 17.8° S), one wonders whether there are elephants to be discovered in adjacent northernmost Chile, where exploration, to date, has uncovered large— but not “giant”—porphyry systems as far north as 20° S. The late Paleocene-age Cerro Colorado porphyry system comprises approximately 220 Mt of supergene oxide + sulfide ores with an average grade of 1.01% Cu at a 0.5% Cu cutoff, and total probable ore reserves perhaps halve as much. Exploration continues at the Mocha porphyry prospect immediately north and adjacent to Cerro Colorado, but these are the northernmost large porphyry systems known in Chile. Given the short-term predictions for depressed copper prices, it is good to observe that copper exploration remains a priority in southern Peru.

OCEANIA

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Oceania has borne the brunt of the worldwide downturn in the pricing and perception of mineral commodities. Profitability of base metal and energy producers has fallen and led to very negative sentiment toward the search for new resources, both by company directors and by investors. Exploration, because of its position as the “long-term” research arm for resource renewal in the minerals industry, is perceived to be of diminished importance and budgets have been slashed. Numerous geologists have joined the ranks of the unemployed. This situation of reduced funding is draining the institutional/university exploration research that depends on industry funding to gain government matching grants. Overall, the outlook for the immediate future is difficult for many colleagues. Those with secure jobs, particularly those tenured university geologists, are the fortunate ones.

However, my experience tells me that such harbingers of gloom must be taken instead as the heralds of prosperity. Talk of a fundamental change to the pricing of commodities such that
everything is of less value and that profits will be lower is quite wrong. The resources industry will rebound yet to extremes of commodity highs—all part of the episodic lifestyle that we in the exploration business must live through. We must remember: it is the discovery of low-production-cost deposits, which can weather economic downturns, that is the name of the game.

The following brief notes are but a sample of the happenings in Oceania, and as you can see, things are still quite active.

**AUSTRALIA**

Australian expenditure on mineral exploration (including oil and gas) during 1997–1998 was up by 2.3% to A$2.035B, the highest in real terms since 1984–1985; the expenditure was influenced by a 25% increase in offshore expenditure on petroleum.

A major source of gas hydrates in an area half the size of Tasmania has been discovered deep in the Tasman Sea, 1,400 km east of Australia and 400 km southwest of New Caledonia. In a joint survey with IFREMER, a French marine institution, the Australian Geological Survey Organisation (AGSO) has found the gas (methane) frozen with water at a depth of several kilometers. Unfortunately, recovering gas from the hydrates is currently non-commercial, but again, the vast inherent energy resources of the Earth have been demonstrated. Also on the hydrocarbon side of things, Woodsdale Petroleum (50%) has been finding more oil in the Timor Sea with Laminaria 5 likely to lead to upgrades on oil reserves.

Australian exploration has suffered from ever-decreasing base and precious metal prices, saved only by the weak Australian currency. In general, the exploration industry in Australia has experienced continuing layoffs. BHP announced further exploration staff cuts worldwide. Offices in Hong Kong, Salt Lake City, Utah, and Wisconsin were closed. Others have been reduced, including Denver, Tucson, and Perth. WMC’s exploration division reduced their workforce, and the budget was down by 20% to A$50M. Offices were closed in Kazakhstan, West Africa, and the Philippines.

Great Central Mines had a major staff reduction following the takeover of Willuna Mines and Eagle Mines. Great Central is one of the Gutnick stable of companies, which has considerably reduced exploration expenditure across the board.

On a brighter side, the Australian government agency AGSO has moved into a purpose-built A$110M headquarters in Canberra.

Australian gold production for the financial year to June 30, 1998, was a remarkable record of 10.2 Moz (318 t); and the calendar 1998 year will be near to, or at, record production.

Explorers have been concerned, for many years, about the removal of land from exploration by the process of government classification into a land-holding type, within which exploration is banned or restricted. In 1972, nature conservation reserves covered 140,000 km² (2%). By 1993, this had increased to 530,000 km². In 1972, Aboriginal and Torres Strait Islander (ATSI) lands totalled 78,000 km²; but by 1993 this had grown to 1,000,000 km² (13%). The rapid growth of ATSI lands coincided with high levels of exploration activity in the early 1980s. In many of these areas, the mineral potential was unassessed before gazettal, but in the case of the ATSI lands, some areas are known to be highly prospective. A system called TRACS is now being used by the Federal Government to provide information on such lands. Data sets include tenure and biophysical and socioeconomic aspects for explorers and others to provide trends in land acquisition. Another database exists for

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**NORTHERN TERRITORY**

The best exploration news for some time came in 1998 when Kilkeneny Gold announced encouraging details of resources at Maud Creek, with 11.82 Mt at 2.4 g/t Au for 950,000 oz. A high-grade zone within this contains 1.7 Mt at 7.9 g/t Au, split between open cut and underground. Intersections include 1.4 t at 63.2 g/t Au. Production of some 80,000 oz/y is being considered at a cost of A$250-300/oz. Onyer Gold has developed resources of 0.57 Mt at 5.9 g/t Au in the Pendragon area west of the
Tanami gold mine. Sons of Gwalia has closed its Alice Springs exploration office and has dropped a large exploration holding in the Tanami area. The resource at the Callie deposit (of Normandy-North Flinders Mines) is now some 13 Mt at 0.7 g/t Au with intersections at depths of 1 km: this is clearly one of Australia’s major discoveries in recent years.

Ashton Mining Limited’s (100%) Merlin project is advancing to development as Australia’s second hard-rock diamond mine, with plant commissioning commenced in January 1999. Stage 1 will process ore from seven pipes to produce 700,000 t/yr at an expected grade of 0.43 ct/t. The Merlin diamond deposit has 12 diamonddiferous kimberlite pipes with grades of up to 125 ct/100t and valuations from US$41 to $140/ct.

The Federal Court of Australia in early 1997 upheld the validity of ERA’s Jabiluka mining lease, which, in effect gave a green light for development. Aboriginal approval was given some years ago, and in 1996, the bipartisan select committee of the Australian Senate confirmed there would be no detrimental impact on the environment. Other protocols are now in place and the mining is advanced. Surface work has been completed and the decline is in progress. Recently a bicentenary occurred with the UN’s World Heritage Bureau three-day mission designating Kakadu as a World Heritage Site of potentially “threatened” status; this status is disputed and the Australian government is supporting development of the new mine.

**NEW SOUTH WALES**

The Cadia $440M gold deposit came into production on exceptionally low gold grades, production is expected to be about 300,000 oz/yr. Future plans center on the nearby, higher-grade but deep Ridgeway deposit where a $24M feasibility study is underway, including an $11M decline. Silver Standard Resources continues to obtain encouraging intersections at its Bowdens Silver prospect, with 59 m at 167 g/t Ag. The Tritton copper discovery of Nord Resources and Straits Resources, 24 km southeast of Girilambone, has a primary chalcopyrite resource of 10 Mt at 3.5% Cu, with minor Au and Ag credits: a feasibility study is in progress.

Black Range Minerals now has a resource of 59 m at 1.38% Ni (equivalent) at their Syerston nickel-cobalt deposit, at Fifield, with potential for pads of higher grade, and is considering production by 2001.

The market became briefly excited by the announcement, in mid-1998, of the discovery of a scandium deposit in central NSW by Uranium Australia. Some 10 drill holes have grades of 110 to 770 ppm Sc, reportedly indicating a resource of perhaps 100 Moz. Scandium occurs usually in trace quantities of one or metals and is a by-product recovered in China and Russia; it is noted that the economic significance is yet to be ascertained.

**QUEENSLAND**

Macmin NL plans to conduct metallurgical studies on its southern Queensland Texas silver-gold deposit that has resources of 8.2 Mt at 130 g/t Ag, 0.4 g/t Au.

At Gunpowder in the Cloncurry district of western Queensland, the Mammoth mine, containing some spectacular intersections, including 46 m at 7.1% Cu, is in production by Western Metals. At the Esperanza South deposit, an intersection of 15 m at 9.2% Cu was
made; reserves at the Esperanza mine increased to 4.6 Mt at 7.5% Cu and 0.08% Co.

The AS270M George Fisher (previously Hilton North) mine, located 22 km north of the Hilton mine, was declared a goer by MM, production will commence in 2000.

The Ely uranium deposit of Alcan will be developed jointly by Comalco and Alcan South Pacific and will share Comalco's infrastructure at Weipa.

The market was surprised by the commitment of Barclays Bank and Presion Resources to develop a $700M nickel-cobalt mine on the Marlowborough Laterite deposits. They believe that low-cost production can be achieved. Inferred resources are 210 Mt at 1.02% Ni, 0.06% Co; proposed production is 1.8 Mt of ore of 28,000 t Ni cathode and 2,360 t of Co cathode, using an acid leach process.

Resources at the Valhalla uranium deposit near Mount Isa, held partly by Summit Resources, were upgraded to 14 Mt at 1.17 kg/t U3O8. Construction of WMC's phosphate project at Phosphate Hill in western Queensland's Mount Isa district has commenced. A magnesium demonstration plant of Australian Magnesium Corporation is a forerunner of a facility to be constructed at Gladstone, Queensland.

- **TASMANIA**

Magnesium is also the talk of Tasmania. crest Magnesium NL is planning to build a $31M 94,000 t/yr magnesium alloy and metal plant at Bell Bay to process ore from the Arthur and Lyons River magnesium deposits. Resources are 29 Mt at 42.8% MgO. Similarly, Golden Triangle Resources is considering options for processing ore from another magnesium deposit in Western Tasmania at Main Creek and Bowry Creek, where resources are 47 Mt at 43.4% MgO. Fueling the initiatives is the possibility of gas from Tasmania's offshore yolla gas field in Bass Strait. If the processing costs to produce magnesium metal can be reduced, there is an attractive market in the manufacture of lighter cars engines.

- **SOUTH AUSTRALIA / BROKEN HILL**

The Carnamumra cation has been attracting interest of explorers in the likes of the Ernest Henry-type Cu-Au ore deposits. At Mund Mundi, BHP, in joint venture with Savage Resources and Platematch, has obtained Au-Au intersections. The White Dam project of MM-Normandy-Wesmin Metal project in western Broken Hill, west of the White Dam project, has shown some good intersections, such as 44 m at 1.2 g/t Au, 0.8% Cu from a m depth. The shallow deposit apparently has a poor geophysical and geophysical signature and a relatively high Au/Cu ratio.

The Honeymoon uranium project in South Australia is likely to be the first in situ leach uranium mine in Australia, with Southern Cross Resources of Toronto obtaining approval to commence a demonstration phase. Scale-up to 1 Mlbs U3O8 is planned for 1999 at a cash cost of US$65/lb. Sedimentary Holdings holds 35% of Southern Cross.

A substantial new gas field has been discovered in the Cooper Basin by Santos, Delhi, Boral joint venture at Cabernet 1, indicating about 30BCF of reserves.

- **VICTORIA**

The Victorian government's initiatives in flying aeromagnetic surveys across large parts of the state have paid dividends with new mineral sands discoveries. The Murray Basin has been the focus of interest in 1998-1999, with heavy mineral sands discoveries by RGC/Westralian Sands at Kulwin, Woodhead, and Rowntree.

Resource estimates are around 1 Mt rutile (3% grade in situ and of premium quality), 0.6 Mt Zr (2% ceramic grade), 1.8 Mt ilmenite (6% altered and requiring Cr separation). The coarse-grained classic strandline placers, differing from the very-fine-grained deposits explored by CRA/RIO some years ago. Overburden is 10 to 15 m, with saline water table affecting the deposit. A conference is to be held in Mildura in April 1999 (goedings@uts.uts.edu.au).

Bendigo Mining NL has been able to beat the bearish financial trend and raise $35M to investigate “new” ideas. They believe that persistent shear controls on ribbons of reef formation are the predominant style rather than narrow saddle reefs, that in truth represent only a small proportion of the original ore mined last century. A decline is being sunk to enable ideas on repeat mineralization to be tested. Initial targets are 1,000 m below surface at the predicted extension of the Debrah anticline and Sheephead anticline, with expectations of 1 Moz Au.

In the Mt Wellington belt of western Victoria, New Holland Mining reported some interesting results from their Hill 800 prospect with an intersection of 25m at 6 g/t Au within a wide zone of 0.2 g/t Au.

- **WESTERN AUSTRALIA**

Gold: Probably the best result in 1998 was announced in July by Great Central Mines, with a new discovery in the Nimpy Deep deposit below the Nimpy open pit area. Resources are 2.7 Mt at 12.6 g/t Au containing 1.1 Moz. This discovery is further stimulating the assessment of a possible 3 km long x 1 km deep “super pit” that would combine resources at Junee and Nimpy. Although this Nimpy Deep discovery is outstanding, the prevailing bear market was hardly moved and GCM continued to trade at prices that were marked down. Such was the life of gold companies in 1998. Pacific Mining announced excellent results from the Tarmoola mine, where new intersections of 60 m at 8 g/t Au and 34 m at 14 g/t Au have enhanced resource potential. The East Kundana project of Gilt Edged Mining NL returned encouraging RC drill results including 10 m at 15.9 g/t Au.

Taipa Resources NL announced discovery of the Pauhens Prospect in the Ashburton region; about 1 Moz have been indicated. The White Foil gold deposit returned further encouraging results for Mineral Commodities and Mines and Resources Australia including 12 m at 3.5 g/t Au from 12 m. A discovery has been made by Delta Gold in the Wallaby prospect, near the Granny Smith mine. The nearby Just-in-Chance deposit of Homestake and Abednego is also returning encouraging results.

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Good results are being found in the Chatterbox shear zone in the Laverton district of the Eastern Goldfields, where Metex has announced resources of 5.6 Mt at 3.6 g/t Au. WMC has continued success at the Agnew gold operation, drilling down the Redeemer West oxide zone where one hole intersected 12 m at 7.4 g/t Au. Anacorda is planning to spin-off the Just in Case gold deposit, with a resource of 2 Mt at 6.3 g/t Au. The Khatoun gold deposit of Western Metals/Pacific Mining resource has been increased to 1 Moz at 2.9 g/t Au.

The Harlequin prospect of Central Norseman Gold retained good intersections including 3.5 m at 21.3 g/t Au. There is considerable speculation on the potential ore resource at the Wandoor Project with the current resource of 8.9 Moz expected to rise following drilling.

- **Nickel:** Nickel producers have suffered from exceptionally low nickel prices. Comet Resources has announced a resource at their Ravensthorpe nickel deposit of 90 Mt at 1.2% Ni and have ideas of producing 0.5 Mt/yr ore. WMC has made a new nickel discovery on the eastern side of the Widocheka dome; massive sulfide has been intersected with 2.7 m (15.5 m true) 11% Ni at a depth of 440 m. This is located about 1 km north of the MialJe ore zone. At Mt Keith, drilling to the immediate northwest of the main ore zone discovered new disseminated mineralization with zones of massive sulfide (e.g., 0.4 m with 3.8% Ni). Jubilance Gold Mines completed a 150,000-t/yr ore feasibility study on their Cosnos nickel deposit, 40 km north of Leinster. Operating costs are estimated at a low US$0.71/lb Ni after Co credits, because of the high grade of 7.5% Ni.

Capricorn Resources completed a feasibility study of its Emily Ann nickel project; other partners are Forrestania Gold and Billiton with 37.5% interest. Abednego has defined a probable reserve of 41 Mt at 1.18% Ni, 0.08% Co on tenements close to Anacorda’s Murrin Murrin deposit; Anacorda is making a bid for Abednego.

The laterite nickel deposits at Murrin Murrin, Bulong, and Cawse are at various stages of production with Centaur Mining producing the first cathode nickel and cobalt sulfides in January 1999.

- **Other commodities:** The Argyle Diamond Mines joint venture is to develop the AK1 open pit by a major cutback program to gain access to 64 Mt at an average grade of 2.6 ct/ton diamonds. BHAP has pulled the pin on the loss-making, new heavy mineral sands mine at Beenup, 280 km south of Perth. The Ining-in-the-wings Windimurra vanadium project of Precious Metals Australia/Glencore has been committed to development.

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**INDONESIA**

Ashton Diamonds has commenced the assembly of a 2.5 M m³/yr dredge to mine the Cempaka alluvial diamond deposit in Kalimantan.

**MYANMAR**

The Monywa porphyry copper project has advanced to operating status and will be producing 25,000 t/yr Cu as cathode. Expansion plans will involve the development of the adjacent Letpadaung open pit and the production of an additional 63,500 t/yr Cu in a two-phase program with cash costs of US$0.43/lb; Indochina Goldfields holds 50%.

**PHILIPPINES**

The big news is that WMC is trying to attract a partner, or sell, the Tampakan high sulfidation epithermal-overprinted porphyry-style copper deposit. Resources are 900 Mt at 0.36% Cu and 0.75 g/t Au, estimated from 51,000 m drilling with a cutoff grade of 0.5% Cu. Irregular arsenic zones occur in the higher-grade upper parts. Development costs are estimated at some US$1B+.

**PAPUA NEW GUINEA**

Reports suggest that 1998 exploration expenditure has dropped substantially from the 1997 figure of $56M. There are prospects by the government to introduce a 4% gross revenue tax. Resources at Hidden Valley are 54 Mt at 2.3 g/t Au and at Kaverol Creek 13.7 Mt at 2.4 g/t Au. Mt Kare resources are 20.1 Mt at 2.4 g/t Au and 28 g/t Ag. At Frieda River, Highlands Pacific and Cyprus/Amax have resources of 4.8 Moz and 9.1 Mt Cu; a pre-feasibility study has documented proposed production of 193,000 t Cu cathode and 312,000 oz Au over a 23-yr life.

The resources at the Ramu deposit have been upgraded by Highlands Pacific Ltd, to 155 Mt at 1.065% Ni and 0.099% Co; project feasibility is underway. Diamond core drilling re-commenced at Kabang (Northeast), with the re-entry and deepening of Macmin/New Guinea Gold Corporation’s first hole at the prospect. The drill hole extension is designed to partially test across the strike of a gold-prospective, mercury/arsenic geochemical anomaly, and an induced polarization anomaly that are coincident locally within a 5-km-long structural zone. Gold assay values encountered in hole 1 included 52 m at 1.65 g/t Au, between 68 and 120 m. Aurora Gold has increased the reserve base of its Toka Tindung gold project, by 122,000 oz, to 883,000 oz of gold equivalent. Aurora is awaiting final project approval from Indonesian authorities.

**SOLOMON ISLANDS**

The Gold Ridge gold mine of Ross Mining exceeded feasibility expectations and passed its first wet weather test, coping with more than 1,100 mm of rain.

**SRI LANKA**

Consolidated Rutile and RGC have explored the Puttalam district on the west coast of Sri Lanka, 140 km north of Colombo. Grid drilling on the PQ prospect has established a large, heavy mineral sands deposit 6 km long x 1.5 km wide x 15 m thick, with 9% heavies, mainly of ilmenite (40%) and altered ilmenite (10%), with minor rutile and zircon.
ALASKA

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Alaska continued to see abnormally high levels of claim staking and property negotiations in the last three months in anticipation of another busy year for mineral exploration. Eastern Interior Alaska remains the hot spot; however, all eyes are not focused on this area. Interest is growing in less competitive areas where mineral potential is equally promising. New mineral resources have increased by nearly 5 Moz of gold and nine new mining companies have entered the fray in Alaska since January 1.

WESTERN ALASKA

The biggest news this month was a revised resource estimate for Placer Dome’s Donlin Creek project. The 1998 program at Donlin Creek resulted in an increase to the estimated measured and indicated resource of 46% to 5.4 Moz of gold contained in 57 million tonnes (Mt) grading 3.0 g/t Au. The total estimated resource including the inferred category increased to 11.5 Moz.

At Cominco’s Red Dog mine, year-end 1998 production increased to 799,000 t of zinc concentrate and 123,000 t of lead concentrate.

In a surprise move, NovaGold Resources has arranged to purchase one of Alaska’s oldest companies, Alaska Gold. Mueller Industries, Alaska Gold’s parent, agreed to sell the company to Nova Scotia-based NovaGold for US$1 million in cash plus US$1.5 million in NovaGold common stock at closing, a further US$1.5 million by December 15, 1999, and a royalty on future placer production capped at US$1 million. Among the assets of significant interest to NovaGold are 14,000 acres of patented lands in the Nome mining district, including the Rock Creek gold deposit (10.2 million tons grading 0.07 t oz per ton gold) and approximately 1,000 acres of additional lands in the Fairbanks mining district. NovaGold hopes to receive something more substantial from Alaska Gold’s contract with joint venture partners Newton Mining and Kinross Gold, who have leased Alaska Gold lands on Dome and Eldorado Creeks. The lands are adjacent to the 1.3 Moz True North deposit and can be acquired from Alaska Gold for cash, stock, and royalty considerations totaling US$8 million. NovaGold indicated it intended to diversify itself of the non-mining interests of Alaska Gold to strengthen its cash position.

Dakota Mining Corp.’s Illinois Creek heap leach gold mine came within hours of the auction block before being pulled off the docket in early February. The exact status of the mine is currently unknown.

Real Del Monte Corporation announced third quarter results for operations at its Nixon Fork underground gold-copper mine near McGrath. The operation milled 7,311 t of ore and recovered 7,759 oz of gold, giving a recovered grade of 1.06 oz/t.

Altar Resources announced the results of this summer’s exploration efforts on its holdings in the Cape Nome, Council, and Fairhaven mining districts on the Seward Peninsula. Results from soil sampling, trenching, and shallow core drilling at the Bulk Gold prospect in the Cape Nome district returned encouraging gold and arsenic values over a strike length of 900 ft. Soil sampling on the Wild Bunch prospect in the Fairhaven mining district near Candle discovered a northeast-trending gold anomaly covering an area measuring 3,800 ft x 160 ft. In the Council mining district, Altar’s efforts included a mobile metal ion (MMI) soil sample survey that defined a 5,200-ft x 2,000-ft area with anomalous zinc and base metals on the Zinc Hill prospect. The MMI survey also defined a northeast-trending gold-in-soil anomaly in 10- to 40-ft-thick fluvo-glaciar cover on the Wheeler Gold prospect. Noranda currently has a first right of refusal to acquire the Zinc Hill and Wheeler prospects.
EASTERN INTERIOR

Kinross Gold Corporation announced that it produced 203,010 oz of gold from the Fort Knox mine during the seven months since they acquired it from Cyprus Amax. Total cash costs for the mine during the seven months ending December 31, 1998, were $199 per oz, although fourth quarter cash costs increased to $210 per oz due to mining of a lower-grade portion of the orebody. Production costs are expected to return to the $180-per-oz level now that mill expansion is complete and higher-grade material is being processed. Production for 1999 is projected at 370,000 oz.

Kinross Gold and joint venture partner Teryl Resources announced a preliminary resource calculation for the Gil project east of the Fort Knox mine. Indicated and inferred resources stand at 10.7 million tons grading 0.045 oz/t gold (450,000 oz). Preliminary metallurgical tests indicate gold recoveries of more than 90% from a 300-pound bulk sample that was tested at Fort Knox. Gold mineralization in the Main Gil zone has been extended to a strike length of 2,500 ft. Strata-bound mineralization is hosted in two or more calc-silicate horizons. The upper zone, ranging from 5- to 7-m thick, carries grades ranging from 0.070 to 0.10 oz per ton, whereas the lower zone ranges from 15- to over 200-m thick with grades averaging 0.025 to 0.035 oz per ton. A new anomaly was discovered at the North Gil prospect, where subsequent drilling returned values of up to 75 ft grading 0.043 oz per ton of gold. The 1999 program budget of approximately $800,000 includes 6,200 ft of core drilling and 11,000 ft of reverse circulation.

Placer Dome has terminated its exploration venture with Silverado Mines on the Estor Dome project in the Fairbanks district. Silverado retains 100% control of the property.

Teck Corp. and partner Sumitomo Metal Mining submitted their long-awaited underground exploration permit application for the Pogo deposit to the State of Alaska on December 18. The application calls for a total project footprint of about 17 acres, which will include all facilities for camp, storage, fill material, and access roads for the proposed underground shaft. Surface exploration drilling plans for a 50-hole program in 1999 are also included in the application.

Alaska newcomers Almaden Resources Corp. and Williams Creek Explorations Ltd. announced that they have jointly acquired 13,120 acres of ground on the Sonora property south of the Pogo deposit. Alaska newcomer Snowfield Resources announced acquisition of more than 21,000 acres of property in the Goodpaster mining district northeast of the Pogo deposit and adjacent to lands recently staked by Newmont Exploration. The property was acquired from Strictly Seafood Holdings Inc., who received a combination of cash, shares in Snowfield, and resale royalties.

Not to be outdone, another Alaska newcomer, Alberta-listed Troymin Resources, quietly acquired five land blocks covering 35,200 acres in the Goodpaster mining district.

Caanor Resources announced the staking of 2,240 acres of land on their South Selcha claim block east of the Pogo deposit. Staking was based on favorable geology, anomalous tungsten, gold, and bismuth in pan concentrate samples, and magnetic lows in the vicinity of the property.

Blue Desert Mining Inc. announced acquisition of three properties in the Pogo area that are prospective for intrusive-related gold occurrences. The Portal/Gobi properties are several miles west of the Pogo deposit, the Sahara property is located to the northeast of the Pogo deposit, and the West Point property is situated 15 miles north of Pogo.

Valerie Gold Resources Ltd. announced acquisition of the Octo property from Fairbanks prospectors Dave Johnson and Mike Raby. Valerie can earn a 70% interest in the property by making cash and share payments over 36 months and expending $200,000 on the property over the first year. Valerie has the right to acquire the remaining 30% interest by issuing 200,000 shares of its stock and can purchase 1% of a retained 3% NSR for a cash payment of $1 million. The Octo property is located 8 miles northwest of the Pogo deposit along the northwest trend defined by the Pogo mineral occurrences and a series of magnetic lows associated with intrusive bodies.

Eastfield Resources Ltd. announced acquisition of the 16.5-square-mile Porcupine property located about 10 miles northeast of the Pogo deposit. The Porcupine property is situated along a northwest-trending zone of magnetic lows associated with intrusive bodies in a belt parallel to the one that hosts mineralization at the Pogo deposit.

Engineer Mining Corp. announced the formation of a joint venture with property owner Rimfire Minerals on the 4,800-acre ER claim block 5 miles west of the Pogo deposit. The ER property is located in terrain believed to be favorable for intrusive-related gold deposits of the Pogo type.

Ventures Resource Corp. announced the results of the 1998 exploration at the Carrie Creek prospect east of the Pogo deposit. The program carried out in conjunction with equity partner Teck Corporation, outlined four parallel zones of anomalous gold with values of up to 1.6 oz per ton from surface samples. Each zone...
measures 2.5 miles long by up to 1,000 ft wide. Three drill holes were completed in one area of the property and returned widespread anomalous gold associated with quartz veining. Shortly thereafter, Teck Corp. informed Ventures Resource that it would exercise its right to acquire $1,725,000 worth of Ventures Resource common stock and continue its agreement to explore the Veta project (which includes the Carrie Creek prospect) in 1999. Approximately 85% of the proceeds from the equity purchase will be incorporated in a $2.3 million exploration budget for 1999 that will include 8,000 ft of core drilling.

Golden Phoenix Minerals announced the signing of an exploration agreement on their Richardson project with Kennecott Exploration. Kennecott has the right to conduct mapping and sampling until July 15, 1999, after which they may elect to enter a joint venture agreement giving them the right to earn 15% of the property in exchange for exploration expenditures totaling $2 million and cash payments totaling $400,000.

Tri-Valley Corporation and Golden Phoenix jointly announced a capital sharing plan designed to raise up to $9.8 million for mineral and petroleum projects in Alaska and the western United States. If fully subscribed, Tri-Valley would own a 40% interest in Golden Phoenix. Both companies are reviewing joint development plans for their adjacent holdings in the Richardson district.

Pacific Bay Minerals backed the trend by acquiring 5,500 acres of prospective ground in the Ladue River area near the Canadian border. The property is located in the Tinina gold belt in an area with historic placer gold production. Limited hole exploration has revealed the presence of anomalous gold in quartzite and quartz breccias of the Yukon Tana formation.

ALASKA RANGE

Grayd Resources announced the results of a new resource calculation for its DC North volcanogenic massive sulfide deposit in the Bannfield District. The estimates are based on drilling results from 36 holes along a strike length of 1,400 m. An inferred resource of 2.9 Mt grading 4.4% zinc, 1.9% lead, 0.2% copper, 94.6 g/t silver, and 0.55 g/t gold has been calculated. The bulk of the resource, including a higher-grade pod comprising over 50% of the resource, is located in the Fosters Creek zone. Mineralization is open along strike in both directions. Preliminary metallurgical work conducted on composite samples returned very high base and precious metals recoveries, with zinc in excess of 90%, silver, copper, and gold recoveries of 70 to 80%. The zinc concentrate showed low selenium and cadmium contents, both desirable from an environmental standpoint. Exploration plans for 1999 include continued drilling in the DC North and DC South horizons and evaluation of other anomalous areas between DC North and the WIP resource area to the north.

In a not-so-good piece of news, Usibelli Coal Mines laid off 31 employees as a result in delays in signing its new agreement with Korea-based Korea Electric Power Corp. The first shipment of coal to Korea was in September. Usibelli indicated that negotiations are ongoing.

SOUTHEAST ALASKA

Kennecott (70.3%) and Hecla (29.7%) announced fourth quarter production from the Greens Creek mine of 2,209,979 oz of silver at a cash cost of $2.73 per oz. For the year, the mine produced 9,497,679 oz of silver at a cash cost of $2.86 per oz. Total costs were $5.06 per oz, up from $4.55 per oz for 1997.

Ore and Thin Section Petrography

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**OTHER NEWS**

It has been reported that the U.S. Department of State has opted not to intervene via the International Joint Boundary Commission in the permitting of Redfern Resources' Tulesequah Chief deposit in northwestern British Columbia. This is good news for the project and should clear away one of the few sore points between Alaska and the British Columbia mining community.

The Fraser Institute, one of Canada's leading think tanks, released a study of mineral potential and investment attractiveness of North American jurisdictions that underscores Alaska's increasing importance in the mineral industry. Alaska ranked second in mineral potential in the United States and fifth in mineral investment attractiveness out of a field of 17 reporting jurisdictions. In comparison to the rest of North America, Mexico, and for comparison, Chile, Alaska ranks seventh for mineral potential and ninth for investment attractiveness out of a field of 31 reporting jurisdictions. Not surprisingly, Alaska's poorest showing was in infrastructure to support mineral exploration and development. Anyone interested in this report should log onto the Fraser Institute's website <www.fraserinstitute.ca>.

**WESTERN CANADA**

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**BRITISH COLUMBIA**

At the annual January Cordilleran Exploration Roundup in Vancouver, T.M. Schroeter ably summarized activities in the province and much of the following is extracted from his review. The Myra Falls mine, located in central Vancouver-Island, is owned by Bolden-Westmin and began production in 1986. The operation includes a number of closely spaced massive sulphide deposits hosted by Paleozoic felsic to intermediate volcanics; production plus reserves exceeds 50 million tonnes (Mt) at an average grade of approximately 5% zinc, 2% copper, 2 g/tonne gold, 32 g/tonne silver, and 0.3% lead. Geologists at Myra Falls have been successful recently in discovering a new zone of barite and massive sulphides with particularly high precious metal values. At Golden Bear, located 75 km northwest of Telegraph Creek in northwestern B.C., Wheaton River Minerals and North American Metals produced gold by heap leaching during the summer season. During 1998, 397,000 tonnes (t) grading 3.8 g/t were mined and an estimated 35,900 oz gold were produced. Most of the ore zones at Golden Bear are hosted by oxidized, brecciated, silicified dolomite and have characteristics similar to Carlin-type deposits. Claimstaker Resources and partner Jipengu initiated production at the Blackdome mine 235 km north of Vancouver. Blackdome produced 224,000 oz gold and 761,000 oz silver, between 1986 and 1989, from vuggy, locally chloritic quartz veins. At Eskay Creek (Homestake) in the Iskut River area of northwestern B.C., 900 km north of Vancouver, mine life has been extended to 10 years as a result of exploration success in replacement of mined ore and completion of a mill for lower grade material. Delineation of reserves in some cases requires drilling on 10 m centers or closer. Eskay Creek is one of the highest-grade, gold-silver deposits known; Karl Edmunds indicated at the Roundup that production plus reserves total less than two million tons ore but contain more than 3.4 Moz gold and 161 Moz silver. Eskay is a zinc-lead-copper VMS deposit hosted by mudstone and felsic volcanics, with unusually high precious metal, antimony, and mercury contents, but has many features in common with other VMS deposits. Also in the Iskut River area 30 km west of Eskay Creek, the Snip mine, also owned by Homestake, is likely to close early in 1999 as recent drilling did not intersect additional ore. Late last year, Snip exceeded 1 Moz gold produced. Adjacent to Snip, International Skyline continued to massage data for a feasibility study of the Bronson Slope porphyry deposit with a resource of 79 Mt grading 0.17% copper, 0.48 g/t gold, plus minor silver and molybdenum. East of Telegraph Creek...
and 150 km north of Esquimel Creek. American Bullion estimated a new resource of 520 Mt grading 0.35% copper and 0.47 g/t gold for the Red Chris porphyry deposit.

Exploration expenditures in B.C. during 1998 are estimated at $40 million, the lowest level in 20 years. As a result of depressed metal prices, several mines in the province have reduced or ceased production.

**NORTHWEST TERRITORIES**

Diamonds continue to be the focus in the NWT. At Lac de Gras, 300 km northeast of Yellowknife, Ekati mine (BHP, Diavik Metals, C. Fipke and S. Blusson) attained commercial production on schedule and within budget late in 1998. 18 years after Chuck Fipke found diamond indicator minerals in the area, Ekati is Canada's first diamond mine and is expected to produce 3.5 to 4.5 million carats of gem- and industrial-quality diamonds a year, about 4% of global production by weight or 6% by value. An estimated 17-year mine life is based on five kimberlite pipes; however, five additional pipes have economic potential and several others are being explored.

Also in the Lac de Gras area, at the Diavik project (Aber Resources and Rio Tinto/Kennecott), a CAN$70 million feasibility study is expected to be completed this year with production possible in 2002. A recent reserve estimate for Diavik was 26 Mt at 3.9 carat_CARAT/GEM1meg,Pct, or 102 million carats contained in five kimberlite pipes to a depth of 400 m. Approximately 120 km southeast of Lac de Gras, Monopros, a DeBeers subsidiary, Mountain Province Mining and Camphor Ventures continued drilling at the AK Diamond project where four pipes with significant grades are reported. At Snap Lake, 120 km northeast of Yellowknife, Winspear Resources (67.8%) and Aber (32.2%) continue to drill and bulk sample the northwest dike, where macro and micro-diamonds have been recovered. Considerable drilling and mini-bulk sampling have been completed since discovery in 1997, although insufficient data are available to estimate grade. The dike averages 2.5 m thick, dips 15° east, and contains about 1.4 Mt of kimberlite in the area drilled; it remains open along strike and down dip. On Victoria Island, approximately 700 km north of Yellowknife, operator Monopros with partners Major General Resources and Ascot Resources, have discovered five kimberlite pipes. Drill samples returned 83 diamonds, including 2 macro-diamonds, in 270 kg of sample from two of the pipes. The 1999 program on Victoria Island is expected to include additional drilling.

**SASKATCHEWAN**

Exploration for uranium in the Athabasca basin continues at a relatively modest pace. Cameco recently purchased all the assets of Uranex, terminated most of the Uranex geologists, then laid off eight of their own geologists. Late in 1998, Cameco also announced significant production cuts at its operations, from 26 million pounds U3O8 in 1998 to approximately 16 million pounds in 1999, in response to continued weak uranium markets. There have not been any major uranium discoveries in Saskatchewan for 10 years; however one new discovery, P-Patch, is significant. It was discovered by Uranex, is located just east of Key Lake, drill hole intersections of 1.0% U3O8 over 50 m are reported. The P-Patch deposit is totally within basement units, at least 50 m below the unconformity with overlying Athabasca Group sediments, and is within strongly bleached pelitic gneiss. The Athabasca sandstone above the deposit is altered. However, an unusual feature is that between the deposit and the sandstone, the basement is largely unaltered. The deposit probably only contains a few million pounds at this stage, although it is still partially open. Also, it is situated on a favorable geological contact, so there is excellent potential for several deposits to exist along that trend, like other Saskatchewan deposits. Geologist K. Wheatley suggested P-Patch has some morphological similarities to roll front uranium deposits—not too surprising a comment, considering that genetic processes which formed the two deposit types are probably very similar.
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Cu-Ni-PGE

Nuinsco Resources made a big splash in January with news of a Ni-Cu discovery on its Lac Rocher property in northwestern Quebec, some 120 km northeast of Maragami. The reason for the excitement was that the first drill hole of the 1999 drilling program intersected 61.5 m, which assayed 1.69% Ni, 0.49% Cu and 0.04% Co. This interval, between vertical depths of approximately 80 and 140 m, contained higher-grade intervals of 10.8% Ni, 0.25% Cu and 0.26% Co over 3.2 m, and 2.34% Ni, 1.15% Cu and 0.06% Co over 14.5 m. Minor platinum and palladium (up to 0.7 g/t and 0.1 g/t, respectively) were also reported. The mineralization, which consists of semimassive to massive pyrrhotite, chalcopyrite, and pentlandite, occurs in a gabbroic intrusion close to the contact with basement gneiss. Preliminary analysis of the sulfides indicates that all the nickel occurs in pentlandite. The discovery hole was one of three drilled to test geophysical (deep electromagnetic pulse and induced polarization) anomalies. The remaining two holes did not intersect economic mineralization.

Disseminated sulfides were discovered in a gabbro outcrop last year. Two channel samples totaling 15 m were taken over this mineralization and averaged 0.53% Ni and 0.30% Cu. A subsequent induced polarization survey identified a 900-m-long anomalous zone coincident with the mineralization.

Drilling during 1998 consisted of 10 holes, seven that intersected sulfides in what is described as a noritic phase of a layered mafic intrusion. The average grade of the mineralized intersections from this program was 0.5% Ni and 0.2% Cu. The intrusion was found to plunge to the southeast, and the Ni-Cu content of mineralization increased in that direction.

The 1999 drill program was restricted to three holes owing to limited funding. The results have certainly solved this crisis. At the time of this writing, Nuinsco had just announced that CDN$10 million had been raised for exploration and development of the Lac Rocher project and the Rainy River gold project in northwestern Ontario.

Platinum-group element (PGE) exploration continues to be in vogue with junior explorers in Ontario. Mustang Gold reported results of an eight-hole drilling program from its East Bull Lake property north of Sudbury, Ontario. The program was designed to follow up anomalous surface values of up to 18.8 g/t combined Pt + Pd + Rh + Au. Seven of the holes intersected mineralization in two zones: the near surface (less than about 30 m) A zone and the deeper (approximately 40 to 90 m deep) B zone. The A zone ranges from about 3 to 14 m in thickness, with grades between 0.73 and 1.4 g/t combined Pt + Pd + Rh + Au. The B zone tends to be thicker (up to about 40 m in thickness) and lower grade (up to 0.57% combined Pt + Pd + Rh + Au). Higher-grade intersections (up to 5.65 g/t combined PGE over 1.5 m in zone A and 1.76 combined PGE over 1.5 m in zone B) were contained within these mineralized intervals. Mineralization is hosted by an anorthosite and occurs close to the edge of the layered intrusion.

Cu-Pb-Zn

Southern Africa Minerals and senior partner Noranda continue to get results on the Calder property in the Matagami region of Quebec. An indicated resource of 412,600 t grading 12.4% Zn, 1.0% Cu and 35 g/t Ag was calculated for the Calder deposit by Noranda using a 5% Zn cutoff grade and a minimum mining width of 4.5 m. This is contained within a larger resource estimated at 1.3 Mt grading 5.5% Zn and 1.3% Cu. The deposit is located on the interpreted extension of the “Key Tuffite” exhalite horizon, along which the 10 known Cu-Zn massive sulfide deposits of the Matagami camp are located.

Drilling of the Calder North zone, approximately 2 km north of the Calder deposit, has revealed several mineralized zones that are interpreted to be one large magnetite-sulfide lens broken up by mafic sills. Drilling of the Calder North zone also intersected a mineralized exhalite horizon (Lower Tuffite) which is believed to correlate with the “Key Tuffite.” The most significant intercept of this horizon was 2.7 m grading 5.3% Cu, 0.07% Zn, and 3.4 g/t Ag. An 8,000-m drill program is currently underway to test the Calder North targets, the Lower Tuffite, and to check for downdip extensions of the Calder deposit.

Follow-up of geophysical anomalies has led to the discovery of deep massive sulfide zones on the Lyndhurst property of joint venture partners Globex Mining Enterprises and Ambilin Resources. Situated in western Quebec, 45 km north of Rouyn-Noranda, the property is underlain by altered and sheared felsic volcanic rocks. Initial drill testing of gravity anomalies coincident with sodium-depleted and potassium-enriched rhyolite flows intersected massive pyrite-chalcopyrite and pyrrhotite over 18.79 m. More recently, follow-up of bore-hole pulse electromagnetic (EM) anomalies intersected two massive sulfide zones and a copper stringer zone at vertical depths of around 1,337 m.

The massive sulfide intersections averaged 4.14% Cu and 28.8 g/t Ag over 8.37 m and 0.1% Cu, 2.04% Zn, and 15.8 g/t Ag in 11.27 m of pyrite and disseminated sphalerite. At the base of this zone is a copper-rich zone that averages 1.3% Cu over 3.5 m. The stringer zone was intersected 33 m below the copper-rich zone, and assayed 2.77% Cu and 17.8 g/t Ag over 2.35 m. Future drilling is planned to follow up new bore-hole pulse EM anomalies.
A new base metal occurrence was discovered by prospecting while following up a large (1 km × 4 km) airborne radiometric anomaly on the Spider Lake property of Major General Resources. The property is located in the Archean-age Hemlo-Schreiber greenstone belt of Ontario and is underlain by sheared and altered felsic-to-intermediate volcanic rocks. Disseminated, stringer, and banded sphalerite, chalcopyrite, pyrite, and pyrrhotite mineralization is hosted by intensely sericitized felsic fragmental rocks. The best result from channel sampling was 2.06% Zn, 0.05% Pb, 0.86% Cu, 31.6 g/t Ag, and 0.2 g/t Au.

Good old-fashioned prospecting has also uncovered a zinc-gold zone on the McKewen Lake property of Freewest Resources, situated about 12 km west of the no-longer-producing Renshaw gold mine in the Archean Michipicoten greenstone belt. Disseminated to semi-massive pyrite, sphalerite, and minor chalcopyrite occur in sericitized and chloritized felsic volcanic flows and fragmental rocks. Grab samples of semi-massive sulfide mineralization assayed up to 6.6% Zn and up to 5.59 g/t Au.

GOLD

Freewest Resources has also reported a gold discovery on its Golden Ridge property that scuttles the border of New Brunswick and Maine some 60 km west of Fredericton. The discovery consists of 12 occurrences hosted by altered pyroclastics, volcanic flows, and intrusions of dacitic to andesitic composition. These rocks make up a 4.5-km × 1.5-km volcanic center that is closely associated with a major ground boundary marked by a crustal scale fault.

The chain of events that led to the discovery of the occurrences started with a New Brunswick Department of Natural Resources and Energy geologic till survey in 1992. Don Ward, a local prospector, followed up Au, As, and Sb anomalies in the till with soil sampling and successfully delineated the extent of the gold anomaly. Freewest took an option on the property in 1997, staked additional ground, and commissioned an induced polarization survey and an airborne magnetic and electromagnetic survey. Follow-up of the resulting geophysical anomalies led to the discovery of the gold occurrences.

Two styles of mineralization have been recognized: (1) finely disseminated arsenopyrite and pyrite in intensely altered (sericite, Fe carbonate, and albite) andesite, and (2) quartz-albite-cemented hydrothermal breccia. An association of Au-As-Sb-Hg, together with the volcanioclastics, suggests an epithermal-type environment. The mineralization is controlled by second order transfer faults off the main Woodstock fault. Grab samples have assayed as high as 8.1 g/t Au, whereas channel samples across shear zones revealed by trenches averaged 1.2 g/t Au over 28 m and 1.3 g/t Au over 21 m.

Prospecting on the Maine side of the property has led to the discovery of large bodies of pyroclastic rock containing line

grained massive sulfide class. Exploration is continuing on the property with an overburden drilling program to be followed by diamond drilling.

Two drill holes on the Beauchastel property of Vior Mining Exploration, 15 km west of Rouyn-Noranda Quebec, have confirmed a 1960s intersection of 4.57 g/t Au over 2.42 m. Both holes intersected near-surface, low-grade (approximately 1 g/t Au) mineralization over widths of 19.5 m. Higher-grade intersections within this envelope included 4.38 g/t Au over 3.0 m and 3.93 g/t Au over 1.5 m. The gold is associated with hematite and pyrite, and is hosted by intermediate volcanics of Archean age.
WESTERN UNITED STATES

Regional Correspondent: Roger C. Steininger (SEG 1978)
Consulting Geologist, 1401 Sun Valley Ave.
Reno, NV 89502
Tel: +1.702.323.7775 • Fax: +1.702.323.1134

ARIZONA

Sumo Minerals is conducting a detailed evaluation of the Burro deposit at the Johnson Camp mine in Cochise County. The deposit contains a shallowly dipping zone of > 0.20% Cu that is about 450 ft thick, with a thinner chalcocite blanket that has an average grade in excess of 1% Cu. The deposit is a mixture of oxide and sulfide copper minerals that appear to be amenable to leaching. Four holes were recently drilled and confirm the initial view of thickness and grade in the deposit.

IDAHO

Latitude Minerals is continuing the exploration of the Kilgore gold deposit in Lemhi County with the completion of 4,070 ft of drilling. The most recent news release discussed drill hole results in terms of "mineralized intervals," but does not give specifics. Most of the activities appear to have centered about 1 mile southwest of the known deposit (resource contains about 700,000 oz of gold). The infamous "more drilling is planned" statement was also issued.

ONTARIO

Orvano Minerals has reported that the Nevin Hill deposit at Butte Highlands contains an indicated resource of 600,000 tons at 0.33 opt Au, and an inferred resource of 1,500,000 tons at 0.29 opt Au, totaling about 575,000 oz of gold. The deposit is still open down plunge.

NEVADA

The Fraser Institute (a Canadian think-tank) completed a survey recently and concluded that Nevada is the most attractive region in North America for mining exploration ventures. The definition of is that North America includes Chile and from Mexico north. The survey rated attractiveness to include mineral potential, public policies such as taxation, regulatory consistency, and land use policies. For completeness, Ontario was second, followed by Chile, Manitoba, Quebec, Saskatchewan, New Brunswick, Alaska, and Arizona. I don't need to tell you who was at the bottom of the list, but one of the states makes a lot of cheese.

The big news out of Nevada is that Placer Dome has made a bid to buy Getchell Gold. Placer feels it can increase the resources and reserves on the Getchell property (Humboldt County) to 20,000,000 oz of gold by the end of 1999. They also see significant potential to greatly expand the resource beyond the 20 Moz level. The initial
development plan is to complete the Turquoise Ridge mine and expand the mill to produce more than 800,000 oz of gold per year at less than $200 per oz by 2003. The comment most often heard is that Placer is paying too much, but then, those were the same comments that were made when Barrick bought Goldstrike.

Royal Gold has announced that the resource at South Pipeline (Lander County) has been expanded to 135.4 million tons with an average grade of 0.044% Au, containing approximately 5.96 Moz of gold, at a 0.01% Au cutoff. The resource expansion resulted from the completion of 65,941 ft of drilling in 1998 by Cortez Mining Co. Shortly after Royal Gold's announcement, Placer Dome released a new proven and probable reserve for the deposit of 122,340,000 tons with a grade of 0.058% Au. Permits for South Pipeline are expected this summer.

A new reserve has been released by Placer Dome for its Bald Mountain deposit in Elko County. The proven and probable reserve is 10.8 million tons with an average grade of 0.075% Au. There is also optimism that additional mineable gold mineralization that will add to the reserve base will be found in the district.

White Knight Resources has concluded its 1998 drilling program at Indian Ranch in Eureka County. They have identified a body with mineralized and altered Roberts Mountains Formation as shallow as 350 ft below the surface. The area of alteration is at least 2,800 ft x 3,500 ft. Most of the drill hole intercepts can be best defined as "monolite gold," although a few are in the 0.02 to 0.04 opt Au range. The infamous "more work is planned" statement (or words to that effect) was issued.

Rayrock Resources had a successful exploration year during 1998. They announced a 73% increase in reserves at their three Nevada mines. At a $300 per oz gold price, the total reserves are now 17.156 million tons with an average grade of 0.042% Au. Daisy and Dee now have sufficient reserves to continue operations until 2002 (of course, if the Y2K problem hits them they could then mine for 102 years). Marigold seems to be the biggest winner with the extension of life to 2007, and the possibility of adding additional reserves as exploration is completed in 1999. Meanwhile, Glanis Gold and Viceroy Resource Corp. are in a battle to see who can take over the company. As of this writing, it seems that Glanis Gold will buy Rayrock.

After about one year in bankruptcy court, Pegasus Gold has reorganized into a new company called Apollo Gold. The assets of Apollo include Florida Canyon, Montana Tunnels, and Diamond Hill. The latter two properties are in Montana, while Florida Canyon is in Pershing County. If you would like to see a feeding frenzy, go to a bankruptcy proceedings and watch the lawyers rack up the hours that can be billed out. Your average consulting geologist has a lot to learn about charging out time.

Here is another good website if you are conducting exploration in Nevada, or interested in the state's mining activities: <www.state.nv.us/hsti/minerals>. This is the Nevada Division of Mines site, and if you log on, say hi to Alan Coyner, the administrator.
CANDIDATES FOR SEG FELLOWSHIP:

TO ALL FELLOWS:

Pursuant to Article I, Section 2, of the Society’s Bylaws, names of the following 3 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, to the Chair, Admissions Committee before June 15, 1999. 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
5808 S. Rapp Street, Suite 209 • Littleton, CO 80120 • USA

Corner, Branko, Corner Geophysics Nanibia, Swakopmund, Namibia: W.E.L. Minter, Felix Mendeleshin, C.R. Anheuser
Els, B. Gerard, Poetserstrom University, Poets, South Africa: W.E.L. Minter, Felix Mendeleshin, C.R. Anheuser
Ntingicimpaye, Audoae, BHP Minerals, Dar Es Salaam, Tanzania: Noel C. White, Hugo Damant, Andy Wilde

THE SOCIETY ALSO WELCOMES THE ABOVE CANDIDATES AS NEW MEMBERS

NEW SEG FELLOWS:

Mark J. Fitzpatrick, IMAGIS Data Imaging, Cobb, Co. Cork, Ireland; Peter W. Leaman, BHP Minerals, Brisbane, Queensland, Australia: Alvis L. Litenbee, South Dakota School of Mines & Technology, Rapid City, SD; Graciano P. Yumul, Jr., University of the Philippines, Manila, Philippines; Yongfeng Zhu, Peking University, Beijing, China.

THE SOCIETY WELCOMES THE FOLLOWING NEW SEG MEMBERS:


The Society Welcomes The Following Student SEG Members:

Efem Alikoob, Colorado School of Mines, Golden, CO; David S. Boyer, Western Washington University, Bellingham, WA; Lec Bray, Brigham Young University, Provo, UT; Eric Chaloux, Laurentian University, Sudbury, ON, Canada; Nathan Churas, University of Washington, Seattle, WA; Darryl J. Clark, University of Tasmania, Hobart, TAS, Australia; Thomas J. Danielson, The University of British Columbia, Vancouver, BC, Canada; Marcelle Deslauriers, Laurentian University, Sudbury, ON, Canada; Thomas A. Douglas, Pannorah College, Hanover, NH; Steven D. Dunlop, Laurentian University, Sudbury, ON, Canada; Judd W. Fee, Laurentian University, Sudbury, ON, Canada; Chris B. Gaul, Laurentian University, Sudbury, ON, Canada; W. V. Andrews Graves, New Mexico Institute of Mining and Technology, Socorro, NM; Aurel R. Grigoras, Ecole Polytechnique, Montreal, QC, Canada; R. Scott Hefferton, University of Alberta, Edmonton, AB, Canada; Martin A. Herrmann, University of Arizona, Tucson, AZ; Darren R. Hodder, Laurentian University, Sudbury, ON, Canada; Albert R. Holm, University of Toronto, Toronto, ON, Canada; Seen S. Lee, University of California, Los Angeles, CA; Majed A. Lacic, University of Western Ontario, London, ON, Canada; Daniel Layton-Matthews, Laurentian University, Sudbury, ON, Canada; Michael J. Lister, Royal School of Mines, London, Great Britain; Joy L. Lister, South Dakota School of Mines and Technology, Rapid City, SD; David S. Lewis, University of Idaho, Moscow, ID; Alberto Lobo-Guerrero, Queen’s University, Kingston, ON, Canada; Carol Anne K. MacDonald, Laurentian University, Sudbury, ON, Canada; Stephanie M. Maks, New Mexico Institute of Mining and Technology, Socorro, NM; Lorna C. Martin, Laurentian University, Sudbury, ON, Canada; Patrick Mercier-Langerlein, University of Quebec A Chicoutimi, Chicoutimi, QC, Canada; Steven Micklechurch, University of Leeds, Leeds, Great Britain; Andrew P. Molduchowski, New Mexico Institute of Mining and Technology, Socorro, NM; Grant A. Moure, Laurentian University, Sudbury, ON, Canada; Shellee A. Nowak, Laurentian University, Sudbury, ON, Canada; Lisa K. Penny, Laurentian University, Sudbury, ON, Canada; Tanayala Pulspipher, Brigham Young University, Provo, UT; Michael R. Reich, Laurentian University, Sudbury, ON, Canada; Trevor L. Richardson, Laurentian University, Sudbury, ON, Canada; Digne N. R. Rosa, Colorado School of Mines, Golden, CO; Perkan Sajdak, Kazakh Gold Corporation, Gausumase, Turkey; Denton Smyh, Queen’s University, Newry, County Down, Northern Ireland; Kristian H. Straub, Laurentian University, Sudbury, ON, Canada; Nicole P. Tardif, Laurentian University, Elliot Lake, ON, Canada; Linnea Von Hessert, University of Montana, Missoula, MT; Jollie E. Wood, Laurentian University, Sudbury, ON, Canada.
Ore Deposits Mapping Course

October 20–23, 1999 • Tucson, Arizona
Prior to the GSA Annual Meeting in Denver

Course Instructors:
Dr. Spencer R. Tilley, 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 and underground mapping of mineral deposits. The Tucson area provides opportunities for participants to map at exploration and mine scales, with emphasis on recognition of the tectonic, structural, and mineralogic features characterizing porphyry and skarn-type ore deposits.

We will spend two days mapping features exposed in surface outcrops and open-pit mine benches, familiarizing participants with brunton-and-tape methods of mapping. Stressing recognition of "what is important" in exploration-style and 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 mapping at exploration and ore deposit scales. A session dealing with underground mapping will allow participants to become familiar with methods used in geologic mapping of drifts and stopes at very detailed scales. Participants will be able to check their mapping with that of the instructors, providing for feedback throughout the field course.

Participants will gather in Tucson on Wednesday evening, October 20, with the course finishing at about noon on Saturday, October 23. This will allow participants time to travel to Denver for the GSA annual meeting, which begins Sunday, October 24. Because this is a hands-on mapping course, the number of participants is limited to 25. Brunton compasses will be provided, as will base maps, as necessary. Course costs include three nights (double) lodging, three breakfasts and lunches, transportation to/from the Ramada Inn to field sites, and course materials.

Cost for the field course is $395 for SEG members and $495 for non-members; a limited number of spaces are available to students, at $195.

For additional details, please contact Spencer Tilley, email <stilley@geo.arizona.edu> or William X. Chávez, Jr., email <wxc@nmt.edu>.

Decimo Octavo Curso Internacional de Postgrado en Metalogenia
14 al 25 de Junio, 1999 • Quito, Ecuador

CON EL AUSPICIO DE
UNESCO y Society of Economic Geologists (SEG)

El Curso Internacional de Postgrado en Metalogenia para postgraduados de Latinoamérica y El Caribe, está estructurado de acuerdo a las exigencias del desarrollo moderno de las Ciencias de la Tierra. Este evento Internacional tiene como objetivo la difusión de nuevos conocimientos y adelantos alcanzados en estudios metalogénicos útiles en la búsqueda, desarrollo y explotación de los yacimientos, sin descuidar los aspectos de impacto sobre el Medio Ambiente a causa de actividades geológicas/mineras. El curso está organizado en módulos autónomos cubriendo aspectos específicos que incluyen Geoquímica de Fluidos Hidrotermales, Alteración Hidrotermal, Transporte y Precipitación de Metales, Estudios Básicos de Metalogenia, Modelos Metalogénicos de Yacimientos de tipos: Sulfuro Masivo, Volcanógenico, Skarn, Epitermales de Au y Ag, así como Procesos Supergénicos, Uso de Isótopos de Plomo en Exploración, y Metalogenia de El Caribe. El curso teórico estará complementado por prácticas de terreno para visitar yacimientos de tipo: Sulfuro Masivo, Skarn y Epitermales de Au y Ag. Los instructores son expertos internacionales de Ecuador, UE, España, Reino Unido y Suiza. El curso, que será en español, cuenta con el apoyo de UNESCO y Society of Economic Geologists (SEG).

DIRECCIÓN DE CONTACTO:
Dr. Jaime Jarrín
Curso Internacional de Metalogenia • Universidad Central del Ecuador
Facultad Ingeniería Geología, Minas y Petróleos • Instituto Superior de Postgrado
Casilla Postal 17-21-1405 Quito-Ecuador
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email: <director_j@uio.edu.ec> • <jarrin@uio.telcomer.net>
http://www.unic.edu/estudios/tecia/min2/mient/ore

CURSO TEÓRICO COMPLETO:
Profesionales 3000USD • Miembros de SEG 1500USD • Estudiantes 1000USD

PRÁCTICAS DE CAMPO:
Profesionales 3000USD • Miembros de SEG 1500USD • Estudiantes 1000USD

(Pedir precio especial por sólo algunos módulos)
Hotel en Quito categoría ** == 180,00 USD/día
Hotel en Quito categoría *** == 100,00-150,00 USD/día
(El curso puede organizar las reservas)

BECAS: Existe un programa de becas de la UNESCO y SEG que cubren el costo total o parcial del curso, hotel y viajes para participantes de instituciones Latinoamericanas de investigación y enseñanza y servicios geológicos.

Solicitudes con Curriculum Vitae deben ser enviadas a la dirección indicada antes del 16 de abril del presente año.
SOCIETY OF ECONOMIC GEOLOGISTS
Meyer Research Conference
Request For Submissions

In October 1998, the Council of the Society of Economic Geologists approved a proposal for the development of special field-based research conferences to be held every four years. The goal of these conferences will be to bring together researchers and explorationists to discuss topical issues. The field setting will be used to illustrate problems and to stimulate discussion, but the theme of conferences may extend beyond the specific location of the meeting. The conferences are named after Charles Meyer, to commemorate his contribution to applied research based extensively on field observations.

SEG is seeking applications from individuals or groups who wish to organize the first Meyer Conference for 2002. To be considered for support from SEG, the proposal must satisfy the following general criteria:

- The topic of the conference may be thematic, focusing on a specific type or deposit or process, or regional, focusing on a specific area.
- The location, anywhere in the world, must be suitable for a mix of field and conference activities. The setting must be compatible with the conference theme; approximately 50% of the time should be devoted to the field.
- The conference should involve about 100 participants of varied interests and backgrounds. Industry participation is necessary (target, 25% of participants), and student participation must be encouraged with appropriate subsidies (-50% of costs).
- There will be no formal conference proceedings, but the organizers will be required to prepare a general report summarizing major areas of discussion, new ideas, and areas for future research, to be published in the SEG Newsletter.

SEG will provide a grant of up to US$20,000 of seed capital to support the conference, with the expectation that this amount would be recovered from registration fees or other sources (donations, collaborating organizations, and grants).

Potential organizers should contact the Chair of the SEG Research Committee (address below) for detailed guidelines. Written applications, including budget, for the 2002 conference must be submitted by October 1, 1999. The Research Committee will review proposals and submit the chosen application to Council for approval.

Richard J. Grauch—SEG Research Committee
U.S. Geological Survey • MS 973 Denver Federal Center
Box 25046 • Denver, CO 80225 • U.S.A.
tel. +1 303.236.5551 • fax +1 303.236.3200
email: <grauch@usgs.gov>

Faculty and Professionals

Opportunities for lecturing or advanced research in nearly 136 countries are available to college and university faculty and professionals outside academia. U.S. citizenship and a Ph.D. or comparable professional qualifications are required. For lecturing awards, university or college teaching experience is expected. Foreign language skills are needed in some countries, but most lecturing assignments are in English. For more information, contact USIA Fulbright Scholar Program, Council for International Exchange of Scholars, 2007 Tilden Street, NW, Suite 31, Box GNEWS, Washington, D.C. 20008-3009. Tel. +1 202.686.7877; website: <www.cies.org>; email: <apprequests@cies.iie.org> (requests for application materials only).

SEG Research List Server

The SEG RESEARCH LIST SERVER has moved! The new address is <seg-research@lists.utah.edu>. Postings to this address will result in the communication being delivered to all subscribers. Any SEG member may subscribe to the list server. To subscribe simply send an email to the address <seg-research-request@lists.utah.edu>. The body of the message should contain only the command, subscribe.

The purpose of the SEG list server is to promote discussion of topics of interest to the membership. The list may be used to alert Society members to sponsored field trips and conferences. Additional information about the list server is available on the SEG website in the section LINKS.

— Erich Petersen
Epithermal Mineralization of the Western Carpathians

SEPTEMBER 4–13, 1999

Organized by: Department of Mineralogy, Eötvös L. University, Hungary, and Geological Survey of Slovakia

The Au-Ag base metal deposits of the Tertiary volcanic arc of the Carpathians were among the most important European sources of precious metals during medieval times. This field trip will examine three major areas of the arc in Hungary and Slovakia, with typical low- and high-sulfidation epithermal environments from the paleotrend down to subvolcanic levels. The 1,400-km-long journey will also provide an introduction to the Tertiary metallogeny of the Western Carpathians, and an opportunity for interaction between geologists of Central and Eastern Europe and other regions.

Field observations at nutreape and in quarries and mines will be preceded by review lectures from specialists working in each area. The program also includes underground visits to Medieval mines at Telkišťany, Tokaj Mts., at Hodoška in the Banská Štiavnica region, and to the working Rozália gold mine in the Štiavnica stratovolcanic central zone.

Coordinators: Ferenc Molnár (Eötvös L. University), Jaroslav Leza (Geological Survey of Slovakia), and Jeffrey W. Hedenquist (Ottawa, Canada).

Registration fee: US$1,500. SEG members, $1,200; SEG and SGA student members, $800. Registration fee includes accommodation, meals, transportation in field from Budapest and return to Budapest, SEG guidebook, maps, and social events. Limited funding is available to help support the participation of several students from regions with economic difficulties. The number of participants is limited to 25, on a first-come, first-served basis.

Registration deadline is June 15, 1999, and payment-in-full must be received at the SEG office (address below) by that date. Checks in US dollars drawn on a US bank or a US affiliate only, please. For payment by wire transfer, please contact the SEG office for instructions.

All participants must sign an assumption of risk agreement prior to departure.

For details of the complete program and registration, plus application for student support, please send your name, affiliation, address for correspondence (including fax and email), and status (SEG member, SEG or SGA student member).

Jeffrey W. Hedenquist
Fax +1.613.230.9282email <SEGh@telus.com>
SOCIETY OF ECONOMIC GEOLOGISTS
8808 South Rapp St., Suite 209
Littleton, CO, 80120, USA
fax +1.303.797.0417email <sec@seg.org>

SEG-SME Annual Meeting
in Salt Lake City, Utah
FEBRUARY 28–MARCH 1, 2000

New Frontiers in Mining Meeting 21st Century Challenges

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• Global Exploration
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Kennecott Exploration
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TEL: 907.243.2185
FAX: 907.243.5526
EMAIL: presnell@alaska.net

Abstracts due: August 1, 1999
Manuscripts due: November 1, 1999

1998–1999 Thayer Lindsley Visiting Lecturers Video Series

Video cassettes of lectures presented by the current Thayer Lindsley lecturers are now available to purchase from the SEG. Topics from Michael Lesher, Professor of Economic Geology, Laurentian University, Sudbury, Ontario (lectures delivered September 1998) are: The genesis of magmatic Ni-Cu-(PGE) sulfide deposits, and Physical volcanology, geochemistry, and petrogenesis of basaltic lavas and channelized sheet flows in the Cape Smith belt, NW Quebec.

 Topics by Michael J. Knuckey, President, Noranda Mining Exploration, Ltd., Toronto, Ontario (lectures delivered November 1998) are: Worldwide exploration: Can we afford it? and Exploration strategic planning.

Each tape includes two one-hour lectures and the subsequent audience discussion session. Cost is US$25 per tape, including postage and handling. Available only from SEG, 5008 S. Rapp St., Ste. 209, Littleton, CO 80126; fax: 1.303.797.0417; tel: 1.303.797.0332.
“Mineralization” must be one of the most commonly used nouns in the field of economic geology, but I note with dismay that it is often used as if it has two meanings, viz. (1) the process of mineralizing a rock, substance, etc. or (2) the mineralized body itself. In a recent issue of Economic Geology, there is an example of one meaning being applied in a sentence, the other in the succeeding sentence, indicating that one could write, for example, “repeated episodes of mineralization produced the mineralization.”

In the modern world, a somewhat cavalier attitude toward etymology, and particularly precision of meaning, has become evident in several fields of endeavor, but this is no excuse for scientists to write with less exactitude than formerly; indeed, it behooves us to write with greater precision.

The New Shorter Oxford English Dictionary (1993) defines mineralization according to (1) above, i.e., it is a process, a noun related to the verb “to mineralize.” The Glossary of Geology (1987), published by the American Geological Institute, gives the same definition. The mineralized rock, vein, massive sulfide, or whatever is defined and described by its composition, or some convenient local term or acronym: it is the product of mineralization.

As pointed out to me by Marco Einandi, similar misapplications apply to words such as “alteration” and “sericitation.”

---

**NEW! ** ★ MiningPro Matrix ★

MiningPro Matrix is a new tool for strategic planning and evaluation of acquisitions and exploration-stage projects.

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★ A mine model showing your project assumptions
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See our website: www.miningprofiles.com
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$65 for Members and US$42.50 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., 5808 S. Rapp St., Suite 209, Littleton, CO 80120, USA. phone: 303-797-0332; fax 303-797-0417.

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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Graduate:

Professional Experience: (List in order from most recent at the top.)

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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.

ADDRESS OF SPONSOR

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DATE RECEIVED
NEW SEG PUBLICATIONS

REVIEWS VOLUME 7


Recent technological advances have made possible in situ sampling and analysis of individual growth bands within crystals, and of tiny solid and fluid inclusions within crystal lattices; this opens a level of detailed geological information heretofore unavailable. This publication is divided into four topical sections: Geochronology and Radiogenic Isotopes, Stable Isotopes, Elemental Analysis, and Fluid Inclusions. Each chapter provides an overview of a microanalytical technique and its practical applications to understanding mineral and rock forming processes.

REVIEWS VOLUME 10

Techniques in Hydrothermal Ore Deposits Geology: Jeremy P. Richards and Peter B. Larson, editors; 1998; 264 p.; US$34.00.

This publication is both a reference guide and a handbook containing practical information ranging from the construction and interpretation of diagrams, to the size and type of samples required for geochronological analyses. Individual chapters provide basic principles of their respective topics and explore the practical applications of techniques in the study of ore deposits.

GUIDEBOOK VOLUME 29


The revised edition of this blockbuster Guidebook, prepared for the SEG field conference held in Salt Lake City, October 24-26, 1997, is now available. The volume, now in a two-column, bound format, includes 15 geological papers reflecting the three one-day segments of the field trip: (1) intrusions of the central Wasatch Mountains, (2) the Bingham Canyon porphyry copper deposit and (3) the Melco gold deposit and the Pb-Zn-Ag halo of the Bingham copper deposit. Much new research, presented at a half-day symposium prior to the field trip, is incorporated in the Guidebook. Detailed road logs, new descriptive material, and oversize color plates (prepared by Kenneally), are included.

GUIDEBOOK VOLUME 30

Gold Deposits of Northern Sonora, Mexico: Kenneth F. Clark, Editor; 1998. 252 p., 12 colored figures, 1 oversize figure, 2 oversize plates (in pocket), US$36.

This Guidebook was prepared for the SEG field conference held in Northern Sonora, Mexico, October 19-24, 1998. Sonora is the premier gold-producing state in Mexico, and the bulk of that production comes from the mines described in the volume: Santa Gertrudis, Llvia de Oro, San Francisco, Cerro Colorado, La Colorada, La Herradura, and La Choya. Information on exploration history, mining methods, production and reserve figures, and metallurgy is also included. Other articles provide an introduction to the geologic framework within which these deposits occur, and discuss regional and local stratigraphy, structure, tectonics and paleomagnetism. A concluding article by C. Jacques Ayala and K.F. Clark summarizes the "Lithology, Structure and Gold Deposits of Northwestern Mexico." Photographs, diagrams, and numerous maps provide ample illustrations, and the detailed road logs are particularly useful for self-guided tours.

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Parophy and Hydrothermal Copper and Gold Deposits. Proceedings of Conference held November 1998, Australian Mineral Foundation. 65 Coneyingham St., Glenside, South Australia 5065; Fax: +61 8.8379.4634; email: <bookshop@amf.com.au>; cost US$145.00 plus US$35.00 air mail. Accept VISA.

Fault Related Rocks. Smoke, A.W., Tullis, J., and Todd, V.R. Editors, A photographic atlas; Princeton Univ. Press, Fax: +1 800.999.1958; cost US$100.00 plus postage. Accept VISA.


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Nov 3-5, International Symposium on Geochemical and Mineralogical Tracers in Mining Exploration ORSTOM, Nancy, France. Organized by the Department of Geology, University of Nancy and “Institut Français de Recherche Scientifique pour le Développement en Coopération” (ORSTOM). Contact: ORSTOM, 53500, Corso Central Washington 1, Nancy. Tel.: +33.3.2363.4646, Fax: +33.3.2363.463, e-mail: orstom@nancy.fr.
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May 12-20, 2000, Europe’s Major Bass Metal Deposits, Slovakia, Iceland. Contact: Leif L. Fuglesang, with Association for Economic Geology, c/o Mercato Services Ireland, NL, Milton, Mayo, Co. Mayo, Ireland. Tel.: +353.59.454.5553, Fax: +353.59.454.5554, e-mail: fuglesalm@merkato.co.uk.
May 15-16, “Gold and Ore Deposits 2000: Great Basin and Beyond,” Geological Society of Nevada Symposium. Reno- Sparks, Nevada. Contact: GSU Symposium Editor, P.O. Box 12021, Reno, NV 89510-12021, Tel.: +1.702.323.3500, Fax: +1.702.323.3500, e-mail: gsu@msn.com. See announcement p. 21.
Aug 6-17, 21st Session of the International Geological Congress, Rio de Janeiro, Brazil. Contact: IGC Secretarial Bureau, 9999999999, Brazil. Tel.: +1.999.999.9999.
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