The Golden Triangle of Southeast China: Another Carlin Trend?

Andy Wilde† (SEG 1998 F), Predictive Mineral Discovery Co-operative Research Centre, School of Geoscience, Monash University, Victoria, Australia

Editor’s note: This article is an expanded version of The Golden Triangle of SE China: Potential for another Carlin trend, which appeared in the inaugural SEG Newsletter (July 2003, no. 1) published by the Special Group in Economic Geology at Monash University. Andy Wilde’s paper provides an interesting complement to the current special issue (98-6) of Economic Geology, which focuses on gold deposits of the Carlin trend in northern Nevada.

INTRODUCTION

Numerous gold deposits and occurrences in southeast China are located in an area known as the “Golden Triangle,” mainly in Guizhou province (Fig. 1). Comparisons have been made with sedimentary rock-hosted or “Carlin-type” deposits of northeast Nevada (e.g., Li and Peters, 1998), and at least one major multinational mining company has explored for Carlin-type deposits in this area. Such deposits represent attractive mineral exploration targets owing to the size of the contained resources, high grades, and amenability to open-pit mining operations. Furthermore, the deposits tend to occur as clusters (or “trends”). Discovery of a new mineralized cluster would represent a major coup. In this paper I provide a short summary of aspects of the geology of the southwest Chinese deposits and comment on their similarities and differences compared to the deposits of Nevada.

CHARACTERISTICS OF CARLIN-TYPE DEPOSITS OF NEVADA

Gold deposits of the Carlin trend of Nevada are hosted by Ordovician to Devonian clastic and carbonate sedimentary rocks from the zone of transition between continental shelf and basin (Cook 1988; Armstrong et al., 1998). The presence of buried Precambrian crust beneath the continental shelf has been inferred from radiogenic isotopic composition of Mesozoic rocks that have significantly more crust-derived Nd and Sr in central and eastern Nevada (Farmer and De Paolo, 1983; Wooden et al., 1997). Progradation, transgression, and periods of nondeposition within the early Paleozoic sequence have been attributed to changes in sea level but may also reflect movement along a bounding fault or faults at the edge of the Precambrian crustal platform. Emsbo et al. (1999) portray the presence of such faults in their reconstruction of the Carlin trend during the Middle Devonian. Furthermore, Teal and Jackson (1997, p. 13) have noted that “the north-northwest regional

FIGURE 1. Geology of the Golden Triangle. The Golden Triangle is the triangular Mesozoic basin that straddles Guizhou, Yunnan, and Guangxi provinces. Gold deposits are shown for Guizhou province only.
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Note: Feature articles are peer reviewed before they are accepted for publication.
Members will notice on the front cover of this issue that it is again time to renew dues payments for next year and I urge you all to do this prior to January 1, 2004. The good news is that regular member dues have been set at $85 for the tenth consecutive year. This is particularly good value when one considers that inflation-adjusted dues should be set at $105 for next year. How is this possible when the average society based in the United States finds it necessary to increase dues every fourth year? Whereas income from the investment portfolio and support from the SEG Foundation have helped to offset the operating costs of expanding programs, ultimately the Society’s fiscal health depends on our ability to generate adequate non-dues revenues (i.e., money from publications, meetings, field trips, and short courses/workshops). Further, to avoid incurring needless costs related to shipping and handling, we have reluctantly instituted a late fee for dues renewals received after March 1. Please go online for details at <http://www.segweb.org/2004BenefitsExplanation.pdf>.

The Society is committed to limiting the extent of any future increase in the membership dues, and timely payment of your dues will help significantly in containing our costs.

Several changes in membership of the Executive Committee and Investment Committee occurred during August and September. Harold Noyes has accepted the position of SEG Treasurer, while George Ireland, former Treasurer, succeeds Gary Huber as Chair of the Investment Committee. We’re very pleased to have retained the services of both George and Gary on the Investment Committee, and all of us look forward to working with Harry as the new Treasurer. In the build-up to our business meetings in Seattle this November, the ad hoc strategic planning committees will be preparing recommendations on a variety of Society activities, several of which will have a direct bearing on the continuing financial security of the Society.

Turning once again to the importance of non-dues revenues, the SEG is trying to focus on major events and in this regard we’re placing significant emphasis on our stand-alone meeting “Predictive Mineral Discovery Under Cover” in Perth, Australia, next year (see details on p. 21 of the July issue of the SEG Newsletter). David Groves, who served as the first Australian President of SEG (2001–2002), and his organizing committee have put together a first-rate program. The conference will maintain its Australian flavor under the presidency of yet another Australian, Ross Large. This stand-alone meeting will provide members with a rare opportunity to rejuvenate their science, gain new exploration ideas, and network with many of the world’s foremost exploration geologists and economic geology researchers. Participating in SEG 2004 will enhance your professional career and boost the value of your Society membership no matter where you work in the world.
Planning for the Future of SEG

Thanks to the hard work of many individuals, the SEG Council is moving forward with strategies to better fulfill our mission. We invited SEG Foundation trustees and other SEG leaders to participate in the Council’s strategic planning session on Saturday, May 24, immediately before the Geological Association of Canada annual meeting in Vancouver. I’m pleased to report that we came to agreement on a new strategic plan for SEG, and we assigned a number of important tasks to existing and ad hoc committees. Over the last three years, during the presidencies of David Groves and Hugo Dummett, we have had many meetings and e-mail exchanges to formulate a workable strategic plan. I have gained appreciation for the breadth of our members’ opinions on what they see as important programs and directions for SEG. In Vancouver, we settled on the following mission statement, which focuses on the key duties of SEG:

“The Society of Economic Geologists is an international society committed to excellence in the science, discovery, documentation, interpretation, evaluation, and responsible development of mineral resources and to the professional development of its members. The Society supports the professional and scientific needs of its members, the mineral-resource and related environmental requirements of society, and the growth and application of the science of economic geology. We do this chiefly through our services and programs that:

• Support research on mineral resources and related areas of science;
• Disseminate information concerning science and its application to exploration and mineral-resource development and production;
• Encourage members to promote sustainable mineral-resource production for the benefit of society; and
• Encourage, maintain, and support high standards in research, publications, and applications of the science of geology to mineral resources.”

We readopted “principles” or philosophical underpinnings of the Society, which were articulated in a 1997 report of an SEG strategic planning panel (excellence, responsiveness, diversity, accountability, cooperative relationships, learning and innovation), and we added another principle, volunteerism. We then focused on goals for membership, governance, services and products, outreach, and financial viability. The full text of the statements of mission, principles, and goals are posted on the Web, at <http://www.segweb.org/Strategy.pdf>.

The plan also includes strategies and tactics for accomplishing the goals, or at least making good progress within the next three years. To do so, several committees are addressing specific tasks. The committees will report on their progress and make recommendations for consideration by the Council. An ad hoc committee on membership, chaired by Bill Chavez, is addressing ways to increase, upgrade, and diversify the SEG membership on a cost-effective basis, with specific attention paid to membership fees, subscriptions to the Newsletter, enhanced services to members, use of the Web as a recruiting tool, measurable goals for membership, student membership, stimulating volunteerism, identifying appropriate members to be promoted to Fellow status, and possible corporate membership. The Program Committee, also chaired by Bill Chavez, has the task of scheduling an appropriate mix of SEG technical sessions and conferences, including stand-alone economic geology symposia, field-oriented conferences, and meetings with other organizations, assuring that students are encouraged to participate in all SEG meetings, short courses, workshops, and field trips.

The Executive Committee is charged with proposing appropriate changes to the SEG bylaws to assure the best leadership; reviewing strategic alliances with other organizations; providing guidelines to organizers of meetings, workshops, short courses, and field trips; defining SEG’s appropriate role in outreach to the public; proposing a process for adoption of policies and position statements; and proposing specific position statements. Brian Hoal, SEG’s Executive Director, is charged with assuring that SEG’s fundraising efforts for special conferences, publications, student support, and other programs are coordinated.

The Publication Board, chaired by Sam...
Adams, has been asked to review the scope, balance, and mix of SEG publications; evaluate the costs and benefits of making the contents of SEG publications available to the membership and institutional subscribers online; and continue to evaluate SEG’s possible participation in the journal aggregate of nonprofit geoscience publishers, who are banding together to provide a more useful electronic product to their members.

An ad hoc committee on excellence in applied economic geology, chaired by Duncan Large, is investigating whether and how SEG should recognize success in exploration, development, and production. Expect to see more about this issue in the pages of the Newsletter. An ad hoc committee on mentoring, chaired by David John, is investigating ways to promote mentorship of young economic geologists and will be investigating such items as an SEG award for excellence in mentoring and Web-based opportunities to link mentors with young professionals.

Richard Goldfarb is chairing an ad hoc committee that is evaluating the regular development and format for offering SEG short courses, including the content and mix of short courses, whether a companion Reviews in Economic Geology volume should always be required, and the ability to offer the same short course repeatedly.

The SEG Strategic Plan will be revisited regularly. We will be using it to structure the Council’s business meeting on November 3 in Seattle, and we will update and revise the plan during an all-day session on March 6 at PDAC next year. In the meantime, feel free to contact me (jprice@unr.edu) with your ideas.

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**SEG Contributions**

6/4/03–9/16/03

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**ANNUAL MEETING SEG-GSA 2003**

Seattle, Washington, November 1-5, 2003

**SEG Program Coordinator:**

Larry Meinert (SEG 1989 F): Tel. +1.413.585.2657 E-mail: Lmeinert@smith.edu

For SEG technical sessions, please see July 2003 SEG Newsletter, p. 40.

**SEG Distinguished Lecture Session**

**Distinguished Lecturer for 2003: Marco T. Einaudi**

**When:** November 3, 2003, Room 307/308, 12:15 – 1:15 p.m.

**Where:** Washington State Convention & Trade Center, Seattle, WA

**Presidential Address and Awards Ceremony**

**When:** November 4, 2003, Room 2B, 5:45 – 7:15 p.m.

**Where:** Washington State Convention & Trade Center, Seattle, WA

**Presidential Address by Jonathan G. Price**

Honoring

**Anthony J. Naldrett ..........Penrose Gold Medal**

**Richard H. Sillitoe ..........Silver Medal**

**Brian J. Skinner.............Marsden Award**
Foundation Announces Changes in Student Grants Program

Your SEG Foundation awarded Student Research Grants totaling $57,430 to 48 students last April, and SEG Canada Foundation awarded an additional C$12,500 in grants to seven students. Recipients are listed in the July Newsletter. Students receiving grants are required by U.S. tax regulators to submit a final report to us upon completion of their research project. Twenty students submitted final reports this year in the form of informative and publishable abstracts. These have been posted on the SEG website and can be accessed by clicking on “Student Research Grants.” Members are encouraged to review these results.

The Foundation has received generous financial support from several sources, and the SEGF Student Grants program may be expanded in 2004. In addition to the generous donation from Dick and Anne Wyman, additional gifts have been received from companies and individual for the newly established Alberto Terrones L. Fund. Grants to cover expenses for academic study and research will be awarded from this fund to students from Mexico, Peru, and other Latin American countries enrolled in North American universities. Funding now is sufficient to award at least one grant in April 2004 to a Latin American student studying economic geology or geologic engineering.

Newmont Mining Corporation has committed $45,000 over a three-year period to augment the Student Research Grants Program. This financial support is especially timely as it will replace the BHP Student Research Grant funds that are now exhausted. In April a total of $11,700 was awarded as grants to 10 students—a final distribution from the BHP funds. The Newmont Student Grants will allow us to maintain and perhaps increase the level of funding available for research grants in 2004. The Hugh E. Mckinstry Grants to support student research with a significant field component will remain at about the same level as in 2003. Grants for research in Arctic regions will be available from the Hickok-Radford Memorial Fund. Students planning to submit applications for any of the available grants will find information in this Newsletter and on the SEG website. Deadline for applications for all grants is February 1, 2004.

Friends and family of the late Timothy Nutt, who died tragically while carrying out field work in Eritrea have provided generous financial gifts to a Timothy H.C. Nutt Memorial Fund. Funds received are sufficient to begin a program of support in 2004 for SEG programs and activities in Zimbabwe and southern Africa. Colleagues of Tim in Zimbabwe will be working closely with Laurie Robb, SEG Regional VP for Africa, to determine the most effective use for these funds.

Your SEG Foundation president sat in on the August meeting of the SEG Investment Committee, and we are pleased to report that Foundation assets grew by about $360,000 during the second quarter of 2003, from about $3.5 million to $3.9 million. Total returns on our investment portfolio for the quarter were about 9.5%. These returns fell short of those experienced by the popular stock indices, which moved upward, propelled by robust price increase in equities that have little or no earnings. The SEG group does not invest in these types of volatile stocks.

It is a pleasure to acknowledge the 17 members who are celebrating their 50th year of membership in the Society. Each of these members has a record of distinguished contributions to our profession and support for the Society of Economic Geologists. Trustees and officers of the SEG Foundation join SEG members in warm congratulations to these long-time members. Congratulations also go to the 185 members who received their 25-year certificates in recognition of their continuing membership in the Society.

Finally, in this, my penultimate Newsletter column, I want to express appreciation to all members who have so generously contributed to the Foundation this year. Membership response to our letters and appeals has been generous and we certainly will exceed our fund-raising goals for 2003.

SEG Recognizes Long-Time Members

The Society and SEG Foundation congratulate the following long-time members who recently received certificates commemorating 50 years of SEG Membership:

- Dr. Alberto Benavides Quintana (SF-52)
- Mr. Otis M. Clarke, Jr. (SF-52)
- Dr. Donald L. Everhart (SF-52)
- Dr. Verne C. Fryklund, Jr. (SF-52)
- Dr. John W. Gabelman (SF-53)
- Dr. Thomas E. Gillingham (SF-50)
- Dr. William C. Gussow (SF-51)
- Mr. William P. Johnston (SF-51)
- Mr. Thor H. Kiligsgaard (SF-52)
- Mr. George E. Kruger (SF-52)
- Mr. Louis Moyd (SF-49)
- Dr. J. M. Cotelo Neiva (SF-52)
- Mr. James J. Norton (SF-52)
- Dr. Ernest L. Ohle (SF-50)
- Mr. Robert R. Reynolds (SF-52)
- Dr. Robert J. Wright (SF-51)
- Mr. Robert R. Reynolds (SF-52)
- Dr. J. M. Cotelo Neiva (SF-52)
- Mr. James J. Norton (SF-52)
- Dr. Ernest L. Ohle (SF-50)
- Mr. Robert R. Reynolds (SF-52)
- Mr. Glenn C. Waterman (SF-52)
- Dr. Robert J. Wright (SF-51)

We also extend congratulations to 185 members who recently received certificates in recognition of 25 years of Membership. Please see <www.segweb.org/25-50.htm> for complete list of names.
The Hugo Dummett Mineral Discovery Fund

(From inception to September 3, 2003)

- $10,000–14,999
  - BHP BILLITON, AUSTRALIA
  - LOUDON, GEOFF, GREAT BRITAIN
- $5,000–9,999
  - RIO TINTO, GREAT BRITAIN
- $1,000–4,999
  - CHARLES E. FIPKE FOUNDATION, CANADA
  - HUNTER DICKINSON, INC., CANADA
  - NEWMONT MINING CORP., USA
  - WMC EXPLORATION, USA
  - BALLANTYNE, GEOFF, USA
  - DOW, JOHN S., AUSTRALIA
  - HATTORI, KEIKO H. AND HEDENQUIST, JEFFREY, CANADA

- Up to $1,000
  - ASHTON MINING OF CANADA, CANADA
  - C.F. MINERAL RESEARCH, CANADA
  - GALLANT MINERALS SERV. LTD., GREAT BRITAIN
  - MEYER CREST LTD., USA
  - TAHIERA CORP., CANADA
  - DRAKE, KIMBERLY F., USA
  - GLOYN, ROBERT W., USA
  - KIRWIN, DOUG, THAILAND
  - KOUTZ, FLEETWOOD R., USA
  - LASKOWSKI, KEITH, GREAT BRITAIN
  - LINDOVIST, WILLIAM F., USA
  - MCDOWALL, JAMES J., CANADA
  - NIELSEN, RICHARD L., USA
  - OAKLEY, CHESTER, USA
  - PATTON, THOMAS C., USA

- $35,000–39,999
  - RICHARDS, JEREMY, CANADA
  - SHAVER, KENNETH C., USA
  - STAUNAWAY, KERRY J., USA
  - STAUNAWAY, KERRY J., USA
  - THOMAS, RODNEY N., CANADA
  - THOMPSON, JOHN, CANADA
  - WOOD, D.G., AUSTRALIA

Ivanhoe Mines announced that its Far North Zone discovery at the Turquoise Hill (Oyu Tolgoi) project in Mongolia will be renamed the “Hugo Dummett Deposit,” and the ensuing underground development will be known as the Hugo mine. Dummett, who died in a car accident in South Africa in August 2002, believed that the Oyu Tolgoi could become a world-class copper and gold mine. He was Executive Vice-President, Project Development, for Ivanhoe at the time of his death, and also was SEG president (2002-2003).

Far North is the largest of four deposits at Turquoise Hill and latest drilling results indicate a bornite-rich porphyry mineralization with high-grade copper and gold values within a highly mineralized quartz monzodiorite intrusion.
STUDENT RESEARCH RESULTS, 2003

Students who received Student Research Grants in 2002 or prior years from the SEG Foundation have recently completed the following 20 M.S. and Ph.D. projects. The research projects were supported by grants from the Hugh E. McKinstry (McK) Fund, the Hickok-Radford (H-R) Fund, the BHP Student Research (BHP) Fund, and the SEG Foundation (SEGF) general fund. The abstracts provide a survey of current ore deposit research at various university departments worldwide and give recognition to this new group of economic geologists. The abstracts are published in their entirety on the SEG website at <www.segweb.org/AbstractSummary 02.htm>.

- New data on the mineralogy and petrogenesis of the Jacupiranga carbonatites, Brazil, and the application to mineral processing. Paula R. Alves, University of Missouri-Rolla, USA [prayb4@umr.edu]. R.D. Hagni, advisor. M.S., McK.

- The geology and geochemistry of the Mammoth Breccia Pipe and its position in the Copper Creek mining district of southeast Arizona. Eric Anderson, University of Colorado, USA [ericanderson@Colorado.edu]. W.W. Atkinson, Jr., M. Alexandra Skewes, and Richard J. Goldfarb, advisors. M.S., McK.

- The geology and geochemistry of the high Au-Ag-Cu Pascua deposit, Chile-Argentina. Annick Chouinard, McGill University, Canada [annick@eps.mcgill.ca]. A.E. Williams-Jones, advisor. Ph.D., BHP.


- Topaz and cryolite equilibria in granitic systems: Implications for late-magmatic evolution and hydrothermal mineralization. David Doyle, McGill University, Canada [doles@eps.mcgill.ca]. Don R. Baker, advisor. Ph.D., McK.

- The role of chrome spinel in PGE fractionation in Archaean komatitites and ferropicrites. Marco Fiorintini, University of Western Australia [mfiorent@geol.uwa.edu.au]. William Stone, Mark Bailey, and Steve Beresford, advisors. Ph.D., McK.

- Sequence stratigraphic framework for the Siluro-Devonian host rocks, northern Carlin trend, Elko and Eureka Counties, Nevada. Roger A. Furley, Colorado School of Mines, USA [rfurley@mines.edu]. J.D. Humphrey, advisor. M.S., SEG.

- Application of field spectroscopy to mapping alteration related to mineralization in the Neoproterozoic carbonate-dominated terranes of the Otavi Mountainland, Namibia. B.D. Hansrod, South Dakota School of Mines, USA [no current e-mail available]. C.J. Paterson and E.F. Duke, advisors. M.S., McK.

- Metamorphic origin of ore-forming fluids for orogenic gold quartz vein systems in the North American Cordillera: Constraints from $\delta^{13}$C, $\delta^{15}$N, $\delta^{18}$O and Se/S. Yifei Jia, University of Saskatchewan, Canada [yij499@mail.usask.ca]. Robert Kerrich and Richard J. Goldfarb, advisors. Ph.D., McK.

- Age and genesis of the Alpenerscharte Mo mineralization, northern Tyrol, Austria. Klaus J. Langthaler, University of Leoben, Austria [no current e-mail available]. J.G. Raith, advisor. Ph.D., BHP.

- Selenium and other trace elements in Wolverine and Kudz Ze Kayah VMS deposits, Yukon. Daniel Layton-Matthews, University of Toronto, Canada [laytonmatthews@geology.utoronto.ca]. S.D. Scott, advisor. Ph.D., McK.

- Spatial and temporal relations between evolving fault orientation and mineral deposit type in the Atacama fault system, northern Chile. Desmond Leech, Kingston University, U.K. [dleech@Kingston.ac.uk]. P.J. Treolar, J. Grocott, and A.H. Rankin, advisors. Ph.D., McK.

- Brecciation within the Mary Kathleen Group of the Eastern Succession, Mt. Isa Block, Australia: Implications of district-scale structural and metasomatic processes for Fe-oxide-Cu-Au mineralization. Lucas J. Marshall, James Cook University, Australia [mlrucas@telus.net]. Nicholas H. S. Oliver, supervisor. Ph.D., McK.

- Ore forming processes in the BIF hosted gold deposit Musselwhite mine, Ontario, Canada. Alexander Otto, Freiberg University of Mining and Technology, Germany [otto@iml. rwth-aachen.de]. Ulrich Schwarz-Schampera, advisor. M.S., McK.


- The petrology and mineralogy of gold-containing sulfidized zones in black shales of the Kharbei potential gold-bearing area, Polar Urals, Russia. Nina S. Sokolova, Peoples’ Friendship University of Russia [ntrofimov@mx.pfu.edu.ru]. Nickolai Trofimov, advisor. M.S., McK.

- Volcanic and tectono-magmatic evolution of the Cadia-Neville region, Lachlan fold belt, Australia. R.J. Squire, University of Tasmania, Australia [r.squire@postoffice.utas.edu.au]. A.J. Crawford and J. McPhie, advisors. Ph.D., BHP.

- Structure and metamorphic setting of shear zone-related mineralization, Tulu Dimtu belt, Western Ethiopia. Gebremedhin Tadesse, University College Cork, Ireland [gebre_30@yahoo.com]. Alistair Allen, advisor. Ph.D., McK.

- The early Tertiary gold-rich La Plata volcanic-hosted massive sulphide (VHMS) deposit, Pichincha province, Ecuador. David Tripodi, University of Geneva, Switzerland [David.Tripodi@terre.unige.ch]. Massimo Chiaradia and Lluís Fontboté, advisors. M.S., McK.

- Inclusion assimilation and ore genesis along the Foy offset dike, Sudbury hypervelocity impact structure. Martin G. Tuchscherer, University of New Brunswick, Canada [mrlucas@telus.net]. John G. Spray, advisor. M.S., McK.
alignment of the Carlin trend reflects an apparent pre-existing zone of crustal weakness that transsects the present-day north-south trending Basin and Range topography.”

The bulk of gold in the Carlin trend is contained within the stratigraphic interval of the Silurian to Devonian Roberts Mountain and the Popovich Formations (Teal and Jackson, 1997; Peters et al., 1998). The environment of deposition of these formations ranges from inter- and supratidal to toe of slope and tidal shelf at the very top of the Popovich Formation (Armstrong et al., 1998). A large portion of the economic gold is restricted to a distinctive debris-flow breccia containing “mega-blocks” of over a meter in maximum dimension (Armstrong et al., 1998; Peters et al., 1998). The suitability of the Popovich Limestone as an ore host can be ascribed to diagenetic porosity resulting from early dolomitization of calcite (Armstrong et al., 1998) and probably intrinsic depositional porosity and permeability of the mega-block breccia.

Much of the gold is disseminated throughout the host rock, and is fine grained and typically encapsulated in arsenian pyrite, making the primary ore refractory. Gold ore is greatly enriched in As and also contains elevated Hg, Ag, Sb, Tl, and other elements, notably Pb and Zn. Primary hydrothermal alteration as manifested as deposition of quartz (commonly in fine-grained form as jasperoid, rather than in veins), as illite and kaolinite, and as dissolution of carbonate minerals. Ferroan carbonate dissolution may have been an important gold depositional mechanism (Stenger et al., 1998) and therefore the distribution of and controls on ore—presumably diagenetic—ferroan carbonate is of some interest. Using an analogy with the Lennard Shelf of Australia, Wilde and Muhling (2000) have suggested that the distribution of ferroan dolomite may have been controlled by early basinal brine emission along major rift-bounding structures that also controlled development of subeconomic Au-Pb-Zn and barytes deposits (as documented by Emsbo et al., 1999).

The full extent and distribution of hydrothermal channelways related to gold transport and deposition is poorly understood. A combination of vertical faults and intrinsic and reaction-enhanced permeability permitted access by hydrothermal fluids. The presence of relatively impermeable siliciclastic basin rocks thrust over the host sequence (Roberts Mountain thrust) is thought to have been important in focussing fluid flow as upward-moving fluids would have been retarded at this interface and spread laterally (Hofstra and Cline, 2000).

The chemical processes of ore formation involved hot (probably in excess of 200°C), reduced, and sulfur-rich fluids. Thus gold would probably have been transported as a reduced sulfur complex and deposited by a combination of cooling and neutralization (Hofstra and Cline, 2000). According to Hofstra and Cline (2000, p. 24), the ideal host-rock “consists of permeable ferroan carbonate that is completely dissolved and its contained iron completely sulfidized such that all that remains is gold-bearing arsenian pyrite.”

**REGIONAL SETTING OF THE CHINESE DEPOSITS**

The Golden Triangle is located at the southwestern margin of the Archean to Proterozoic Yangtze craton within the Phanerozoic Nanpanjiang basin (Fig. 1). Initiation of the Nanpanjiang basin was the result of Cambrian extension of the Yangtze Precambrian basement (e.g., Cooke, 1998). The sedimentary rocks of the Nanpanjiang basin range from Cambrian to Triassic in age, but the bulk of outcrop is of Permian and Triassic age. Triassic sedimentary rocks host most of the gold deposits in the region. Larger deposits lie at or close to the transition from carbonate platform facies (e.g., tidal flat and reef) to deeper-water siliciclastic basinal facies (Fig. 2). Buried rift-margin structures may have provided transient permeability and focussed fluid flow at various times (during reactivation) in addition to producing a major chemical contrast between basin sediments and platformal ones (Wilde and Muhling, 2000).

Major Carboniferous and Permian orogenic events are recognized in northeast Nevada, in which major thrust faults developed and basinal facies siliciclastic rocks were thrust eastward over platformal facies carbonate-rich rocks. Although thrust faults are interpreted in southwest China (e.g., at the Lannigou and Getang deposits) these appear to be related to Cretaceous compression and there is...
little evidence of major Carboniferous or Permian compressive tectonic events. On the contrary, a Permian extensional event (or events) has been inferred from the discordance between various Permian and Triassic units, and in places disconformable contact between Middle Triassic and Late Permian sedimentary rocks (Cooke, 1998). Support for an extensional event is provided by the alkalic basalt lavas and volcaniclastic rocks of the Emeishan Basalt, deposited at the early to late Permian transition. These basalts are associated with a few ultramafic pipes.

The major deformation event in the Nanpanjiang basin is the Late Cretaceous Yanshanian orogen (Li and Peters, 1998). This event produced small-scale folding and domal structures, with which gold deposits are commonly associated (Fig. 2). Apart from minor dikes, there is no associated magmatic activity (Li and Peters, 1998). Indeed, no large felsic intrusions of any age are known in western Guizhou province. This represents another major contrast with northeast Nevada where large volumes of felsic and mafic magma of various ages have been mapped.

Vitrinite reflectance measurements on organic material demonstrate a regional heating event in which temperature reached between 175° and 250°C (Ashley et al., 1991). The age of this heating remains in doubt, although Ashley et al. (1991) suggest that it predated gold emplacement. It seems likely that this heating event was the result of the Yanshanian compression.

**GOLD DEPOSITS OF THE GOLDEN TRIANGLE**

The largest gold deposit known in the Golden Triangle is at Lannigou (Fig. 2), which was originally discovered as a mercury prospect in 1986. Caution is required in specifying a gold resource for this deposit, owing to poor core recoveries and inability of the Chinese drill rigs of the day to drill other than vertical or steeply inclined holes. It is likely, however, that the Lannigou gold resource exceeds 1 Moz. Apart from a shallow oxidized zone that extends for a few meters only, the ore is considered to be refractory. This is one reason that the Chinese government permitted foreign access, as local technology for treating refractory ores is rudimentary.

Lannigou gold ore is found in cataclasite from near-vertical, northwest- to southeast-trending faults displacing Triassic clastic rocks, predominantly sandstone, siltstone, and argillite (Fig. 3). In primary (unweathered) ore, gold is fine grained and located within arsenian pyrite and arsenopyrite. Orpiment, realgar, cinnabar, and stibnite are also conspicuous and native mercury is being recovered by local tribes-people. Pervasive hydrothermal alteration and vein phases include quartz, chalcedony, illite, ankerite and calcite (Lou, 1998).

The main ore-hosting fault is interpreted as the result of compression although it has a complex history of reactivation (Lou, 1998). It is related to a domal feature attributed to the Cretaceous Yanshanian orogeny. A thrust fault has been identified to the west of the deposit, and has juxtaposed limestone with the top of the mineralized clastic rocks (Fig. 3). The limestone is not known to host significant gold. The thrust fault may, however, have influenced ore deposition by creating a permeability barrier above the mineralized Triassic rocks.

The Yata deposit (Fig. 2) is spatially restricted to vertical faults displacing open-folded Mid-Triassic Xinyuan Formation (Fig. 4; Ashley et al., 1991). The host rocks were originally carbonaceous ferroan-dolomite-rich shales and arkoses (Ashley et al., 1991). Of significance is the observation that ferroan dolomite and ankerite were partly removed during ore formation, supporting the idea that reactions(625,1027),(986,1085)

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**FIGURE 3.** Geology of the Lannigou gold deposit, Guizhou Province. From Chinese mapping.
common but probably postdate gold deposition (Ashley et al. 1991). Bulk-rock samples clearly show enrichment in As, Sb, Hg, and Tl.

The Getang deposit (Fig. 2) is hosted by the Early Permian Maokou and Late Permian Longtang formations (Ashley et al. 1991). Coal beds are present in both units. Structural control is less significant in localizing gold ore, which occurs preferentially within a pervasively silicified breccia horizon. The origin of the breccia is disputed with interpretations including sedimentary, karstic collapse and tectonic. Hydrothermal alteration phases include quartz, kaolinite/dickite, and mixed-layer illite-montmorillonite. Anatase of uncertain origin is abundant as is organic matter. Quartz veins, uncommon in the Carlin-type deposits of Nevada, occur in abundance in high-grade ore from Getang, along with calcite, fluorite, pyrite, and traces of arsenopyrite, stibnite, and sphalerite (Ashley et al. 1991). Realgar and cinnabar are also present in high-grade gold ore.

At the Sanchahe deposit (Fig. 2) gold is spatially associated with a reverse fault. Host rocks range in age from Late Permian to Early Triassic and include shale, siltstone, coal, and limestone. The highest gold grades occur in pervasively silicified limestone. Alteration minerals include illite, kaolinite and arsenian pyrite. Unusually high levels of anatase are also a feature of the host rocks at this deposit. Realgar, cinnabar, marcasite, barite, fluorite, and stibnite have been described (Ashley et al. 1991). The deposit is also enriched in Tl.

**DISCUSSION**

The host rocks to the Golden Triangle deposits and those of northeast Nevada are lithologically similar and share a similar evolution up until the Carboniferous. Gold deposits of both areas share a spatial association with a zone of transition between shallow water platformal sediments and deeper sediments with a stronger marine influence. This is believed to reflect the presence of profound and long-lived structures that focussed fluid flow from a large ‘catchment’ area during ore formation (Hofstra and Cline 2000; Wilde and Muhling 2000). Secondly, the transitional zone represents a substantial chemical gradient between generally reduced and sulfur-rich marine sedimentary rocks likely to favour gold dissolution and transport as aqueous bisulfide complexes, and carbonate-rich sedimentary rocks that might cause gold deposition through promoting pH change in the ore-forming fluids (Hofstra and Cline 2000; Wilde and Muhling 2000).

During the Carboniferous basin facies in Nevada were thrust back over the platformal sedimentary rocks to the east and began a quasi-continuous history of magmatic intrusion and extrusion that continued into the Quaternary. A consensus is emerging, based on a variety of dating techniques, that the Carlin-type gold deposits of northeast Nevada formed between 42 and 30 m.y. ago (see summary in Hofstra and Cline 2000). It has been postulated that this is due to the arrival of a mantle plume during crustal extension, while a direct link to felsic magmatism is yet to be proven (Hofstra and Cline 2000).

In southwest China there is evidence for a mild Permo-Triassic extensional event as deduced by Cooke (1998) and the presence of the Emeishan basalts may be an indication of a coeval mantle plume event. The introduction of gold, however, appears to be a later event, although there are no high quality absolute age determinations to support this contention. Whatever the real age of gold emplacement, there is no doubt that the role of felsic magmatism is minor and there is a singular dearth of felsic magmatic bodies of any age. Clearly, felsic magmatism played no part in the genesis of the Chinese Carlin look-alike deposits.

At the deposit scale, similarities between deposits of the two regions extend to the refractory nature of the gold, its fine grain size and location in arsenian pyrite and arsenopyrite, and relatively high As and Hg content of the ore (as arsenian pyrite, arsenopyrite, cinnabar, native Hg, realgar, and orpiment), as well as enrichment in Sb and C. Significant differences at deposit scale include the tendency for the Chinese deposits to be restricted to vertical faults in siliciclastic rather than carbonate-rich rocks (although comparable deposits do exist in Nevada, for example the Alligator Ridge deposits) and for them to be significantly smaller.

Why then are there no significant deposits in the Permian limestone of southwest China? If we accept the depositional mechanisms proposed by Stenger et al. (1998) and Hofstra and Cline (2000) the Permian limestone is a less than ideal host rock as it tends not to show secondary dolomitization. Another factor is the apparent absence of an impermeable seal or aquitard above the limestone that would have promoted fluid flow within the limestone sequence.

**CONCLUSIONS**

It has long been recognized that the Carlin-type or sedimentary rock-hosted gold deposits of northeast Nevada and southwest China share many common characteristics at deposit scale. The similarity of
alteration and ore assemblages is a clear indication that similar chemical processes occurred in both regions. However, there are also significant differences, particularly in their deformational and magmatic history. There is good evidence that the deposits of northeastern Nevada were generated during the Tertiary, a period of high heat flow accompanying extension and, perhaps, a mantle plume event. Although there is a need for high-quality, absolute dating of the Chinese deposits, the available evidence points to their association with Cretaceous compression. This leads to the proposition that a specific regional fluid flow regime (be it topography, deformation or thermally driven) is less important than the chemical characteristics of the host sequence and the local physicochemical controls on ore deposition.

Could the Golden Triangle host a cluster of deposits with similar gold endowment to the Carlin trend? There are three factors that suggest an answer to this question. First, the Golden Triangle lacks a large volume of the ideal host rocks (as defined by Hofstra and Cline, 2000). Secondly, the Gold Triangle presents an “inverse” hydrodynamic regime compared to the Carlin trend in that the aquitard or seal units (siliciclastics) are beneath rather than above the potential host limestone sequence. Thirdly, it is likely that the multiple deformation events and presence of intrusions as mechanical inhomogeneities in northeast Nevada have contributed to a greater overall porosity and permeability there, compared to the Golden Triangle. On the basis of these factors, it seems that the Golden Triangle is likely to be less well endowed with gold than Nevada.

REFERENCES
SEG COUNCIL ACTIONS
VANCOUVER, CANADA • May 24, 2003

The SEG Council held a specially constituted joint strategic planning meeting with the SEG Foundation and SEG Canada Foundation at the Sheraton Wall Centre Hotel in Vancouver, Canada, on May 24, 2003. Members of the Council present were the following:

J.G. Price1,2 (President and Chair), S.S. Adams, A. Arribas R., Jr., W.X. Chávez,1 Jr., V.S. Gillerman, R.J. Goldfarb, B.G. Hoal,2 D.A. John, D.E. Large, R.R. Large,1 J.P. Richards, and J.F.H. Thompson.2 SEG Foundation trustees present were the following: R.W. Hodder, G.G. Carlson2 (Canada Foundation President), A.P. Juhas, S.E. Kesler, G.E. McKelvey, R.L. Nielsen3 (Foundation President), J.A. Thoms, C.E. Vidal, and M.S. Enders. Guests in attendance were J.W. Hedenquist, C.E. Seedorff, and G.N. Phillips. President Price called the meeting to order at 8:15 a.m. The following actions were taken at the meeting:


2. Ratified the nomination of Ferenc Molnár (Eotvos Lorand University, Hungary) for Regional Vice President for Europe by the Vice President for Regional Affairs, Noel C. White.

3. Discussed the strategic plan recommended by the Executive Committee on April 2, 2003, which resulted in five successful amendments:
   - A. Arribas R., Jr. on the vision statement: “The Society of Economic Geologists is an international society committed to excellence in the science, discovery, documentation, interpretation, evaluation, and responsible development of mineral resources and to the professional development of its members.”
   - V.S. Gillerman on a rewording of part of the mission: “Encourage members to promote sustainable mineral resource production for the benefit of society.”
   - A. Juhas on adding to the mission: “Encourage, maintain, and support high standards in research, publications, and applications of the science of geology to mineral resources.”
   - C.E. Vidal on the inclusion of “Principles” from the 1997 Strategic Issues document and the addition of volunteerism as one of these principles.
   - J.G. Price on rewording of the goals under membership: “Recognizing contributions to the Society and to the study of mineral resources through SEG awards, medals, and lectureships,” and under governance: “Assessing and enhancing the effectiveness of SEG governance, financial management, committees, and headquarters staff.”

4. Approved feedback on strategies (three-year plans) by breakout groups under W.X. Chavez, Jr. (Membership), R.R. Large (Governance), S.S. Adams (Services and Products), J.G. Price (Outreach), and B.G. Hoal (Financial Viability).

5. Provisionally agreed on the composition of the following ad hoc committees to further study key issues related to the strategies:
   - Membership: W.X. Chavez, M.S. Enders, Jr., F. Molnár, C.E. Vidal, N.C. White
   - Mentoring Award: D.A. John, S.L. Garwin, G.E. McKelvey
   - Short Courses: R.J. Goldfarb, W.X. Chavez, R.L. Nielsen, J.P. Richards

6. Agreed that the Executive Committee finalize the ad hoc committee slates and chairs, and report back to the Council on revisions to the strategic plan.

7. Adjourned the meeting at 4:45 p.m. after confirming that the next regular business meeting of the SEG Council would take place at 2:00 p.m. on Monday, November 3, in Seattle, Washington.

1 Ex-Officio Member of the SEG Foundation Board of Trustees
2 Director of the SEG Canada Foundation Board
3 Ex-Officio Member of the SEG Council
Over 300 participants gathered for the 7th Biannual SGA Meeting held August 23-28 in Athens. Most who attended represented the academic sector but a number of industry geologists also participated. The SEG Symposium entitled “Exploring for Tethyan Ores: Development from Historic Roots” was part of the program and took place on August 26 in four sessions. All together, 21 talks and 10 posters were presented during the symposium, including 6 presentations (4 talks and 2 posters) by speakers from industry. The program aimed to summarize the newest achievements and reviews, both from academia and industry, about mineral deposits, mostly related to various Tethyan magmatic belts stretching between southeast Europe and Iran. Thirty-three papers on the subject of SEG symposium are published in the SGA conference proceedings (Mineral Exploration and Sustainable Development: Proceedings of the Seventh Biennial SGA Meeting, Athens, p. 1133–1256).

Two morning sessions that focused on southeast Europe started with a keynote presentation by Prof. Franz Neubauer, Salzburg University, who summarized the present state of our understanding about metallogeny in the Alps-Balkan-Carpathian-Dinaride orogen on the basis of the results of the GEODE-ABCD project. This paper was followed by a series of talks discussing origin, ages, and mineralogy of and exploration for mostly porphyry-copper and epithermal gold deposits in the ABCD region.

The first afternoon session was devoted to Tethyan metallogeny of Turkey and was introduced with a keynote presentation by Mesut Soylu, country manager of the Southern European Exploration Ltd. Talks about granitoid-related metallogeny of Turkey, VMS deposits of Turkey, and PGE potential of chromitites in Turkey followed.

The focus of the last part of symposium was the Tethyan metallogeny of Iran with reviews on the geodynamic context of formation of ore deposits and specific talks about porphyry-copper and gold deposits and a newly discovered giant Mississippi Valley-type base metal deposit.

The estimated attendance for the SEG symposium was between 50 and 80 conference participants (two other sessions were running parallel with the SEG sessions). The symposium generated some discussions among participants, especially in the field of future academic cooperation and about a need of a broad international cooperation (possibly an IGCP project) for comparison and better understanding of metallogeny in the western and eastern Tethyan systems. Delegates from both academia and industry considered the Tethyan symposium to have provided useful information on many aspects of metallogeny in the target area, and the event can thus be regarded as a success.

Student volunteers help out at the SEG booth in Athens, Greece, during the SEG-SGA meeting (pictured here are Krisztian Szentpeteri of Hungary, left, and Sophia Katsouri of Greece, right)
SEG-GAC-MAC Joint Spring Meeting
May 25–28 • Vancouver, British Columbia

Steve Rowins (SEG 1998 F)

After a 12-year hiatus, the Society of Economic Geologists once again joined forces with the Geological Association of Canada (GAC) and the Mineralogical Association of Canada (MAC) to present a superb geological meeting emphasizing the natural resources of the North American Cordilleran at the 2003 SEG-GAC-MAC joint spring meeting. More than 1,000 delegates attended the event, which was held at the newly built Sheraton Wall Centre in downtown Vancouver. The venue was stunning and well suited to accommodate the meetings 6 symposia, 27 special sessions, and 9 general sessions spread out over 3 days. The SEG directly sponsored or co-sponsored 1 symposium, 8 special sessions, 1 workshop, and 4 field trips. These ranged from a symposium on “Sustainable Development in the Mineral Resources Sector,” chaired by Jeremy Richards, to a special session on “Applications of Geophysical Inversions in Mineral Exploration,” chaired by Doug Oldenburg and John McGaughey. This latter session was linked to a hands-on SEG workshop given by Doug and Francis Jones on “Geophysical Inversions in Mineral Exploration.”

Other program highlights included SEG special sessions on “Ore-forming Processes in the Porphyry Copper-Gold and Epithermal Gold Environments” (chaired by Steve Rowins and Anthony Williams-Jones), “New Perspectives on the Evolution of Platinum Group Elements in Magmas and Ore Deposits” (chaired by James Scoates and David Peck), “Cutting Edge Exploration Techniques for Concealed Ore Deposits” (chaired by Ron Britten and Dick Tosdal), “Massive Sulphide Deposits on the Edge: Formation of VMS and SEDEX Deposits within Evolving Continental Margins” (chaired by Steve Piercey and Jim Mortensen), and “New Analytical Developments in Isotope Geochemistry” (chaired by Dominique Weis and Jim Mortensen). Many of these sessions were so popular that seating was at a premium, even in some of the larger 300-seat convention halls.

A special highlight of the meeting was the joint luncheon hosted by SEG and the GAC’s Mineral Deposits Division (MDD). At this luncheon, Nora Dummett was presented with a special award from the SEG and BHP-Billiton on behalf of her late husband, Hugo Dummett, past president of the SEG and a pioneer in diamond exploration and mine development in Canada. The award presentation coincided with a SEG special session honoring her late husband, entitled “Canadian Diamond Deposits: History and Techniques of Their Discovery—A Tribute to Hugo Dummett.” Well-known Vancouverites Felix Kaminsky and Don Mustard chaired the session, which was attended by many of Hugo’s friends from the diamond industry.

For those whom simply couldn’t get enough economic geology during the 3-day meeting, there was a slate of superb pre- and post-meeting mineral deposits field trips coordinated by the over-worked Dave Lefebure of the British Columbia Geological Survey (just renamed the Geosciences, Research, and Development Branch). Vans and buses full of geologists headed off to destinations that included the volcanic massive sulfide deposits at Myra Falls on Vancouver Island, the Highland Valley porphyry copper deposits, several plutiniferous deposits in southern B.C. (Sappho, Afton), and a variety of base- and precious-metal deposits in southeastern B.C. (e.g., Rossland, Greenwood, and Hedley).

A real benefit of this joint scientific meeting was the opportunity it provided to showcase and promote the discipline of economic geology to a much wider audience than is normally reached by specialist meetings. Many GAC and MAC members came away with a much better appreciation of the issues facing the mineral exploration and mining industry, and how both applied and pure research in economic geology was applicable, in many cases, to their own research programs. The large number of co-sponsored symposia and special sessions was a testament to this cross-fertilization of ideas.

I would like to thank all those SEG, GAC, and MAC volunteers who helped to make this joint meeting a great success. A personal note of thanks to Dirk Tempelman-Kluit (SEG Technical Program Chair) and Ron Britten (SEG Deputy Chair) whom continued to answer my e-mail messages and phone calls right up to the very end. Given the resounding success of this meeting, I am confident that we will not need to wait for another 12 years before having another joint meeting with the GAC and MAC!
The 2003 UNESCO-SEG Metallogeny Course held at the Universidad Central de Ecuador on June 1–14, 2003, was attended by 55 participants, including 37 non-Ecuadorians (Peru, Argentina, Chile, Colombia, Mexico, Cuba, and Brazil were represented, in order of numbers that Latin American Ph.D. students currently in the United States, Canada, and Australia). Twenty-eight attendees received support from the Swiss Agency for Development and Cooperation (SDC-KFPE), UNESCO, SEG and the Universidad Central. The group was a good mixture of industry (17), academia (28), and geological surveys (10).

Topics covered in the 2003 edition included tectonomagmatic controls on porphyry and epithermal deposits in the central Andes (Jeremy Richards, University of Alberta, 2003 SEG International Exchange Lecturer); epithermal deposits (Jeff Hedenquist, Colorado School of Mines), structural controls on epithermal deposits (Peter Lewis, Vancouver), overview of lead isotope signatures and metallogeny of Ecuador (Massimo Chiaradia, Leeds, UK; Bernardo Beate and Arturo Eguez, Universidad Politécnica, Quito); the Nambija gold skarns (Lluís Fontboté, Agnès Markowski, Jean Vallance, Geneva, Switzerland, and Massimo Chiaradia, Leeds, UK), and the Zaruma-Portovelo intermediate sulfidation gold deposits (Richard Spencer, IAMGOLD, Quito). Participants received, in addition to the printed course notes, a CD-ROM with most of the presentations in Powerpoint and as pdf files.

After six days of classroom sessions in Quito, 33 participants attended a one-week field trip to the Nambija gold skarns, the Zaruma-Portovelo gold deposits (where we were host of IAMGOLD), and the Au-rich VHMS deposit of La Plata, currently owned by Sultana del Condor Minera. The field guide, including abundant graphics, is accessible at the course website, <http://www.unige.ch/sciences/terre/mineral/ore/min_ore.html>.

The metallogeny course is about to undergo major changes. It will now travel around Latin America, so that training available in this part of the world will be even more extensive. Other benefits will be the access to a larger pool of lecturers as well as many new fields to visit. In addition, there should be opportunities for increased support from companies located in each host country, not to mention support from rotating host institutions. The designated 2004 international course coordinator, Fernando Tornos (IGME, Salamanca, Spain), is in contact with several centers of economic geology in the southern part of the region. Expressions of interest in hosting the UNESCO-SEG Metallogeny Course for future years are welcome.

As coordinator of the 2003 edition, I would like to especially acknowledge the Universidad Central de Ecuador for its 22 years of hosting, in Quito, the “Curso Internacional de Postgrado en Metalogenia,” supported by UNESCO (and since 1999, also by SEG), as well as all instructors, sponsors, and companies that have made the course possible. Last but not least, I would like to thank the 55 participants for the interest and enthusiasm expressed by their endurance of the very long classroom program (sessions from 8 a.m. to 7 p.m.).

Contact addresses and further information on past and future editions of the UNESCO-SEG Metallogeny Course can be obtained from the web page, <http://www.unige.ch/sciences/terre/mineral/ore/min_ore.html>.
The Society of Economic Geologists was a sponsor of the IGCP-473 field symposium in the northern Xinjiang Uygur Autonomous Region, northwestern China, from August 9 to 21. This specific IGCP project is focused on “GIS Metallogeny of Central Asia,” and the aim of this year’s symposium was to develop an improved understanding of the “Paleozoic Geodynamic Processes and Metallogeny of the Chinese Altay and Tianshan.” The area is a remote region of extensive base and precious metal mineral resource potential, but with little detailed economic geology described as yet in the western literature. Hence, the symposium attracted significant interest from workers in both industry and academia, with attendees from Australia, Canada, China, Japan, Kazakhstan, Kyrgyzstan, Mongolia, Russia, South Africa, United Kingdom, and the United States.

A pre-field conference included numerous presentations on some of the more important mineral deposits from both the Altay and Tian Shan. Talks by local experts covered the Paleozoic evolution of the region (Li Jinyu), regional metallogeny (Dong Lianhui, Wang Denghong), strata-bound Pb-Zn ores (Wang Jingbin), porphyry copper and epithermal deposits (Qi Kezhang), ore genesis models (Chen Yanjing), and the newly discovered Tuwu Cu-Mo porphyry deposit (Liu Dequan).

There were also a number of broader presentations on metallogeny elsewhere in China, in central Asia, and in other Phanerozoic collisional belts throughout the world. Many of the ore deposits in the Altay and Tianshan are typical of those found in many of the world’s better-studied collisional belts. Thus, the SEG distinguished lecture presented by Yasushi Watanabe on subduction zone dynamics and metallogenic evolution in Chile and Japan was particularly relevant. SEG was also represented by Rich Goldfarb, who presented his Thayer Lindsley lecture on “Metallogenic evolution of collisional orogens: The Alaskan example.”

Subsequent to the conference, an entire week was spent visiting the varied types of deposits within the Neoproterozoic through Permian terranes, which were accreted in the middle to late Paleozoic to the southern margin of the Siberian craton and which now define the southern part of the Chinese Altay. The long drive north from Urumqi, the capital of Xinjiang, to the town of Fuyun, in the Altay foothills, crossed the eastern side of the immense Junggar basin and provided some spectacular views of the glaciated northern Tianshan.

On the outskirts of Fuyun, we examined the zoned mafic and ultramafic rock-hosted Kelatongke Ni-Cu deposit. The ca. 280 Ma disseminated and massive ores, mainly hosted by norite, are estimated to have reserves of 0.4 Mt of Cu and 0.2 Mt of Ni based upon average ore grades of 0.488% Ni and 0.309% Cu. Other excursions from Fuyun included a visit to the famous Keketuohai rare metal deposit, where a large pegmatite system was mined between 1935 and 1996. Significant debate among the field trip participants focused upon whether the deposit was actually mined for resources such as Li, Ta, and Nb, or rather for uranium and beryllium for the old Soviet nuclear program (beginning at a time when Xinjiang was known as the Republic of East Turkestan). In addition, it was obvious that an abundance of isotopic ages spread from middle Paleozoic to Jurassic for the main zone pegmatite needed to be further evaluated before the age of the deposit could be accepted with any degree of certainty.

Devonian volcanic rocks in adjacent Kazakhstan host economically significant VMS deposits and it has long been recognized that this belt is permissive for similar ores in northern Xinjiang. Near Fuyun, we visited the small-scale Koktal Pb-Zn deposit (3 Mt of Pb + Zn @ 3.16% Zn, 1.51% Pb) and the large open pit of the Mengku Fe deposit (110 Mt of ore with 23.9-57.6% FeO), both within the...
belt of Devonian rocks. Controversy at both deposits included whether these were indeed VMS systems, or perhaps a manto-like and skarn deposit, respectively. However, as the trip moved to the northwest, continuing within the Devonian rocks, there was little doubt that the Ashele copper deposit was a significant VMS orebody hosted by mafic volcanic rocks. The deposit, discovered in 1984, contains 900,000 t Cu (@2.3% Cu) and 400,000 t Zn (@2.7% Zn), with significant gold and silver. A large underground mining operation should begin by next year at Ashele.

Two orogenic gold deposits, Saidu and Duolanasayi) were also visited within the more western part of the southern Altay. These deposits of probable late Paleozoic age are presently each recognized as containing perhaps 200,000 to 300,000 oz Au and are yielding a few thousand ounces of gold each year. However, additional resource potential may exist in the deposits and in surrounding areas. In fact, gold placer workings from the 1970s and 1980s are found along many of the rivers in the southern Altay. From the southwestern Altay, a lengthy two-day journey across the western Junggar basin took most participants to the western Tianshan and a visit to the 50-t Au Axi gold deposit, the largest gold deposit in northwestern China and the 8th largest gold producer in China. These Early Carboniferous low-sulfidation epithermal veins and breccias have been yielding about 40,000 oz Au/year since mine start-up in 1995. Although not visited, smaller high sulfidation epithermal gold deposits are scattered elsewhere in this region.

This field symposium was collectively recognized as a successful and productive program by all attendees, in large part due to the outstanding organization by Mao Jingwen from the Chinese Academy of Geological Sciences, many of Dr. Mao’s colleagues at the academy, and their collaborators from the Xinjiang Bureau of Geology, Exploration, and Development. Visits to outstanding geological exposures and ores in this frontier region of China, were mixed with wonderful cultural experiences that included dances with the colorful local Uighur people, sampling of the varied local cuisine and brands of Maotai, and a trip to Kanas National Park centered around China’s deepest glacial lake. Much of our present understanding of the economic geology of this prospective region is detailed in a new book published for the symposium on “Tectonic Evolution and Metallogeny of the Chinese Altay and Tianshan” (Mao, Goldfarb, Seltmann, Wang, Xiao, and Hart, eds., 2003, IAGOD Guidebook Series v. 10, 282 p.). The book is available from CERCAMS at the National History Museum in London (R.Seltmann@nhm.ac.uk).
The South African Student Chapter of the Society of Economic Geologists (SAS-SEG) had its inception in 1993 at the University of Cape Town but was dormant through much of the decade. Recently several students from Rand Afrikaans University (RAU) and the University of the Witwatersrand (Wits) reactivated the chapter and moved it to the Gauteng province.

At the Student Geocongress 2003 held at the University of the Orange Free State in Bloemfontein, 24–27 June, SAS-SEG was quite active. The meeting was sponsored by numerous mining or mining-related organizations, including SEG. During the conference, approximately 85 undergraduate and postgraduate students from universities and technikons throughout Africa (Angola, Ghana, South Africa, Zambia, and Zimbabwe), the United States, Britain, and India presented talks on the research occurring at their universities. Conference keynote speakers covered topics ranging from geoarcheology to forensic geology; however, most of the presentations, keynote and student alike, focused on economic mineral deposits or the minerals industry. Among the more noteworthy student presentations of the meeting was an award-winning overview of the reclamation processes occurring on the Central Rand mine dumps of the Witwatersrand gold field in Johannesburg, presented by Fred Mphephu of Wits. Also noteworthy was a presentation by Chiluba Lunda, University of Zambia, on the sedimentology of the Chambishi Cu deposit of the Zambia Copperbelt, which sparked considerable discussion.

SAS-SEG also sponsored an exhibit booth that highlighted many of our current and upcoming activities, as well as the benefits of joining not only SAS-SEG, but SEG, as well. As a direct result of its presence at the conference, the chapter signed up 19 new chapter members, including several individuals from Zimbabwe and Zambia, with interest shown by Ghana, Zambia, and Zimbabwe. Special thanks to Benny Chisonga (RAU), Libby Sharman-Harris (Wits), and Kaydy Pinetown (University of the Orange Free State/Wits), who all helped run the booth.

SAS-SEG is planning several exciting future events, including (1) talks by Nic Oliver, James Cook University, and Murray Hitzman, Colorado School of Mines; (2) a geologic field trip to the mineral deposits of the eastern Limpopo and northeastern Mpumalanga provinces; and 3) a symposium co-organized with the Mineralogical Association of South Africa (MINSA) and the Paleoproterozoic Mineralization Group, Rand Afrikaans University.

For more information on SAS-SEG, contact either Craig McClung (ggy4@na.rau.ac.za) or Charlie Seabrock (seabroc@science.pg.wits.ac.za).

Craig McClung, SAS-SEG President

For information and a listing of SEG student chapters, see our website: <http://www.segweb.org/Studentchapters.htm>
SEG Student Grants Available in 2004

Students of mineral resources throughout the world may apply for grants to be awarded in 2004 by the Society of Economic Geologists Foundation and the Society of Economic Geologists Canada Foundation. Awards provide partial support of graduate studies leading to master’s and doctoral degrees although support may also be provided for exceptional B.S. Honors or B.S. Titulo degree projects.

Grants from several funds and endowments are for specific research expenses, although the Alberto Terrones L. Fund, in addition to research expenses, may be used to defray any bonafide costs such as tuition and other costs related to a regular graduate study program in applied economic geology. Grants from the Hugh E. McKinstry Fund are awarded to support research with a substantial field component. The Hickok-Radford Fund provides support for research in challenging arctic or subarctic conditions. The Newmont Grants support research on gold deposits—their geology, mineralogy and metallogeny. The Alberto Terrones L. fund promotes studies at U.S. and Canadian universities by Mexican, Peruvian and other Latin American students. Grants from the SEG Canada Foundation promote work by Canadian or foreign students on mineral deposits or districts in Canada; foreign projects at Canadian universities; foreign students studying at Canadian universities; or Canadian students doing research at foreign universities. Applicants are considered for all awards.

Individual grants usually range from US$500 to US$3,000, but larger awards may be made to particularly meritorious candidates. Awards are competitive and are intended to fund specific expenses related to thesis research. Applicants must describe what the project is, why the research is important, and how it is to be done, along with a budget summary. In addition, those requesting financial support for non-research expenses from the Alberto Terrones L. Fund will need to submit a separate letter describing the need and purposes of such request.

Contact for application forms and more information:
Chairman
SEG Student Research Grants
7811 Shaffer Parkway
Littleton, CO 80127, USA
Tel: 720-981-7882 ext. 204; Fax 720-981-7874;
E-mail: seg@segweb.org;
<http:www.segweb.org/StudentGrants.htm>

Applications must be postmarked by February 1, 2004. Awards will be announced by April 30, 2004.
Jean S. Cline

Jean Schroeder Cline is a professor of Geoscience at the University of Nevada, Las Vegas. Her research is centered on understanding the evolving pressure-temperature-chemistry of hydrothermal mineral systems. Work has focused on Carlin, porphyry, and epithermal deposits.

Jean grew up in Wisconsin and attended Wisconsin State University-Platteville in the Upper Mississippi Valley lead-zinc district. Underground mines still operating in the late 1960s and early 1970s provided great opportunities for mineral collecting and, along with stories of mineral exploration from Jean’s advisor, W.A. Broughton, they sparked an interest in economic geology. After obtaining her BS degree, Jean moved to Arizona and went to work for Inspiration Development Company, the exploration subsidiary of Inspiration Consolidated Copper Company. She spent the next 11 years exploring for base and precious metals, primarily in the western United States.

The downturn in the economy during the early 1980s caused Inspiration to close its exploration offices and Jean went back to school at the University of Arizona to pursue a master's degree under the direction of Spencer Titley. With a goal of returning to the exploration industry, she obtained funding from Sunshine Mining Company and studied alteration and fluid inclusions at the 16-to-1 deposit, a small epithermal silver-gold deposit near Silver Peak, Nevada.

After completing her MS degree, Jean moved east to continue studying ore deposits at Virginia Polytechnic Institute and State University with Robert Bodnar. Her PhD research included numerical modeling studies that quantified silica deposition from boiling hydrothermal solutions, and potential copper mineralization precipitated by crystallizing calc-alkaline melts. The latter study concluded that “typical” calc-alkaline intrusions could produce economic porphyry copper systems, indicating that process, rather than magma composition, determines whether or not a porphyry system is economic. A third project utilized fluid inclusions to track the evolution of hydrothermal fluids in the Questa, New Mexico, molybdenum deposit. This study demonstrated that high salinity, metal-bearing fluids can exsolve directly from crystallizing melts and do not require aqueous fluid immiscibility.

Upon completing her PhD in 1990, Jean (gleefully) returned to the western United States to accept an assistant professorship at the University of Nevada, Las Vegas. The move facilitated continued research on Carlin-type gold deposits, begun while Jean was at VPI, with Bill Bagby of the U.S. Geological Survey. This project evolved into a lengthy and productive opportunity to study the Getchell deposit in north-central Nevada with Getchell Gold Corporation and, more recently, with Placer Dome. The fine-grained ore and gangue minerals and overprinting of multiple hydrothermal events in most Carlin-type systems have made identifying processes of gold deposition challenging. Ore-stage minerals at Getchell, however, exhibit textures and contain tiny but useable ore-related fluid inclusions that are revealing conditions of ore fluid evolution and mineralization.

Jean and her students continue to study Getchell and other Carlin-type deposits in an effort to construct a viable model for the genesis of Nevada’s Carlin systems. Graduate students are currently working with Barrick Goldstrike geologists to constrain ore fluid characteristics at the giant Goldstrike deposit on the Carlin trend. Jean’s work on Carlin deposits has benefited from collaboration with Al Hofstra of the U.S. Geological Survey, and has led to publication of a summary article in the SEG Reviews in Economic Geology Volume 14, Gold in 2000.

During the late 1990s Jean was invited to resolve an ongoing debate as to whether or not geologically recent upwelling hydrothermal fluids had invaded the proposed Yucca Mountain, Nevada, nuclear waste repository site. Nick Wilson, now with the Canadian Geological Survey, joined the project as a postdoctoral fellow. Nick and Jean, with a small team of UNLV graduate and undergraduate students, applied traditional “ore deposit” research methods to provide a detailed time-temperature history of secondary minerals at Yucca Mountain. The study demonstrated that aqueous fluids with temperatures that averaged 50°-60°C were present at Yucca Mountain more than 5 m.y. ago and that these fluids decreased in temperature with time. The study further determined that during the past 2 to 3 m.y., the Yucca Mountain site was infiltrated only by fluids of ambient temperatures.

Current research, in addition to ongoing Carlin studies, includes a project to identify magmatic-hydrothermal processes responsible for economic mineralization.

PROPOSED PRESENTATIONS INCLUDE THE FOLLOWING:

1. The genesis of Carlin-type gold deposits—current models and future research;
2. Upwelling hot water at a proposed nuclear waste repository? An economic geology approach to solve an environmental question;
3. Fluid inclusion petrography: an under-utilized tool in characterizing geologic environments;
4. Investigating Carlin-type gold systems past and present – and lessons for the future.

Dr. Cline is available for spring through summer 2004.

Requests for lectures should be addressed to Christine A. Horrigan, Traveling Lecturers Secretary, at SEG: e-mail, christinehorrigan@segweb.org, tel. 1.720.981.7210 (direct), fax: 1.720.981.7874, Society of Economic Geologists, 7811 Shaffer Parkway, Littleton, CO 80127.
François Robert was born in Montreal, Canada, where he obtained his Geological Engineering (1978), M.Sc. (1980), and Ph.D. (1983) degrees from the École Polytechnique. His Ph.D. focused on the geological, structural, and hydrothermal characteristics and evolution of the Sigma gold deposit in the Abitibi greenstone belt. In 1984 he spent a year as postdoctoral fellow at the University of Michigan, carrying out a fluid inclusion study of the same deposit.

In 1985, François joined the Geological Survey of Canada as a research scientist with the mineral deposits group. The next 12 years he spent working on gold deposits in Canada and abroad. His research focused largely on the geology, structure, and settings of lode gold deposits in a variety of deformed terranes, with a particular emphasis on greenstone belts. This led him to examine a large number of gold deposits in Precambrian terranes around the world. For one year (1990–1991) he was at the CRPG in Nancy, France, working on fluid inclusion studies and related to auriferous vein microstructures. In 1990, he received SEG’s Lindgren Award.

In late 1997, François moved to industry, accepting a position with Barrick Gold Corporation as senior research geologist attached to head office. He assisted with the geologic understanding of selected Barrick projects and participated in project evaluations worldwide. In 2002, he joined Barrick’s Australian exploration team as Chief Geologist, the position he currently holds, with project generation as one of his main responsibilities.

François will be offering four lectures, three on greenstone gold deposits and one on Carlin-type gold deposits. All lectures will place significant emphasis on geologic features of gold deposits and their settings. As such, they are suitable for a wide range of geologic audiences, although the first two talks will be more technical. François is also prepared to give a short informal presentation on the role of external research in a large gold exploration company.

The four lectures are as follows:

1. **Gold-quartz vein field of the Val d’Or district of Abitibi: A type example of a synorogenic system**
   
   The well-documented gold-quartz veins of the Val d’Or district will be used to illustrate the key features of these classic deposits and the key relationships used to determine the structural controls and processes of vein formation, and their timing and setting in a regional context. This will also provide a basis to review the fundamental elements of the classic “rogenic-meso-thermal” gold deposit model.

2. **Giant gold deposits of the Abitibi greenstone belt and related models**
   
   Characteristics of giant Abitibi deposits and their setting will be reviewed to illustrate the spectrum of deposit styles and structural timing. This will provide a basis for addressing the question of genetic models for greenstone gold deposits, linked to the question of whether the observed diversity relates to variations in depth of emplacement of a single deposit type or to the existence of different deposit types formed at different times and crustal depths. The question of distinguishing features of large vs. small deposits will also be considered.

3. **A comparison of gold deposits in the Abitibi (Canada) and Eastern Goldfields (Australia) Archean greenstone terranes**
   
   This presentation will compare and contrast the geology, evolution, and gold deposits in these two well-endowed gold provinces.

4. **Geology and setting of gold deposits of the north Carlin trend, Nevada**
   
   This talk provides a review of the geologic architecture and evolution of the north Carlin trend, and of the nature, timing, and structural controls of Carlin-type gold mineralization in that district.

A travel schedule for the 2004 lectures is not determined at this point. However, François will be available for lectures at Australian and possibly southeast Asian universities in the first part of the year. He will present lectures in other parts of the world throughout the year as he travels between Australia and Canada.

Requests for lectures and information should be addressed to Christine A. Horrigan, Traveling Lecturers Secretary, at SEG: e-mail, christinehorrigan@segweb.org, tel. 1.720.981.7210 (direct), fax: 1.720.981.7874, Society of Economic Geologists, 7811 Shaffer Parkway, Littleton, CO 80127.
Yasushi Watanabe was born and raised in Kyoto, Japan, and subsequently attended Hokkaido University, from which he received a B.Sc. degree in geology in 1982. For his thesis, Yasushi studied sedimentary and deformational processes in a Miocene strike-slip basin in central Hokkaido. The following three years he studied at the university with Gaku Kimura and Sumio Miyashita.

After completing his studies in 1985, Watanabe joined the Geological Survey of Japan (GSJ), working as a scientist in the Hokkaido Branch of GSJ in Sapporo from 1985 to 1992. During this period, he was engaged in a metallogenic study of epithermal deposits in Hokkaido with Junkichi Yajima and Eijun Ohta, as well as geologic, stratigraphic, and structural studies that led to compilation of 1:200,000 and 1:500,000 geologic maps of Hokkaido. He received the Research Encouragement Prize from the Society of Resource Geology in 1992 for papers on Neogene metallogeny of southwest Hokkaido.

In 1992, Watanabe moved to Tsukuba, the head office of GSJ, to join the Department of Mineral Resources, after a year of administration work in the Research Planning Office. He completed his metallogenic study in the southwestern Kuril arc, under the supervision of Shunso Ishihara, and was awarded the Ph.D. degree from Hokkaido University in 1996. He expanded his interest from epithermal to porphyry and plutonic environments in order to understand the complete range of magmatic-hydrothermal systems. He and his colleagues Jeffrey Hedenquist and Yukihiro Matsuhisa worked on a cooperative project from 1996 to 1998 between the Corporación Nacional del Cobre de Chile and Metal Mining Agency of Japan (MMAJ) on the El Salvador porphyry Cu deposit. Since then Yasushi has focused his studies on an improved understanding of the relationship between regional tectonics and mineralization style.

Following the reorganization of GSJ in 2001, Yasushi has worked at the Institute for Geo-Resources and Environment (IGRE), AIST, one of the five institutes formed from the previous GSJ, and in 2003 he was appointed leader of the Mineral Resource Group. Since 2001 Watanabe has investigated the genetic relationship between the Toyoha Ag-Pb-Zn vein deposit and the nearby Muine calc-alkaline andesite volcano in northern Japan. He is presently working on the project “Study of Hydrothermal Deposits and Metallogeny in Western Turkey” with geologists of the General Directorate of Mineral Research and Exploration of Turkey.

Watanabe has been a member of editorial boards of the Society of Resource Geology, Geological Society of Japan, and Association for Geological Collaboration in Japan. He also contributed to several MMAJ grassroots exploration projects in Japan, and has served as a scientific advisory board member of this Agency. He has been seconded as a lecturer and/or technical expert to several Japan International Cooperation Agency projects related to the evaluation of mineral potential. These include technology-transfer projects in Honduras (1991–1994), Mongolia (1997–1999), Vietnam (2000), Morocco (2000–2001), Mauritania (2002–), and Argentina (2003–).

TALKS OFFERED BY YASUSHI WATANABE INCLUDE THE FOLLOWING:

1. Neogene metallogeny of the Japanese islands;
2. The Muine-Toyoha magmatic-hydrothermal system, northern Japan: Lessons for exploration in calc-alkaline volcanic fields;
3. Hydrothermal alteration patterns over the El Salvador porphyry copper deposit, Chile;
4. Plate tectonic settings for porphyry deposits.

Dr. Watanabe is available for talks May through December 2004.

Requests for lectures should be addressed to Christine A. Horrigan, Traveling Lecturers Secretary, at SEG: e-mail, christinehorrigan@segweb.org, tel. 1.720.981.7210 (direct), fax: 1.720.981.7874, Society of Economic Geologists, 7811 Shaffer Parkway, Littleton, CO 80127.
Two Papers on The Use of Hyperspectral Airborne-Satellite Imagery in Mineral Exploration

Two recent papers, “Utility of high-altitude infrared spectral data in mineral exploration: Application to northern Patagonia Mountains, Arizona,” by Berger et al. (2003), and “Mapping hydrothermally altered rocks at Cuprite, Nevada, using the Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER), a new satellite-imaging system,” by Rowan et al. (2003), make a distinctive mark on the use of airborne and satellite hyperspectral imaging as an exploration tool.

These two papers deal with imaging of the Earth’s surface using the visible (0.4 µm) to near infrared (2.5 µm) part of the electromagnetic spectrum to map various mineral species. Depending on their structure and molecular bonding, minerals reflect and absorb the electromagnetic spectrum in unique ways. A large group of minerals have distinct electromagnetic signatures that make it possible to identify them from imaging systems that map the range of the electromagnetic spectrum between 0.5 and 2.5 µm.

These papers represent two distinct approaches. The first paper, by Berger et al., discusses the use of the AVIRIS (Airborne Visible Infrared Imaging Spectrometer) scanner, which provides high-resolution reflectance measurements in the spectral domain (224 channels between 0.4 and 2.45 µm) and variable spatial resolution (20 m), dependent on aircraft altitude. The second paper, by Rowan et al., discusses the use of the ASTER satellite scanner, which offers a limited range of spectra at three spatial resolutions (15, 30, and 90 m). ASTER measures reflectance radiation in 3 bands within the 0.52- to 0.86-µm range (visible-near-infrared) at 15-m spatial resolution, and 6 bands between 1.00 and 2.43 µm (short wave infrared) at 30-m spatial resolution. Emitted radiation is measured in 5 bands between 8.125 and 11.650 µm (thermal infrared) with a 90-m spatial resolution.

The main advantage of the AVIRIS sensor is the level of spectral detail, which provides accurate measurements of reflectance and absorption features of minerals that enables detailed mineral mapping. Its main disadvantages, however, are the extensive processing required to make the reflectance spectra useful, and its limited spatial coverage and acquisition cost based on programmed flights. In contrast, the main advantage of the ASTER sensor is that it measures key portions of the visible, near-infrared, and thermal infrared spectra of minerals for large-scale mapping projects, whereas its main disadvantage is that the data represent only portions of the electromagnetic spectrum and some minerals cannot be distinctively mapped. In addition, the lower spatial resolution in the near- and thermal infrared portions of the spectrum makes it more difficult to map at detailed scales.

These two papers represent significant advances in the use of these imaging tools to map out specific mineralogies related to mineralization processes. One of the challenges mapping minerals from hyperspectral imagery is the ability to distinguish different mineral species that are mixed together within a given pixel. This is done by comparing a given pixel or group of spatially contiguous pixels with laboratory reference spectra of minerals. A spectral analysis procedure is used to evaluate the degree of match of each pixel’s spectrum to specific mineral reference spectra. From the results of the analysis, mineral species can be identified probabilistically.

The paper by Berger et al. covers detailed mineral mapping over two concealed porphyry copper deposits in the northern Patagonia Mountains of Arizona. Distinctive hydrothermal alteration mineralogy had been previously mapped in the field, which principally consisted of iron-oxide leached cap. The hyperspectral survey data were combined with airborne aeromagnetic data, digital elevation data, mineral occurrence data and digital geological maps. The paper documents a thorough comparison of the minerals mapped by the AVIRIS scanner with those from field mapping programs and the aeromagnetic data. In the Red Mountain porphyry deposit three alteration zones were identified from field mapping: quartz-sericite-pyrite, pyritic-argillic, and propylitic. The AVIRIS scanner was able to identify the same principal alteration zones but the spatial distribution of the zones differed from the field maps in a few areas. These differences have been attributed to errors in field mapping and the AVIRIS results clearly provided more information. However, in some cases the AVIRIS scanner was not able to identify alteration assemblages due to the fine-grained nature of the material and other mineralogies, which interfere with the detection of the specific reflectance and absorption characteristics. In addition, vegetation cover and the effects of slope, aspect, and relative position of the sun, as shown by the digital elevation data, have an effect on the capture of the mineral spectra. The leached cap, rich in iron-oxide, is clearly identified from the AVIRIS spectra, and iron-oxide and iron-sulfate minerals are easily identified. However, because of factors such as degree of crystallinity, composition, and structure, not all mineral species can be identified unambiguously.

The authors conclude that mineral mapping using AVIRIS data produces cost-effective results in large areas of exposed bedrock and successfully identifies different mineral assemblages within areas of hydrothermal alteration.

The second paper, by Rowan et al., has used the Cuprite area of Nevada to test the ability of ASTER data to identify various alteration and mineralization assemblages. The Cuprite site is well known for testing hyperspectral scanners and abundant literature exists on the mineralogy of the area. The paper makes a comparison of the ASTER data with a previously flown AVIRIS dataset over the same area. Bands 1 to 9 (0.52 to 2.43 µm) were...

Commentary on Journal Papers

Economic Geology — An Invited Commentary on Journal Papers

Eric Grunsky
Mineral Resources Division, Geological Survey of Canada, 601 Booth St., Ottawa, ON K1A 0E8, Canada
used to identify key mineral assemblages that characterize alteration and host rock types.

Minerals associated with hydrothermal alteration include alunite, kaolinite, opal, dickite, pyrophyllite, calcite, boudinonite, muscovite, montmorillonite, and jarosite, an assemblage indicative of advanced argillic alteration. These minerals are commonly known as hydroxyl-bearing based on the Al-O-H, Mg-O-H, Si-O-H and CO\textsubscript{3} molecular bonding. These bonds display significant absorption features in the visible and near-infrared spectra. Because the ASTER spectra represent only selected parts of the visible to near-infrared spectral profile that can be obtained from ground-based or AVIRIS spectrometers, the ability to resolve differences among several mineral species is reduced. Nonetheless, the ASTER spectra can clearly identify minerals that are typically associated with the hydrothermal alteration.

Mineral mapping using hyperspectral tools is not new to the exploration industry. Larger exploration companies have been using this methodology for several years and a few companies have invested heavily in developing scanners for their own exploration programs. These two papers, as contributions to *Economic Geology*, represent acceptance of these methods as an important tool for exploration and we can expect to see many more contributions describing case studies over deposits and developments in hyperspectral technology.

**REFERENCES**


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**Industry Commentary**

*This is the second in the Industry Commentary series, a regular feature that is not peer reviewed but is edited. To volunteer a Commentary (~1,000 words), please contact the Technical Editor directly.*

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**My Fault? — No Way!**

Noel C. White, (SEG 1993 F), white.noel@bigpond.com

Ever since the crash in exploration and mining investment in 1998 the minerals industry has been blamed for destroying wealth. This accusation comes from investment analysts, brokers and financiers, and even some senior industry managers and explorers. We in the industry are being told this in a way that suggests it is our fault. Some geologists take this accusation seriously, and wonder what they have done that is so wrong. Most people seem to accept that the accusation is true, and we are, indeed, to blame; I do not hear one voice raised in protest. I say it is NOT true, and when we are accused of being responsible for this situation, it is a case of the perpetrators blaming the victims.

It is certainly true that minerals industry has mostly not returned good profits. There is nothing new in that; it has always been the case. The attraction of the industry for investors has been that some mines make a bonanza; they forget that many barely break even, or else lose money. Some investors in mining and exploration shares make huge profits as the share price rockets up; but equally, many lose their money when it plummets again. Mining and exploration have always been an investment gamble, a characteristic that brokers appreciate and profit from.

But the main issue, the big club that is used to beat us over the head, is that there is too much money invested in minerals production that does not earn a good return. This is certainly true. But how does it happen, and are geologists responsible?

Take a newly discovered deposit that looks like it might be economic. Company geologists, usually after years of exploration, have worked hard to get the data required to evaluate the deposit. Do those explorers and project geologists make the decision that development should proceed? Certainly not! Data pass into the hands of engineers and metallurgists for calculations and assessments. They design a mine, estimate mining, metallurgical, and capital costs, etc., etc—things crucial to the eventual outcome. One hopes the geologists that have been involved in assessing the resource are participants in this process, but often they are not.

What the engineers and metallurgists do is not science; it involves assessments and estimates for which a call has to be made somewhere between optimistic and pessimistic extremes. As this process advances, finance people get more involved: “What is this going to cost? Where can we get the money?” Corporate managers are not passive players in this. They exercise judgment and demand answers from technical staff, ideally in the interests of all shareholders, and presumably are uninfluenced by the impact on their own performance reviews, salaries, or bonus. If the company managers decide it’s in someone’s interest for the project to go ahead, the problem of raising the capital follows.

Mostly companies do not use their own money to pay for major development projects—they go to the market. The commonest source for money is a loan from a financial institution, or through the sharemarket, in which case the company managers deal with broking firms that can underwrite the capital raising.

Financial institutions do not lend money out of the goodness of their hearts—they do it because they can profit. Lending money is risky business, and if...
they go ahead it is because they expect the risk will pay off and they’ll not only get their money back but make a substantial profit, as well.

If capital is raised through the market, the same applies to the brokers. They charge a fee for the service and expect an arrangement in which they also act as the share broker (for a price) and have access to a parcel of discounted shares they can sell to clients (for a fee and profit).

Of course, anyone involved in financing a project is bound to check that the project is, in fact, viable. But viability in this context means that they will get their money back and make a profit. It has nothing to do with being viable in the longer term for shareholders. So anyone providing finance has a vested interest in encouraging projects that look as though they will survive at least for as long as it takes to recoup the investment and make a profit. Longer-term viability is not a concern.

For the lenders it is relatively simple: if the project collapses before they have extricated themselves, then the company’s assets will be sold to get their cash back. If it is successful (for them), they have first access to any returns generated by the project, and collect their capital and profit. Once they have collected their return they have no further obligations. They encouraged the project, approved it, financed it, made it possible, and in most cases they walk away with full pockets and clean hands.

It is a bit more difficult for the brokers if financing has been done through equity. Certainly, they make their profit, but it can return to bother them. If they encouraged someone to buy your shares, and it turns out to be a bad investment, then they have an unhappy client. The agent has still made his profit, but he gets some blame from his client, and naturally he tells his client that it is not his fault. Again, the brokers approved the project, encouraged it, made it possible, and in most cases made a lot of money from it. But they place blame for any failures with the industry.

I do not suggest that the industry is blameless in this. What I do say is that the people who point the finger at us, saying it is OUR fault, are themselves equally or more to blame. When the analysts point their fingers at us, there is nothing we can do that will change the situation. Why not?

In issuing a prospectus for a new shoe factory, the financial assessment is fairly straightforward. There is not a lot of blue sky for a broker to promote stock. But a mining venture is a different story. There is a lot of guesswork in the figures, so a lot can be done to dress figures up to look great. Whatever the industry itself does, it is surrounded by and has to deal with people who make a lot of money out of promoting investments and developments, even ones that are not viable in the long term. That is the environment we operate in. How are we in the industry supposed to change that?

Another issue is that the way companies are managed has changed, mainly in response to pressure from investment funds. Investment funds have vast amounts of money, and they want to get the best return they can. Fund managers are assessed on a three-month basis, so they are only interested in short-term results. Fund managers wield great power and can be very interventionist. Companies that need to borrow capital have changed their management approach in response to the demands and expectations of fund managers. Company managers are now appointed to produce high returns in the short term. Their performance targets are set high, with big bonuses for achievement. Naturally, they respond by making decisions based on short-term outcomes, which is a big problem in an industry characterized by long lead times. There are many examples where these short-term performance goals have led to the high grading of deposits and deferment of mine development work to the detriment of the long-term viability of the orebodies. Also to be considered is that a decision to develop a new mine may be look good during a period of high metal prices, but will it still look good, long-term, in periods of average or low prices?

The attraction of the minerals industry for investors has always been the hope of big returns. Only a few minerals companies can provide that.

Whatever we in the industry do, share brokers and investment analysts will continue to promote speculative shares, and financiers will continue to encourage developments based on short-term attractiveness, not long-term viability. Blaming geologists for the situation the industry faces is preposterous. Geologists are typically at the bottom of the data-gathering chain leading to project viability decisions. The problem is not that the geologists have failed to provide the essential information required for correct decisions; rather, people higher in organizational hierarchies are often driven by motives that are unrelated to technical information. Moves to educate geologists in mineral economics would be relevant if geologists made the economic decisions, but they do not.

It is also commonly claimed that exploration is too expensive and we must become more efficient. The fact is that we have been too successful, and too much has been found and brought into production, and so real prices have declined. Does that make explorers inefficient, or are we the victims of our own success? There is also a long list of deposits that have been found by explorers but have not yet been developed because they are not economic. In periods of high prices many of them will be financed, promoted, and developed, and will suffer the fate of many others when prices inevitably fall again, thus continuing to make the situation worse.

With company profit margins being squeezed, it is essential to maximize efficiency, but to accuse explorers of inadequacy because of a situation that has arisen solely because of their being too successful is unreasonable. We are caught in a vicious circle where our success puts us under increased pressure to be even more successful with less. We must accept that pressure, but we should reject false accusations that the situation is somehow solely the fault of the industry or geologists. Our industry is accused of destroying billions of dollars in shareholder funds. In fact, they were destroyed by irresponsible and overly enthusiastic financiers, fund managers, and share brokers—the minerals industry was simply the vehicle they used to do it.
ALASKA
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Despite a slow start to the field season, Alaska activities have increased to levels not seen since the heady days of the mid-1990s. As a consequence, we should see an abnormal number of projects reporting the good, the bad and the ugly in September and October. Why is this happening? How about gold prices pushing $375/oz, platinum prices topping $700/oz and continued strength in the price for copper, nickel and silver? How about a realization by producers large and small that exploration funding has not kept pace with production increases over the last five years? How about the fact that the venture capital markets also have twigged to this same realization and the corollary that properties of merit that are held by junior exploration companies will be in increasing demand in the near future? The current macro-mining picture is an odd one: a strong metal strength in the price for copper, nickel and silver? How about a realization by producers large and small that exploration funding has not kept pace with production increases over the last five years? How about the fact that the venture capital markets also have twigged to this same realization and the corollary that properties of merit that are held by junior exploration companies will be in increasing demand in the near future? The current macro-mining picture is an odd one: a strong metal

EXPLORATION REVIEWS

Kinross Gold announced second-quarter results from its Fort Knox-True North operations. The combined operations produced 101,425 oz of gold at a total cash cost of $241/oz compared to 89,553 oz of gold at a total cash cost of $253/oz during the second quarter of 2002. Gold recovery was 83% compared to 85% in the year previous period. Exploration drilling outside of the current ultimate pit boundary on the western side of the deposit produced encouraging results.

Teryl Resources Corp. discovered previously unrecognized gold mineralization at the Old Glory prospect on its Westridge prospect in the Fairbanks district. Rock samples from reconnaissance work returned values up to 0.29 oz Au/ton and the best results from the auger drilling samples assayed 1,155 ppb gold. The company indicated that the Old Glory zone might represent a significant new intrusive-related gold discovery. The company also indicated that rocks similar to those at the nearby 1.3 Moz True North deposit had been discovered at the company’s Black Dome prospect and was the subject of rock sampling to determine if significant gold mineralization was present.

Western Alaska

Teck-Cominco’s Red Dog mine saw higher throughput and ore grades in the second quarter compared with a year ago, resulting in smaller but still significant $3 million loss during the quarter. For the quarter, the mine generated 142,100 tonnes (t) of zinc in concentrate and 30,200 t of lead in concentrate versus 136,200 t and 26,300 t in the second quarter of 2002. The mine sold 97,500 t of zinc during the second quarter.

Northern Dynasty Minerals announced initial core drilling results at the Pebble property copper-gold project near Iliamna. Results from the first 18 holes within and adjacent to the main Pebble deposit include 91 m grading 0.53 g gold per t, 0.81% copper and 0.027% molybdenum in hole 3071, for example. This drilling effort identified at least four areas that host higher-grade mineralization that appears to be continuous and open to substantial expansion. Three of these areas are within the Pebble deposit proper while the fourth is outside. An additional 30,000 ft of core drilling is slated for completion in 2003.

NovaGold Resources reported results on economic assessment of the Rock Creek deposit near Nome. The resource at Rock Creek is estimated at measured and indicated resources of 6.4 Mt that contain 555,000 oz of gold and an additional inferred resource of 2.9 Mt that contain 303,000 oz of gold using a 1.0 g/t cutoff grade. The project economics are based on the purchase of an all-new mining fleet, construction of a gravity/flotation mill and a gold price of US$325/oz. At Rock Creek, an 8,000-m drill program on the project has been initiated for infill and pit definition to upgrade the inferred resources to the measured and indicated categories in preparation for a feasibility study in 2004. A total of 2,556 m of core drilling has been completed since the program began this spring.

St. Andrew Goldfields indicated that a $500,000 diamond drilling program is scheduled for the Nixon Fork mine near McGrath. The program will consist of 8,000 m of underground drilling designed to upgrade existing resources to reserve status, delineate additional resources and test several targets with potential to add resources to the operation in the future.

Ventures Resource Corp. planned an early-August startup of drilling at their Flat gold property in SW Alaska. The program was to consist of approximately 4,000 ft of core drilling at the Golden Apex and Divide gold targets. The Golden Apex is located 6,000 ft NE along strike from high-grade gold-bearing structures previously identified at the Divide prospect. Results at the south edge of Divide include 4.5 ft grading 6.1 oz Au/ton in core and 5 ft grading 2.89 oz Au/ton in a trench. This summer’s program will drill test the extent of these northeast-trending structures. Results from last summer’s program at Golden Apex shows soil values defining three northeast-trending gold anomalies up to 2,700 ft long × 200–1,000 ft across. Gold values range up to 1,805 ppb.

Geocom Resources announced that core drilling was imminent on its Iliamna copper-gold porphyry project west of Lake Iliamna. The Tundra Telegraph has confirmed that drilling was underway. The area was staked because of the D1-6b geophysical anomaly’s size, strength, and similarity to the geophysical signature of Northern Dynasty Minerals’ Pebble deposit. Because younger, postmineral rocks cover the Iliamna project area, there are no surface geologic or geochemical data available.
Geologix Explorations completed initial exploration at its Macomb gold prospect in northern Alaska Range. Drill targets were selected based on geophysical work and gold in soil geochemical anomalies. Three diamond drill holes were unable to penetrate the glacial till overburden which is at least 120-m thick. A fourth drill hole tested a lower priority target and indicated sporadic low level gold values scattered throughout a 15-m-wide altered and faulted structural zone.

AngloGold USA and partner Rimfire Minerals began work on their ER and Eagle gold projects in the Goodpaster district. Work at ER is designed to drill test a 1,500 Y 300 m gold-arsenic-bismuth-antimony soil anomaly outlined in 2002. The anomaly is coincident with a structural contact between gneissic country rock and a Cretaceous intrusive. Work at Eagle will consist of additional soil auger sampling to expand a 1,500 Y 3,000 m soil anomaly that also appears to be related to the contact between gneissic country rock and younger intrusives.

**ALASKA RANGE**

Nevada Star Resources acquired the Summit Hill prospect on its MAN copper-nickel-platinum group element project in the central Alaska Range. These claims were staked to cover a strong annular magnetic anomaly of approximately 7 miles diameter. The anomaly was identified by an airborne magnetic survey recently released by the Alaska Division of Geological and Geophysical Surveys. Limited sampling from a magnetite-rich showing within the area of the anomaly returned 1.58% nickel, 1.07% copper, 300 ppb platinum, 484 ppb palladium and 110 ppb gold. The company believes that the anomaly is caused by mafic to ultramafic gabbro and pyroxenite that are cut by a granitic intrusion that is reflected by the nonmagnetic core of the anomaly. There is potential for metal enrichment within the mafic rocks adjacent to the contact zone in the area of the strongest magnetic zone. Plans for the new claims include prospecting, mapping and geochemical sampling, followed by geophysical surveys and drilling. The company also announced start-up of phase two work on its MAN copper-nickel-platinum group element property in the central Alaska Range. The planned August-September program was slated at $1.25 million and will be focused on their Canwell and Rainy prospects.

**Golconda Resources** began drilling on their Shulin Lake diamond project west of talkeetna. Drilling will test a 1.5-km diameter circular topographic feature that could represent a volcanic center related to the mantle-derived diamond indicator minerals found in previously collected surface samples. Previous drilling of 15 holes intersected a mixture of sandy material derived from the Alaska Range and volcanic material derived from a nearby source. Lab results showed the existence of indicator minerals in these rocks and one interval from hole 10 contained 16 micro diamonds.

The 60th anniversary of Usibelli Coal Mines was celebrated in late July at an open house at the company’s mine site near Healy. Upward of 1,500 people showed up for the event which included dedication of the newly opened Two Bull Ridge open pit and a chance for visitors to watch the Ace in the Hole dragline and other heavy equipment working in the pit. The hosts were wonderful, the occasion auspicious and the rain let up long enough to make the entire day enjoyable. Thanks UCM!

**NORTHERN ALASKA**

Little Squaw Gold Mining Co., a venerable name in Alaska’s lode mining history, has taken on a new life under new management and looks to become more active in the future. The quartz lodes were last worked from 1979 to 1983, when 8,169 oz of gold was recovered from 11,819 tons averaging 0.97 oz Au/ton. Gold is hosted in mesothermal quartz veins along four major east-west–striking shear zones that cut Paleozoic age quartz-mica schist and calcareous schist. Individual structures, known as the Mikado, Summit, Little Squaw and Envelope, are 2 to 5 miles long and frequently extend over 100 ft in width. Plans are being formulated for future work by the company’s new management team consisting of names that are welcome and familiar here in Alaska: Dick Walters, Jackie Smith, Jim Duff and Riz Bigelow.

**SOUTHEAST ALASKA**

Kennecott (70.3%) and Hecla (29.7%) announced 2nd quarter 2003 production from the Greens Creek mine on Admiralty Island. The total cash cost/oz of silver at Greens Creek for the quarter was $1.00, a forty-five cent/oz decrease compared to the 2nd quarter of 2002. The average grade of ore mined during the quarter was 19.11 oz/ton, down slightly from the 20.07 oz of silver per ton averaged in the same period in 2002. During the second quarter the mine produced 2,800,891 oz of silver, 27,268 oz of gold, 7,144 tons of lead and 22,657 tons of zinc. Total production costs for the quarter were $3.66/oz of silver produced, a significant decrease over year previous figures.

Coeur d’Alene Mines signed a memorandum that should speed development and reduce regulatory costs at its Kensington deposit north of Juneau. Signers of the agreement were the Alaska Department of Natural Resources, U.S. Forest Service, U.S. Environmental Protection Agency, and Army Corps of Engineers and outlines roles and responsibilities of the agencies with respect to the project’s final Supplemental Environmental Impact Statement. The company anticipates receiving all necessary permits for Kensington by the end of January 2004, and plans to reach a final decision on developing the mine after completion of the permitting and a feasibility study update.

Pacific North West Capital and JV partners Freengold Ventures and
Lonmin PLC began drilling and other exploration work at their Union Bay platinum project in the Ketchikan district. An additional 394 claims have been staked in the project area, increasing the size of the existing project by 100%. North zone drilling began while surface channel sampling has been completed on the Jaguar zone where rock types are similar to those at the North zone.

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The United States Bankruptcy Court has approved St. Lawrence Zinc Company’s purchase of the Balmat zinc mine (St. Lawrence County, N.Y.), for $20 million, to be paid out of production, if that ever happens. Apparently, there are no immediate plans to reopen the mine.

ARIZONA

Abington Ventures recently completed four holes at the Verdstone property in Yuma County. The Verdstone deposit contains three stacked zones of gold-silver mineralization, and a newly discovered area of epithermal gold. Mineralized intervals encountered in drilling are several tens of feet thick containing 0.0X opt Au, with narrower intervals of 10 ft, or less, with grades of >0.10 opt Au, up to 0.50 opt Au.

CALIFORNIA

Emgold Mining Corp. has started a surface core-drilling program at the Idaho-Maryland mine, inside the city limits of Grass Valley (Nevada County). Drilling is designed to test for new high-grade gold-quartz veins within the western portion of the property. Rumor has it the Emgold received an extremely favorable contract since the drill crews are able to walk to work and buy a latte on the way. It is also rumored that one of the helpers has filed to run for governor in the coming recall election.

Western Goldfields is working toward purchasing Newmont’s Mesquite mine (Imperial County), although no information has been released about the closing. Is Western Goldfields just looking to become a short-term gold producer, or do they have an interesting exploration idea?

IDAHO

Sterling Mining Company announced that it has signed a lease with an option to purchase the Sunshine mine (Shoshone County). Initial exploration will focus on surface geochemical and geophysical surveys between the Sunshine Mine and the Silver Summit shaft, with an eye toward near-surface drill targets. Apparently, there has been little previous surface exploration in this area.

Beartooth Platinum Corp. is renewing exploration interest in its Friday-Petsite and Buffalo Gulch properties near Elk City (Idaho County). Beartooth reports that Friday-Petsite contains a resource of 16.7 million tons (Mt) with an average grade of 0.0318 opt Au and Buffalo Gulch has a resource of 5.0 Mt with an average grade of 0.023 opt Au.

MONTANA

Russia’s Norilsk Nickel has received approval from U.S. regulators and shareholders to purchase a majority stake in Stillwater Mining Company.

Sterling Mining Company (of Montana, not to be confused with the company of the same name in Idaho, see above) received a favorable Record of Decision for the Rock Creek project (Sanders County). The plan is to build a 10,000-ton-per-day underground silver-copper mine. The deposit contains a resource of 136.6 Mt with an average grade of 1.67 opt Ag and 0.74% Cu. The news release gave no indication as to what happens next. So, let the law suits begin.

Apollo Gold resumed production from Montana Tunnels (Jefferson County). During the second quarter of 2003 1.1 Mt of ore was processed, along with concurrent stripping. The news release also states that “the Company does not currently have the financing to complete the stripping required in the mine plan,” meaning that additional funding is required to maintain production.

Montana Resources announced the re-opening of the Continental Pit (Silver Bow County), which has the capacity to produce 40,000 t of copper, 10 million pounds of molybdenum, and 1 Moz of silver annually.

NEVADA

NDT Ventures Ltd. recently completed a 13-hole reverse circulation drilling program at its CC project (Churchill County). The target was a 5-ft-wide gold-quartz vein associated with hanging-wall and footwall stockworks, and splay veins. Drilling tested about 1000 ft of the vein’s strike. The best interval was 12 ft of about 0.10 opt Au.

Midway Gold reported that a recently completed drilling program in the Enterprise zone contains a 60-ft interval, from 290 to 350 ft, with an average of about ½ oz gold per ton of rock. The Enterprise zone is about 2,000 ft south of the Discovery zone at the Midway project (Nye County).

Cortez joint venture continues to explore the newly discovered Cortez Hills deposit (Eureka County). The announced resource contains about 38.5 Mt (measured and indicated) with an average grade of about 0.10 opt Au, and an additional inferred resource of 17.3 Mt with an average grade of about 0.05 opt Au. The deposit is still open along strike and to the west.

Midway Gold signed a letter of intent to option the Spring Valley property (Pershing County). Previous drilling by Kenneecott and Echo Bay identified a stockworks gold-quartz vein deposit in Permo-Triassic Rochester Formation rhyolite below 50 to 200 ft of alluvium. Mineralization intervals occur in rhyolitic volcanic and volcanoclastic units. Previous drilling identified intervals of greater than 100 ft with average grades in the 0.03 to 0.06 opt Au range.

X-Cal Resources reported results from the remaining three holes of the four-hole program drilled below the West Wood pit at the Sleeper mine (Humboldt County). The best hole contains a 185-ft interval of 0.128 opt Au. The other two holes contain 15 ft of 0.156 opt Au and 35 ft of 0.106 opt Au.

Metallic Ventures completed a 10-hole reverse circulation drilling program at the Tom Keane project, which is about 7 miles southeast of Gemfield (Esmeralda County). The holes were drilled into a silicified northwest-striking structural zone that contains anomalous gold. Mineralized intervals ranged from 5 to 145 ft, with grades mostly in the 0.02 to 0.04 opt Au range. The maximum value is 75 ft of 0.084 opt Au.

At Metallic Ventures’ Esmeralda gold property in the Aurora mining...
district (Mineral County), underground drilling along the Prospectus vein encountered a new high-grade gold shoot. Eight holes have intersected thicknesses of 7 to 20 ft with grades between 0.03 and 1.07 opt Au. More drilling is planned to define the size and grade of the shoot.

Vista Gold has released new resource estimate for of the Hasbrouck and Three Hill projects (Esmeralda County). An indicated and inferred resource at Hasbrouck is 28,460,000 t with an average grade of 0.022 opt Au. The indicated resource at Three Hills is 5,736,000 t with an average grade of 0.023 opt Au.

American Bonanza Gold Mining Corp. drilled a 4,200-ft hole below the Gold Bar mine (Eureka County), which encountered weakly anomalous gold, silver, and arsenic over significant lengths. About one-half of the hole averaged 20 ppb gold, which is a generous use of the phrase weakly anomalous. The hole ended in fractured and altered Lone Mountain Dolomite, which may overlie the Roberts Mountain Formation. A plan is being formulated to continue the hole with core to test the Roberts Mountain Formation for gold mineralization.

Remember the Pan property (White Pine County), which has been shopped since about 1980? Castleworth Ventures recently completed 21 drill holes (5,565 ft total), several of which encountered gold zones with values that are higher than previously encountered on the property. Three separate targets have been identified: Pilot Ridge, Syncline, and Red Hill. The best hole in the new round of drilling at Pilot Ridge contains 525 ft with an average grade of 0.037 opt Au, at Syncline 60 ft with an average grade of 0.057 opt Au, and at Red Hill 125 ft with an average grade of 0.06 opt Au.

Pacific Ridge Exploration completed a 10-hole 5,000-ft drilling program at Golden Arrow (Nye County). One hole of note contains 210 ft of 0.045 opt Au with two five foot intervals of 0.52 opt Au and 0.71 opt Au. This hole apparently confirms the down-dip extension of the Gold Coin East vein to a depth of 350 ft.

Imperial Metals has completed the release of the new drill hole results at the Sterling mine (Nye County). The 17 holes extended the strike length of the 144 zone to 750 ft, from 500 ft. The most significant interval is in hole 41, which contains 30 ft of 0.12 opt Au.

Three reverse circulation rigs are drilling at the newly discovered TZN zone in Section 7 at the Marigold mine (Humboldt County). Glamis Gold states that the mineralization is relatively deep, but intersections are in excess of 100 feet thick. Mineralization is oxidized, above the water table, and appears to be amenable to run-of-mine heap leaching. The grade of this mineralization appears similar to that currently being mined at the property.

UTAH

The Bingham Canyon copper mine (Salt Lake County) entered its second century of production this year. Since startup over 17 Mt of copper have been produced, with associated other metals such as gold, silver, and molybdenum.

ASIA

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CHINA

Caledon Resources announced in August the completion of a joint venture agreement concerning the Gaolong and Badu gold deposits in northwestern Guangxi Province, southern China. Both areas have a history of active gold mining. The main target area is the Gaolong mine.

Griffin Mining raised approximately US$2 million in the middle of 2003 in order to advance exploration on their Caijiaying polymetallic project, located 300 km northwest of Beijing in Hebei province. Griffin expects to complete a feasibility study in order to construct a zinc-gold mine and processing facilities at Caijiaying in the near future. The Caijiaying zone hosts 10.56 Mt @ 11.6% Zn (COG=7% Zn), including 2.6 Mt @ 6.78 g/t Au (COG=3 g/t Au). The project is held by Griffin Mining through its wholly owned Australian subsidiary, China Zinc Pty Ltd.

Minco Mining & Metals Corporation has entered into a co-operation Agreement with the Bureau of Metallurgical Exploration of Sichuan Province, and has the right to earn a 75% interest in the Caodi gold project, located in the west end of the Qinling gold belt. The Caodi Gold License covers an area of 45 sq. km where extensive trenching, aditting and over 1,400 m of diamond drilling in 8 holes by the Sichuan Bureau of Metallurgical Exploration has identified an oxide resource of 10.3 Mt @ 2.57g/t Au.

Southwestern Resources has generated attention with its Boka gold project (Southwest Resources 90%, local interest 10%) located 110 km north of Kunming in Yunnan province, where the company has identified a new gold system. Currently 11 known gold zones exist within the Boka project, all of which occur within a 25-km-long structural zone. In August, Southwestern was drilling at the project and reported an interesting intersection of 88.65 m @ 3.1 g/t Au in hole B03-07 between 257.6 m and 346.25 m characterized by quartz-carbonate stockwork. Southwestern can earn 90% of a 190.8 sq. km area from China Yunnan Province Nuclear Industry Team 209 by spending US$4 million over a 4-year period and making a payment of US$1.7 million in cash and common shares of the Company in the fourth year.

Pacific Minerals reported in May the latest results of ongoing infill drilling on their JBS Pt-Pd-Ni project located approximately 200 km west of Kunming in Yunnan province. Better results included 2.9 m @ 1.53 g/mPt, 2.11 g/mPt Pd, 0.17 g/mAu, 0.19% Cu, 0.24% Ni, 0.01% Co and 9.1 m @ 2.82 g/mPt, 3.74 g/mPt Pd, 0.41 g/mAu, 0.26% Cu, 0.33% Ni, and 0.02% Co. As soon as US$1 million has been spent on the JBS project, Ivanhoe Mines Ltd would have the option to acquire half of Pacific Minerals 70% interest by completing a feasibility study, and could increase its interest to 50% by financing the project into production. If the second option was exercised, Pacific Minerals would retain a 20% carried interest.

Pacific Minerals also resumed its surface-drilling program at the 217 Gold Project, Inner Mongolia, in July. Drilling is intended to increase the size and grade of the currently delineated, near-surface gold deposit. An independent
resource estimate in March confirmed a near-surface deposit containing measured and indicated resources of approximately 35 Mt @ 0.848 g/t Au (0.6 g/t Au COG). An inferred resource of 85 Mt @ 0.928 g/t Au at the same cutoff was also reported.

Pacific Minerals has also recently entered into agreement with Chinese organizations in both Yunnan and Guizhou provinces to earn interests of 70% and 75%, respectively, over exploration areas totalling approximately 4,500 km² in the two provinces and favorable for “Keweenawan native copper”-style mineralization. Under each of the agreements, Pacific Minerals will earn its respective interest by providing US$4 million in capitalization to the Joint Venture companies within 3 years.

Vancouver-based SKN Resources entered into a letter agreement with Gansu Non-Ferrous Metals Geological Bureau (GNGB) covering an area totalling approximately 52 km² in the Xibe area of Gansu province. Previous limited trenching of the area by GNGB identified the presence of gold mineralization.

**INDONESIA**

Kalimantan Gold reported in July the discovery of four separate zones of Cu-Ag-Au mineralization at their Baroi prospect, which is part of the Beruang Kanan CoW (Kalimantan Gold 75%, Government of Indonesia 25%) located in central Kalimantan. Channel sampling of the 8-km-wide Baroi intrusion returned interesting results including 9 m @ 14% Cu, 11 g/t Ag, and 0.11 g/t Au; 9 m @ 4.53% Cu, 71 g/t Ag, and 0.11 g/t Au; and 12 m @ 2.25% Cu, 10 g/t Ag, and 0.14 g/t Au. Mineralization is hosted by an andesite porphyry characterized by argillic alteration and quartz stockwork. Kalimantan plans to undertake a scout drill program on the prospect.

**LAOS**

Pan Australian Resources (80%) reported results in July from a five-hole DD program at the Phu Bia copper-gold porphyry project (20% Newmont Mining), located 90 km northeast of Vientiane in Laos. Better results include 16 m @ 3.8 g/t Au from 2 m in hole GDD15, and 35 m @ 1.5 g/t Au from the surface in hole GDD18. Inferred resources for Phu Kham total approximately 125 Mt @ 0.9% Cu and 0.4 g/t Au (COG=0.5% Cu). Pan Australian intends to commence a RC drilling program at Phu Kham with the aim of doubling the resource area as part of a prefeasibility study.

**MONGOLIA**

Ivanhoe Mines in July announced a new resource estimate for the Turquoise Hill Cu-Au project in southern Mongolia. Ivanhoe reported that the indicated and inferred resources now total 1,200 Mt @ 0.9% Cu and 0.35 g/m3 Au (0.6% Cu-equivalent cut-off). These resources include indicated resources of 267 Mt @ 0.53% Cu and 0.86 g/m3 Au in the Southwest zone and inferred resources of 618 Mt @ 1.19% Cu and 0.1 g/t Au at the Far North zone. Drilling at the Far North zone also delineated a high-grade core containing 68.8 Mt @ 2.92% Cu and 0.28 g/m3 Au (2% Cu-equivalent cut-off), within the larger mineralized envelope.

**PHILIPPINES**

On Anglo American’s (80%) Suriago Del Norte Project, drilling has effectively closed off the northern, southern, and eastern edges of the Boyongan deposit, with a significant intersection of 657 m @ 0.37% Cu and 0.43 g/m3 Au, that included 431 m @ 0.66% Cu and 0.37 g/t Au from 88 m, and 149 m @ 1.12% Cu from 88 m. Measured, indicated and inferred resources currently stand at approximately 250 Mt @ 0.6% Cu and 0.6 g/t Au.

Indophil Resources (42% Lion Selection Group) continues to move forward with regard to the Tampakan project located in southern Mindanao. Indophil successfully secured US$2.1 million in share-purchase financing that will be used to fund a prefeasibility study aimed at identifying a higher-grade resource at the Tampakan copper-gold porphyry project (Indophil 40%, MIM 60%).

**THAILAND**

Kingsgate Consolidated announced in May updated resources and initial reserves for the A prospect on their Chatree project, located 280 km north of Bangkok. Based on a 12,000-m drilling program, measured, indicated, and inferred resources total 7.6 Mt @ 2 g/t Au and 20 g/t Ag (1 g/t Au COG). Proven and probable reserves total 7.4 million @ 1.7 g/t Au and 18 g/t Ag (0.8 g/t Au COG and gold price of $330/oz).

**VIETNAM**

Tiberon Minerals announced in July a private placement in which the proceeds will be used for working capital and for developing the feasibility-stage of the Nui Phao tungsten-gold-copper-bismuth project (70% Tiberon, 15% Geleximco, 15% Thai Nguyen Mineral). Measured, indicated, and inferred resources at Nui Phao total 101.5 Mt @ 0.4% W, 0.2 g/t Au, 0.2% Cu, and 0.1% Bi.
AUSTRALASIA

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AUSTRALIA

Exploration spending continued to rise slightly during 2002. Total mineral exploration spending increased from US$203m for the March quarter to US$278m for the December quarter. This includes a rise in gold exploration spending from US$45m to US$60m. The gold price rise and increased exploration spending led to an optimistic mood at the Diggers and Dealers Conference held in August in Kalgoorlie. Australian gold production rose 5% in the year 2001/02 to 285 tonnes (9.2 Moz). Increases occurred at Ridgeway Cadia, Challenger and Thunderbox. The annual ResourceStock Investment Risk Survey continues to show Australia and then Canada as countries of preferred low sovereign risk. Tanzania, Ghana and Botswana have improved markedly over the last year, whereas South Africa has declined precipitously to join New Guinea, Zimbabwe and Indonesia near the bottom of the rankings. Critical issues for Australia are land access, land claims, and green tape. For PNG it is a range of issues, including security.

The Australian government announced a Minerals Exploration Action Agenda as a measure to arrest the decline in mineral exploration, which has fallen by approximately 45% over the last five years. The Action Agenda has made recommendations related to land access, taxes, geoscientific data, R&D, and education and training.

The National Committee for Earth Sciences (NCES), which has been established by the Australian Academy of Science, is currently in the process of finalizing their draft Strategic Plan. This plan provides a national framework for the solid earth and environmental geosciences in Australia, so they can contribute more effectively to major national and global issues <http://www.science.org.au/natcoms/earth.doc>.

CSIRO Exploration & Mining has announced the focus of its exploration activities will be in Perth, and the intention is to close its North Ryde laboratory in Sydney. The Geological Survey of New South Wales has announced its intention to move activities from Sydney to Maitland.

SEG 2004 in Perth is well underway with several days of invited talks already organized, and plans for a day of open presentations.

WESTERN AUSTRALIA

Pilbara Mines has upgraded the resource at its Jaguar base metal project in the Yandal area of Western Australia as it moves toward completion of a feasibility study. Jaguar contains 1.72 million tonnes (Mt) grading 3.6% copper, 11.9% zinc and 127 g/t silver. The company said the 23% increase in resource tonnes came from only six diamond holes in the upper half of the deposit, and that further upgrades were expected overall. Pilbara expects that preliminary mine design and financial analysis will be completed this quarter as part of the feasibility study.

The Thunderbox gold deposit is the most recent discovery in the Yandal gold province to come into production. Operations at the Thunderbox gold mine during the second quarter of 2003 were in excess of stated production levels with 65,845 oz of gold produced. The property remains on target to produce 220,000 oz of gold during 2003. Cash operating costs for the quarter ended June 30, 2003, were US $67/oz Au produced. The performance of the treatment plant during the quarter exceeded design capacity, with throughput of 2.8 Mt on an annualized basis being achieved. During the second quarter a total of 712,462 dry tonnes of ore were processed at a grade of 2.96 g/t Au and a metallurgical recovery of 97.2%. Drilling results from the long-disputed Bronzewing South lease were disappointing, and without further resource additions, Newmont’s Bronzewing mine is scheduled to close in March 2004. However, to the north, development has commenced toward underground access
to Newmont’s Jundee West Side lodes. Hosted in the Hughes Dolerite, and parallel to the significant Barton Deeps deposit, the West Side lodes are a series of narrow parallel high-grade structures, with drilling intersections including 0.7 m @ 1470 g/t, 1.2 m @ 373.3 g/t and 0.5 m @ 767 g/t.

Tanami Gold will bid for the Coyote gold project being sold by AngloGold, and has taken a 15% stake and management of Pilbara Mines, owner of an advanced polymetallic deposit called Jaguar near Leonora in Western Australia. In the northern Tanami province, Tanami Gold managing director Denis Waddell said both of today’s corporate developments were made to ensure the explorer will have future access to cash flow. Coyote contains over 310,000 oz of reserves (in ore grading 7gpt), and Tanami Gold should be well positioned given it holds a further 180,000 oz at nearby Larranganni, as well as a large ground position and long history in the isolated Tanami region.

QUEENSLAND

At its Woolgar gold project, Strategic Minerals conducted a 23-hole RC program and all but two holes intersected significant mineralization including 8 m at 10.7 g/t and 11m at 14.7 g/t gold. They also recently announced a joint venture with Barrick on the property. Kagara Zinc announced a significant Cu intersection at their Balcooma prospect of 7.5% copper in addition to 16.2% Zn over 8.1 m from 122 m. In the Mount Isa inlier Matrix Metals intersected 0.89% copper over 14 m at the White Range project near the Greenmount deposit.

VICTORIA

Bendigo Mining has announced initial reserves at its gold project in Victoria but said first production has been delayed again until early 2005. Reserves total 440,000 t grading of 7.5-9.5 g/t for a contained 120,000 oz, with a reserve inventory of 200,000 oz required before Bendigo commits to stage one development of the project. That total is expected to be reached by the end of the year, at which time long-lead items for the proposed 300,000 t per annum plant will be ordered. Construction is expected to take 12 months. The company estimates capital costs at $50-60 million, with annual production of 80,000-100,000 oz expected.

Following announcements of a 6 million ounce exploration potential in the old Ballarat goldfield, and 600,000 oz reserve, Ballarat Goldfields has completed a successful fund raising through the issuing of shares. The next phase of work includes further exploration drilling of the recently recognised Sulieman Line and development of conceptual plans for the project.

SOUTH AUSTRALIA

Dominion Mining is to develop an underground operation at its Challenger gold mine in South Australia, indicating the operation is likely to be in production until at least 2007. The development is targeting mineralization from below the bottom of the planned 125-m-deep pit to a depth of 375 m. Resources to 430 m depth total 859,000 t grading 9.3 g/t for a contained 257,400 oz. Production of about 50,000 oz per annum is expected at cash operating costs of US$195/oz. Construction will begin in March 2004, leading to first ore in the September quarter. Meanwhile, Dominion produced 13,303 oz at cash costs of US $227/oz at Challenger last quarter, exceeding budgets.

The potential deposit at Prominent Hill strikes east-west over 600 m and varies in width from tens of meters to hundreds of meters and remains open at depth. The most recently released drilling results included 130 m at 1.41% copper and 0.43 gpt gold, and 162 m at 1.03% copper and 0.46 gpt gold. BHP Billiton is selling its interest in the joint venture project.

NEW ZEALAND

GRD Macraes has successfully concluded the first stage of its exploration program at Sams Creek,
recording intersections of 38 m @ 3.19 g/t Au and 48 m @ 2.62 g/t Au to extend the zone of strong gold mineralization a further 175 m along strike and 150 m in depth. GRD states that strong mineralization in the Main zone remains open at depth and along strike.

**PAPUA NEW GUINEA**

There has been a 160% increase in the level of grass-roots exploration expenditure for early 2003 to $4.1 million. Negotiations between the various stakeholders in the Kainantu gold mine are ongoing. Simberi and Hidden Valley submissions for development are expected late in 2003 to early 2004 subject to the gold price. Drilling is underway at Wafi. Drill hole WR177 returned 159 m @ 6.53 ppm Au from 275 m. Outcrop and float samples from the Milikap prospect, Malamaunda EL, have returned up to 14.4 ppm Au. Geophysics is complete and drilling is underway. Drilling is underway at the Tru Kai prospect, Frieda. Assay results from the first hole returned 114 m @ 0.5% Cu, 0.16 g/t Au.

**EUROPE**

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The SEG Symposium “Exploring for Tethyan ores: Developments from historic roots” at the 7th Biennial SGA-SEG Meeting was held at the end of August, and was organized by Ferenc Molnár, SEG’s new Regional Vice-President for Europe. Unfortunately, the schedule coincided with the deadline for submissions of Exploration Reviews and therefore any comment will have to wait for the next Newsletter—indeed, by then there may be a new Correspondent since it is time that the readership was provided with a fresh view of exploration in Europe.

It was hoped that the meeting would provide a focus on the geology of mineral deposits in southeast Europe, which is becoming an increasingly important area for exploration activity. However, exploration is only worthwhile if the discoveries can be exploited, and there is an unhappy history of projects in several countries in the region being hindered and even abandoned due to problems encountered during permitting—particularly pertaining to environment and social impact. The operators must be totally transparent in their plans and activities, just as the authorities must be allowed to fairly apply their regulations, which are nowadays usually based on internationally acceptable standards. Above all, the importance and impact of mining should be openly discussed to avoid decisions based on poorly informed and emotional reaction. It is thus very apt that the theme of the 7th Biennial SGA-SEG Meeting is “Mineral Exploration and Sustainable Development.”

I am happy to acknowledge those country correspondents who have kept me informed of activity (or the lack of it, which can be just as important) in their areas, notably Pasi Eilu (Finland) and Fernando Tornos (Spain).

**SOUTHEAST AND SOUTHERN EUROPE**

Porphyry and epithermal mineralization in the Carpathian arc and Vardar zone remain a focus of exploration activity—with Bulgaria and Romania being the most attractive to date, but companies are also becoming more active in Slovakia, Serbia, and Macedonia. Although the junior companies tend to generate the most “news,” several major companies—including Rio Tinto, Anglo American, Phelps Dodge, and Goldfields—have a history of activity in the region since the 1990s, although some may be dormant now.

**Gabriel Resources Ltd Rosia Montana** project in Romania (proven and probable reserves 217.9 Mt at average grade of 1.52 g/t gold and 7.5 g/t silver using a 0.6 g/t gold cutoff) is probably the single largest mining development project in Europe (developments costs estimated at US$437 million). The successful conclusion of the project, which includes a major resettlement and relocation plan, will be a real test for both the company and the permitting authorities. Gabriel’s sister company, European Goldfields Ltd, is continuing intensive exploration of various targets in their Cernea project, which is in a similar setting to Rosia Montana and only about 45 km away.

Following接收者ash of Navan Resources their Bulgarian assets, including the Ada Tepe exploration project (indicated resources of 1.48 Mt @ 7.3 g/t gold and 4.3 g/t silver; inferred resources of 4.67 Mt @ 3.7 g/t gold and 1.5 g/t silver)—both using a 1.0 g/t gold cutoff on high-sulfidation epithermal gold mineralization and the Celopech gold-copper mine (measured and indicated resources of 23.74 Mt @ 1.4% copper, 3.5 g/t gold and 10 g/t silver using a 3 g/t gold-equivalent cutoff), have been optioned to Dundee Precious Metals Inc. If the purchase is fulfilled, it is hoped there will soon be some more positive exploration results to report.

Hereward Ventures plc and other companies have now established offices in Serbia, where a new Mining Law is due to be promulgated soon. The government is also committed to privatising the Bor Copper complex. This includes the mines exploiting the Bor and Majdenpek porphyry copper deposits as well as title to exploration ground along the Timok belt, which is belongs to that part of the Carpathian arc as it sweeps through eastern Serbia.

The privatization of the lateric nickel mines in Kosovo is now proceeding. It is also planned to restart at least some of the Trepca zinc-lead mines prior to privatization.

**Tournigan Gold Corporation** is reevaluating the exploration possibilities at the Kremnica gold deposit in central Slovakia. Kremnica consists of epithermal mineralization within the extensive central Slovakian Volcanic District of Neogene age. The resources at Kremnica were recently estimated to be 15.6 Mt @ 1.91 g/t gold and 15.0 g/t silver at a 1.0 g/t gold cut-off.

**Oxiana Limited**, although primarily active in SE Asia, have maintained momentum on their exploration programme in Cyprus through their 60% interest in Eastern Mediterranean Minerals, and recently announced drill intercepts (e.g., 2.9% copper and 5.2% zinc over 2 m) from the Kallekhasides prospect. This Cyprus-type VHMS target also yields interesting gold grades (1.1–1.7 g/t gold). In central Albania, the Turkish company Ber-Ona Madencilik San Tic AŞ is currently reevaluating the Munelle Cyprus-type VHMS deposit, and is reviewing the possibilities of investing in the Lak Rosh and Karme mines, all of which are...
hosted within a Jurassic ophiolite succession. The Albanian Cyprus-type VHMS deposits are also typically enriched in gold.

FENNOSCANDIA COUNTRIES

The latest news from the “APP” PGE exploration program in northern Finland pertains to corporate changes. Gold Fields Ltd have acquired Outokumpu’s 49.9% stake, so that “APP” changes now from a partnership to “Arctic Platinum project” that is 100% owned by Gold Fields. At the same time, there has been no change in the resource estimates.

IOCG targets in central and northern Finland are attracting the attention of Belvedere Resources Ltd and Tertiary Minerals plc. Both companies have identified mineralized targets in the Paleoproterozoic basement. Earlier this year the Geological Survey of Finland released a report on IOCG exploration potential in northern and central Finland. There is little news emanating from major companies (including Anglo American, Phelps Dodge, BHP Billiton) operating the exploration projects for IOCG gold mineralization in the early Proterozoic of northern Sweden.

There has been a revival of activity at two gold mines in northern Fennoscandia—the Pahtavaara mine in Finland is reported to have been reopened by Scan Mining, and Minmet plc is reviewing the possibilities for increasing production from the Björkdal mine in Sweden.

Riddarhyttan Resources AB now has all the permits required for underground and open pit exploitation of the Suurikauiskko gold deposit in northern Finland. A revised estimate has now substantially increased the resources to 11.5 Mt @ 5.4 g/t Au using a 2 g/t Au cutoff. We might soon read reports of actual mine development.

After testing a PGE target in northern Norway, Tertiary Minerals plc are now focussing their efforts on drilling targets for Ni-Cu in the Nottrask gabbro intrusion in Sweden. Meanwhile, North Atlantic Natural Resources AB (NAN) is evaluating the Lappvattnet Cu-Ni prospect in the northern Sweden.

European Diamonds plc reports that “mini-bulk sampling” is continuing from one of the 14 kimberlite targets on their Lenttiira properties in eastern Finland.

Boliden AB is successfully continuing exploration of the vertical, high-grade silver-lead-zinc Lappberget zone of the Garpenberg mine, Bergslagen district in central Sweden. An inferred mineral resource of an additional 7.5 Mt at depths of greater than 775 m has been announced. Drill results include sections of 44.65 m @ 223 g/t Ag and 53.10 m @ 709 g/t Ag.

IRELAND

In spite of low zinc prices, three operating mines are based on the carbonate-hosted sulphide mineralization in the Irish Midlands Carboniferous sequence: Navan (Outokumpu Tara Mines Ltd), which is Europe’s largest zinc producer, with an annual capacity of 200,000 t zinc in concentrate, Lisheen (Anglo American and Ivernia West), and Galmoy. Further to the high-grade intersections mentioned in the last Exploration Review (July 2003), Arcon International Resources plc has announced a resource of 2.3 Mt @ 19.0% zinc, 7.2% lead and 66 g/t silver in the new R-zone at the Galmoy mine. This additional to the ore reserves of 3.3 Mt @ 11.0% zinc and 2.1% lead as of end-2002.

Conroy Diamonds and Gold plc is continuing exploration on the Armagh Monaghan gold belt in the Caledonides of the Longford-Down Massif, and regularly announce new intersections.

In Northern Ireland, Tournigan Gold Corporation is drilling at the Curraghalalt prospect, in an attempt to increase the resource of 255,000 oz of gold that was defined by earlier work. The deposit consists of high-grade gold mineralization (avg 17 g/t gold) in quartz veins hosted by Dalradian metamorphic rocks.

IBERIA

After achieving record production in 2002 of 177,225 oz gold from the El Valle and Carles mines in northern Spain, Rio Narcea Gold Mines Ltd is now focussing on the development of the Aguablanca nickel-copper-PMG project (estimated resource: 15.7 Mt at 0.66% nickel, 0.46% copper, and 0.47 g/t PGM plus gold) in the Ossa Morena zone, southern Spain. The necessary permits have been received, and construction should commence shortly.

Open-pit production is envisaged to be about 8,200 tonnes (t) per year nickel in concentrate. Having acquired title to additional licenses covering the prospective ultramafics in the Portuguese sector of the Ossa Morena zone, the company plans to spend over USD 7 million on exploration for both gold and nickel in 2003.

Cambridge Mineral Resources plc has completed a new EM-survey and are continuing drilling at the Someiro-Poyatos project, which is an unusually gold enriched mineralization in the Iberian sector of the Iberian Pyrite Belt (IPB). The company has increased its exploration area by acquiring the adjacent San Telmo permits. At the eastern end of the Spanish sector of the IPB, MK Gold Co has been awarded a mining concession for the Las Cruces copper deposit. The open-pit reserve (15.9 Mt @ 5.94% copper) is based on a zone of pre-Tertiary supergene enrichment of a VHMS massive sulfide deposit that is protected by overlying Miocene sediments.

The ownership of the Neves Corvo mine in the Portuguese sector of the IPB should be resolved by the end of this year – this after government blocked an earlier attempt by Rio Tinto to sell their share. In northern Portugal, St Elias Mines Ltd has revived exploration around the Jales gold mine and the Granheira gold deposit in northern Portugal. Jales produced 830,000 oz gold from 1932 to 1992 from a series of veins with an average grade of 12.9 g/t gold.

SOUTH AMERICA

ARGENTINA

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After a critical economic and political period, which included three Presidents between 1999 and 2002, Nestor Kichner was elected president for the next five years. His election has brought a new social, political, and business climate in Argentina.

In the northwestern part of the country the Taca Taca (400 Mt @ 0.6% Cu and 0.25 g/t Au) porphyry Cu-Au deposit, previously explored by Gencor, BHP, and Corriente Resources, was acquired by CRS Copper Corporation, whereas BHP Billiton’s share in
Agua Rica (750 Mt @ 0.66% Cu, 0.23 g/t Au, and 0.037% Mo) was acquired by Northern Orion for US$12.6 million. Meanwhile, Barrick has resumed exploration at Veladero, which, together with the Pascua-Lama deposit at the border with Chile, are key to Barrick’s worldwide growth plans. The two projects were consolidated by Barrick’s takeover of Homestake in 2001 and they contain a 35-Moz gold resource. Barrick has made the decision to go ahead with Veladero and a new road for heavy duty equipment is under construction.

Elsewhere in northwestern Argentina, Rio Tinto has completed a long-time delayed program at their El Altar project north of El Pachón, Intrepid Minerals continues exploration of their Casposo low-sulfidation Au-Ag prospect, and Estelar Resources Corporation cranks new numbers at their La Cabeza low-sulfidation Au-Ag deposit, now estimated to contain an inferred resource of 6 Mt @ 2.8 g/t Au in five near-surface veins and breccia systems.

In the Patagonia region of southern Argentina, the Meridien Gold Esquel project is facing strong opposition by domestic and international anti-mining activists. In February 2003, a local court issued a decree halting work on the project, but the provincial government quickly overruled it. Laws forbidding the use of cyanide and open-pit operation have forced companies to leave the region. Elsewhere in Chubut, IMA Resources has discovered significant high-grade Ag-Cu-Pb mineralization at Navidad Hill. Mineralization consists of structurally controlled breccias with up to 2,000 g/t Ag. AngloGold completed acquisition of a 92.5% share of the Cerro Vanguardia Au-Ag mine, with the provincial government maintaining a 7.5% free-carried interest through Fomicruz. Exploration at Cerro Vanguardia has replaced and expanded its reserve base, with proven and probable reserves standing at 9.5 Mt @ 7.6 g/t Au and 106g/t Ag at the end of 2002. Minera Andes and joint-venture partner Mauricio Hochschild have started underground ore-reserve exploration and development at their advanced Huevos Verdes (San José) project, which holds a combined indicated resource of 1.85 Mt @ 214 g/t Ag and 2.1 g/t Au and additional inferred resources of 2.69 Mt @ 253 g/t Ag and 2.5 g/t Au in. Also in the region, Coeur d’Alene has extended life of its small bonanza Ag-Au Martha mine where production is trucked >450 km to Coeur’s Cerro Bayo mine plant in Chile. Martha produced 1.4 Moz equivalent Ag in 2002 and ore reserves stand at 5.3 Moz of contained equivalent Ag.

### BRAZIL

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Since January, Brazil has a new president—Lula, as he is known is the first leftist in power. He is bringing good news for the mining industry, mainly for the small and middle-sized miner. For the very first time all geology and mining agencies will be run by technical people sharing a plan. It’s hoped they will succeed in tapping the country mineral potential. Some positive steps have been taken quickly and those include conflict areas like Serra Pelada and Ouro Roxo gold deposits and Rio Roosevelt Indian Reservation diamond alluvial mine.

### AMAZON

The Amazon rainforest area is the most popular target in the country, with Carajás area as the jewel of the crown. This is CVRD homeland now, although some major companies like Noranda, Gold Fields and BHP Billiton are breaking new ground and looking for additional iron oxide-gold-copper deposits. But a Canadian junior company, Canico, is getting the big trophy: the Onca-Puma lateritic nickel deposit, which is soon going into production, has inferred resources of about 104.4 million tonnes (Mt) at 2.15% nickel and 0.105% cobalt. This is a former Inco discovery made some 30 years ago. South of this site Yamana Gold is putting an exploration program at Cumaru.

A group of junior companies has flocked to the Tapajós gold district and some of them have already started drilling. Sirios Resources began a 400-m drill campaign at Terranova and Serabi, an Australian venture, is operating a tailing deposit and drilling a hard rock target at Palito mine. Other companies recently active in the area include Verena Minerals at Patrocinio, Star Resources at Toquinzinho, and Opawica Explorations at Bom Jardim—both properties brought to the attention of the acquirers by Belem-based Austral Ltda.. New Bullet still faces a garimpo competition at its Ouro Roxo gold deposit.

But the most important deal in the Amazon comes from Amapá state where Brazilian mining tycoon Eike Batista has acquired from AngloGold the Amparapi gold mine.

In the West Amazon, Vaoldiam Resources will acquire the Pimenta Bueno diamond project close to the rich, but poorly known, Rio Roosevelt alluvial artisanal mine.

A sad story in the Amazon mining picture is the failure of the Pitinga tin (and zircon and tantalite) mine to pay for mounting debts that may cause its closure in the short-to-medium term. Paranapanema, the domestic company that owns and operates the mine, is looking for a new president.

### NORTHEAST

The major platinum project in the country is carried out by Solitario Resources at Pedra Braca (Ceará), which is performing a 4,200-m drilling program funded by Anglo American Platinum Corp at three selected targets (Curio, Santo Amaro and Cedro II). West of that Verena Minerals carries on its exploration works at the Bonfim gold-tungsten-bismuth skarn deposit.

In Bahia state Yamana Gold will buy the Fazenda Brasileiro gold mine at the tag price of $20.9 million. This is a former CVRD gold mine with reported underground reserves of 112,000 oz of gold. Desert Sun Mining is also exploring the dormant Jacobina gold mine formerly operated by AngloGold.

### MINAS GERAIS AND GOIAS

Goias state has a new gold mine, Sertão, which is operated by Troy Resources in partnership with Amazonia Mineração (30%). Official reserves stand at 228,900 t @18.2 g/t of gold. Yamana Resources is reported to enter in agreement to acquire the Chapada copper-gold open pit mine deposit whose reserves stand at 187,300 Mt @ 0.39% copper and 0.31 g/t Au. Minas Gerais hosts the well-known Iron Quadrangle district. Eldorado Gold, which operates the Sao Bento
gold mine, has intention to deepen its shaft there. Current production first quarter this year stands at 105,000 oz.

Black Swan Resources actively pursues several targets in Minas Gerais. The company has recently acquired the Canastra I diamond property from De Beers and started a bulk sampling program at its Abaete diamond property. Works proceed at the Cata Preta gold property and at its third diamond target, Santo Antonio do Bonito. The company reports that it is also acquiring all of Canabrava’s assets in Brazil.

**CHILE**

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Although somewhat diminished from previous boom years, exploration activity in Chile continues at a good pace. For example, statistics on exploration claims released by the Chile Geological Survey shows that the number of valid claims increased in 2002 from 18,220 to more than 19,500, interpreted by some as a reflection of the recent classification of Chile as the most favorable country of 47 jurisdictions for mineral exploration.

The IOCG of northern Chile has seen renewed exploration activity. Far West Mining of Vancouver recently reported a 60-m intersection averaging 2.47% Cu and 0.33g/t Au in target 4c3, a gravity target identified through BHP Billiton’s Falcon gravity gradiometer technology near the Mantoverde IOCG mine. Elsewhere in the belt, Pathfinders entered into agreement with Minera IPBX over the latter’s Zulema property along the Atacama fault zone south of Copiapó. Work recently completed by Pathfinders revealed the presence of widespread anomalous metal values (up to 0.69% Cu and 0.27 g/t Au) over a stratigraphic thickness of 308 m and a strike length of 400 m.

Also in northern Chile, Silver Standard agreed to purchase a 100% interest in the Challacollo silver project from Sociedad Contractual Minera Challacollo, approximately 130 km east of Iquique. Work by Silver Standard has included resampling of old underground workings and drilling of several core holes, one of them returning 10.8 oz Ag over 24 m. Indicated resources stand at 10.2 Moz Ag. Expatriate, through its subsidiary Compañía Minera Latina, granted BHP Billiton an option to acquire 60% of its Gracielita property, approximately 55 km west of Chuquicamata. BHP Billiton has committed to expenditures of US$2.5 million over five years.

Codelco has completed first-stage exploration of the Toki porphyry copper discovery located a few km west of Chuquicamata, and defined the limits for an inferred resource of approximately 6 Mt of contained copper. At the same time, Codelco has continued exploration of its Vicky project next to Gaby, south of Chuquicamata.

Development of Escondida Norte has been approved by BHP Billiton and partners. The open pit will be located 5 km north from existing mining operations at Escondida. Development costs are estimated at US$400 million, including installation of a primary crusher, construction of an overland conveyor, new mining equipment, and waste pre-stripping of the new pit. Proven and probable reserves at Escondida Norte are estimated at 526 Mt of sulfide ore at an average 1.42% Cu for a 0.7% Cu cutoff for a mine life of 17 years.

**PERU**

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The Peru Copper Syndicate, led by J. David Lowell, recently acquired the large Toromocho porphyry copper deposit in central Per from the Peruvian state through a public bidding process and is planning to commence exploration through a major diamond drilling program shortly. Also in the region, Inca Pacific aims to complete a 1,500-m drilling program at their Antoro skarn copper project. Also, Inca Pacific and Anaconda Peru have entered into formal agreement to jointly offer for sale their interest in the Magistral copper-molybdenum porphyry-skarn deposit located in Ancash.

Another copper skarn property that is making the news lately is Las Bambas in the Andahuaylas-Yauri belt of southern Peru. The potential of the belt is becoming increasingly apparent in recent years owing to discovery of large porphyry copper-gold deposits at Antapaccay, near Tintaya (BHP Billiton), Los Chancas (Southern Peru), and Cotabambas (Anaconda Peru). Final ruling by the Supreme Court has prompted ProInversion, the state-owned agency for investment, to call for an international bidding process for the project later this year. This is good news for major copper players currently active in the region, including BHP Billiton, Phelps Dodge, CVRD, and Southern Peru Copper.

In the Cajamarca belt of northern Peru, Lumina Copper Corporation has signed an option on the El Galeno porphyry Cu-Au deposit through whereby it can acquire 100% for US$2 million. El Galeno contains inferred resources of 486 Mt @ 0.57% Cu and 0.14 g/t Au and was previously explored by RTZ, Compañía Minera North and Newmont Peru. Lumina was formed in May 2003 by the merge of CRS Copper Resources and First Trimark Ventures Inc, which has also acquired the Pushpap porphyry copper deposit in central Peru.

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Pursuant to the Society’s Bylaws, names of the following candidates, who have been recommended for Fellowship by the Admissions Committee, are submitted for your consideration. Each applicant’s name and current position are followed by the names of their SEG sponsors. If you have any comments, favorable or unfavorable, on any candidate, you should send them, in writing before November 30, 2003. If no objections are received by that date, these candidates will be presented to Council for approval.

Address Comments to:
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Jones Belther, Companhia Vale Do Rio Doce, Rio Claro, Brazil; Robert E. Kell, SAMEX Mining Corporation, Abbotsford, BC, Canada; Tony Page, Page GeoConsulting Limited, Hong Kong, China; Lawrence Segerstrom, P. T. Freeport Indonesia, New Orleans, LA; Roger P. Tallini, Department of the Interior, Battle Mountain, NV; Gabriel C. Voicu, Université du Québec à Montréal, Ile Bizard, QC, Canada; Chengyu Wu, Rio Tinto Mining and Exploration Limited, Beijing, China; Baolin Zhang, Chinese Academy of Sciences, Beijing, China.

NEW SEG MEMBERS:

Raymond J. Angus, Montero Metals PLC, Lima, Peru; Arthur H. Barabas, California State University-Fresno, Fresno, CA; Ian N. Cameron, Khumsup Siam Ltd., Nai Meuang, Phitsanulok, Thailand; Michel W. Dufresne, Noranda/Falconbridge, Timmins, ON, Canada; Keith B. Duguid, Zambesia Holdings T/A, Kadoma, Zimbabwe; Catharine E. G. Farrow, FNX Mining Company, Inc., Subury, ON, Canada; Michael R. Garman, Akara Mining Ltd., Gympie, QLD, Australia; Dennis M. Gorc, Platinum Group Metals Ltd., Surrey, BC, Canada; Robert L. Graves, Carolina Vermiculite Company, Woodruff, SC; Donato Hoyos Julian, Cia. Minera Poderosa S. A., La Libertad, Perú; Ronald D. James, Akara Mining Ltd., Phichit, Thailand; Roger M. Lemaitre, Cameco Consulting, Saskatoon, SK, Canada; Aubrey L. Long, Alchemy Ventures Ltd., Post Falls, ID; George D. MacDonald, Freeport McMoRan, New Orleans, LA; Patrick M. McAndless, Imperial Metals Corporation, Vancouver, BC, Canada; Colin D. McLachlan, Baroid Industrial Drilling Products, Chagrin Falls, OH; Nigel H. Maund, Mineral Consulting International Ltd., Auckland, New Zealand; Daniel Merino Natorce, Minera Yanacocha SRL, Cajamarca, Perú; Tim L. Mosey, SRK Consulting, Evergreen, CO; Thomas Oberthür, BGR, Hanover, Germany; Richard F. Osman, Centamin Egypt Limited, Perth, WA, Australia; Costas T. Papavassiliou, National University of Athens, Athens, Greece; Osman S. Poma Jumbo, Sultana Del Condor Minera S. A., Quito, Ecuador; Andrew J. Rae, University of Tasmania, Hobart, TAS, Australia; Gino Roger, Noranda, Inc., Laval, QC, Canada; Roy J. Rupert, Boríno Incorporado, Sudbury, ON, Canada; Stacy M. Saari, Newmont Mining Corporation, Elko, NV; Reinaldo Saez Ramos, Universidad De Huelva, Huelva, Spain; Chamarat Sangsrichan, Geologic Consultant, Chiangmai Province, Thailand; Christopher M. Sennitt, Senlac Geological Services Pty. Ltd., Bellbowrie, QLD, Australia; Carlos R. Souza Filho, University of Campinas, Campinas, Sao Paulo, Brazil; Ronald Standen, Minera Michilla S. A., Antofagasta, Chile; Edward C. Thatcher, E. C. Thatcher & Associates, Petervale, Gauteng, South Africa; Peter H. Thompson, Peter H. Thompson Geological Consulting Ltd., Ottawa, ON, Canada; Hui T. Tran, Hanoi University of Mining and Geology, Hanoi, Vietnam; Dania Trista-Aguiller, Universidad Catolica Del Norte, Antofagasta, Chile; Jeffrey P. Vought, Western Australia School of Mines, Perth, WA, Australia; Kent L. Washburn, Geologic Consultant, Stratham, VIC, Australia; Dave R. Webb, DRW Geological Consultants Ltd., Surrey, BC, Canada; John M. Wheelton, Wheelton’s Exploration, Whitehorse, YT, Canada; Peter Winkler, Anglogold Limited, Johannesburg, Gauteng, South Africa; Khin Zaw, University of Tasmania, Hobart, TAS, Australia.

The Society Also Welcomes the Above Candidates as New Members

NEW SEG STUDENT MEMBERS:

Natalia I. Astudillo Leyton, Universidad De Chile, Santiago, Chile; Roberto C. Bados-Cueva, Universidad Nacional Mayor De San Marcos, Lima, Perú; Margaret Anne Baker, University of Maryland, College Park, MD; Andrew L.
Economic Geology Launches Map Series

Inaugural Economic Geology Map Series to appear in the December issue of the journal (vol. 98-8)

Geology of the Bajo de la Alumbrera Porphyry Copper-Gold Deposit, Argentina,
by John M. Proffett

The paper will include 4 color maps at 1:5000 and 1:2000 scale, ~20 × 20 inches each.

The maps illustrate the geology, alteration, vein distribution and vein abundance in the Alumbrera porphyry system. Cross sections, also in color, and two foldout sections showing the geology and alteration, as well as color and black-and-white photographs of the intrusions and vein types, are included. The series was initially proposed by Marco Einaudi in 1999 and was intended to meet the demand for large-format maps of mineral deposits and mineral districts. Maps will be in a pocket at the back of the issue.

Publication of these maps was made possible by the generous financial support of Minera Alumbrera Ltd.

Contributions to the Map Series are encouraged. In particular, we are seeking multiple, large-format maps and cross sections in color, depicting the geology and related features of important mineral deposits and mineral districts. The maps may focus on individual orebodies, mining districts, or broader mineralized regions and should be original, detailed, and accurate, and they should contribute in a substantive way to the understanding of the deposit or district.

Information: Detailed instructions can be found in vol. 98-1 of the journal under Instructions to Authors, or contact the Editor, Mark D. Hannington, e-mail, econgeol@NRCan.gc.ca; to submit a specific, written proposal, accompanied by preliminary examples of the maps, and a proposed layout, see the journal website at <http://segweb.org/EG/submit.htm>. 
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Global And Continental-Scale Mineral Resource Assessments

32nd International Geological Congress Symposium
Florence, Italy
August 21-28, 2004

Talks and Posters. Abstracts are invited for oral and poster presentations on progress, results, methods, applications, and new research in global and continental-scale assessments of nonfuel mineral resources to provide maps, databases, assessments, and other information and research in aid of growing international efforts for resource, land, economic, and environmental planning and decisionmaking. Abstracts are due January 10, 2004. For submittal details, download the Second Circular at: http://www.32igc.org/home.htm.

Proceedings Volume. Presenters also are encouraged to prepare up to 14, A4-size pages by March 1, 2004, for a proceedings volume. A limited number of color illustrations permitted on special request. If you intend to submit a paper for the proceedings volume, please notify one of the following conveners prior to January 10, 2004: Daniel Cassard d.cassard@brgm.fr, Andor Lips a.lips@brgm.fr, or Joe Briskey jbriskey@usgs.gov.

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New Horizons in Mineral Deposits: Ore Genesis to Mine Closure
Call for Papers and Posters

SESSION FOR JOINT ROCKY MOUNTAIN—CORDILLERAN GSA SECTION MEETING
BOISE, IDAHO • MAY 2–5, 2004

Topics: Economic Geology, Mining, Environmental Reclamation, Geology and Geochemistry

Co-sponsors:
Society of Economic Geologists (SEG) and Idaho Geological Survey (IGS)

Co-chairmen:
Virginia S. Gillerman, Idaho Geological Survey, tel. 1-208-426-4002; e-mail, vgillerm@boisestate.edu;
Greg Arehart, University of Nevada, Reno, tel. 1.775-784-6470; e-mail, arehart@unr.edu.

Description:
This session covers ore deposits and mining, focusing on current activities in the western U.S.
We seek presentations covering the spectrum from mineral exploration to mine closure and reclamation,
and presenters from industry, academia, and government. Challenges remain in old districts—both
for environmental remediation and understanding the geology.

Session Time and Type:
Theme Session with both invited and open abstracts submitted. Probably a half-day session will
be adequate, though we would be delighted to have sufficient papers for a full day.
Both Oral and Poster formats encouraged and requested.
**Society of Economic Geologists**
(in conjunction with Geological Society of Nevada’s Symposium 2005 – Window to the World)

"Controversies on the Origin of World-Class Gold Deposits: Carlin and Witwatersrand"

May 14, 2005 • Reno, Nevada

The Society of Economic Geologists is sponsoring a one-day forum to examine and discuss the origins of gold deposits in the Carlin and Witwatersrand camps. Despite their importance, there is still no general agreement on their origins. For the Witwatersrand, the debate between placer and hydrothermal origins, and variations in between, has raged since discovery in 1886. For Carlin-type deposits, theories of origin have swung from shallow-hot spring deposits to distal products of porphyry copper deposits to deep mesothermal deposits.

Understanding the origins of these deposits has immense implications not only for future exploration success but also for a better insight into special earth processes that lead to such large metal anomalies. In the tradition of the scientific debates of the nineteenth and early twentieth centuries, we plan a series of talks that give contrasting views to the origin of these deposits, followed by panel discussions between experts and open discussions with the audience.

Although discussions will likely be animated, the emphasis will be on looking forward and identifying where we need to go in the future to better understand and explore for these deposits.

Organizer: John Muntean (John_Muntean@placerdome.com)

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**CAREER-RELATED CHANGES**

**STEPHEN ENDERS (SEG 1981)** has been appointed vice president of worldwide exploration by Newmont Mining Corporation. Most recently, he was president of Phelps Dodge Exploration Corporation. Prior to Phelps Dodge, Steve worked for Terradex, Pegasus Gold and Galactic Resources. He is a graduate of Colorado School of Mines and received his PhD degree from University of Arizona.

**RICHARD A. LEVEILLE (SEG 1998)** has been named president of Phelps Dodge Exploration Corporation. He joined Phelps Dodge in 1994 as chief geologist for South America; he was named vice president of exploration in 2000 and vice president and chief geologist in 2001. He is a graduate of the University of Utah and received his master’s degree from University of Arizona.

**DANA WILLIS (SEG 1985)** has joined Newmont Mining Corporation as a senior mine engineer at the Midas (Ken Snyder) mine in Nevada. Prior to that, he was a senior geologist/architect with Exponent in Bellevue, Washington. Previously, Dana held positions with MRDI, Independence Mining Company, and Freeport-McMoRan Gold Company.

**GEORGE J. COAKLEY (SEG 1997 F)** has been presented the Herbert C. Hoover Award, the highest SME Washington, DC, section honor, given to a member. Coakley, an exploration geologist who has become an African mineral industry specialist, works with the U.S. Geological Survey. Previously he worked as Chief of the Division of International Minerals of the U.S. Bureau of Mines, in private industry, and has served as technical advisor to the federal government. George worked as a Peace Corps volunteer geologist in the late 1960s in West Africa.

**EDWIN NOEL (PENNE) PENNEBAKER (SEG 1997 F)** has been inducted into the National Mining Hall of Fame. He is especially remembered for his work in devising innovative exploration programs for porphyry copper, vein pattern, and strata-bound ore deposits and was known for meticulous work and detailing of ore reserve estimates. Pennebaker worked in the Bisbee district of Arizona and at the United Verde Mine for Phelps Dodge. Other companies he was employed by in Nevada and Arizona include Consolidated Copper Mines, Miami Copper, Cyprus Mines, Homestake, and Hecla. He spent many years in the Cœur d’Alene mining district and also worked internationally.

**JOSEPH B.P. SAWYER (SEG 1993)** of Great Western Exploration has been inducted into the Canadian Mining Hall of Fame for his work. He was elected as a Fellow to the Royal Society of Canada in 1957, inducted into the Canadian Mining Hall of Fame in 1997, and received the CIM Distinguished Service Medal in 2002. An active member of many professional societies, Bob served on several SEG committees. Among his many publications was Gold: History and Genesis of Deposits, published by the SEG Foundation in 1987. Bob is survived by his wife, Marguerite, his daughter, Heather, his daughter-in-law, Christy Vodden, and grandson, Matthew. His son, Dan, predeceased him.

**MINER PUBLICATION**

**CHARLES C. HAWLEY (SEG 1964 SF)** is author of Wesley Earl Dunkle: Alaska’s Flying Miner, published by the University Press of Colorado as part of the Mining the American West Series. The book portrays Dunkle—a miner and aviator who arrived in Alaska in 1910—as a pioneer who managed copper mines and developed what was to become Alaska Airlines. The book covers a dynamic time in Alaska’s history (ordering information: tel. 1.800.627.7377; fax 1.800.735.0476; website, <www.upcolorado.com>).

**ROBERT W. BOYLE (SEG 1960 SF)** died August 5 in Ottawa, Ontario, Canada. He was 83. Bob had a distinguished career as an applied geochemist at the Geological Survey of Canada (GSC) and played a leading role in the development of exploration geochemistry in Canada and around the world. He also established the exploration geochemistry group at the GSC.

Born June 3, 1920, in Wallaceburg, Ontario, Bob served in the military during World War II, and received his Ph.D. degree from the University of Toronto in 1953. He began his professional career while still an undergraduate, working underground for Madsen Red Lake Gold Mines in 1947. From 1948 through the early 1950s he worked at Yellowknife, joining the GSC in 1952. He retired from the GSC in 1985. Bob received many awards and honors for his work. He was elected as a Fellow to the Royal Society of Canada in 1957, inducted into the Canadian Mining Hall of Fame in 1997, and received the CIM Distinguished Service Medal in 2002. An active member of many professional societies, Bob served on several SEG committees. Among his many publications was Gold: History and Genesis of Deposits, published by the SEG Foundation in 1987.

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Star (★) indicates new entry. Send entries to the SEG Office, attn. SEG Production Director: 7811 Shaffer Parkway, Littleton, CO 80127 USA Tel. +1.720.981.7882 / Fax +1.720.981.7874.

SEG Events at GSA:


Nov. 1–5. Geological Society of America Annual Meeting, Seattle, Washington, USA. For information, contact GSA Meetings Dept., P.O. Box 9140, Boulder, CO 80301-9140, USA. Tel. +1.303.447.2020, fax +1.303.447.1133. E-mail: meetings@geosociety.org. Website: http://www.geosociety.org/meetings/index.htm.


Nov. 24. Diamonds and Kimberlites short course. Laval University student chapter. Quebec, Canada. Information: <http://www.segweb.org/UofTdiamondcourse.pdf>; e-mail, chbochud@seg.ulaval.ca.


Dec. 1–5. Northwest Mining Association (NWMA) 109th Annual Meeting. For information, contact NWMA, tel. +1.509.624.1158; fax +1.509.623.1241; E-mail: nwma@nwma.org. SEG technical session: The Old and the New about the Geology of Zinc. E-mail, vaalbara@uw.edu.
