Guidebook

Society of Economic Geologists Foundation, Inc.
Student-Dedicated Field Trip Course –
Gold Systems of Northern Nevada

May 12 - 20, 2009

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¹College of Mines & Earth Sciences,
University of Utah, Salt Lake City, UT, ²New Mexico School of Mines, Socorro, NM
Welcome to the Society of Economic Geologists Foundation, Inc. Field Trip Course – Gold Systems of Northern Nevada, May 12 to 20, 2009. This field trip course is the fifth in Society of Economic Geologists Foundations Series that was established as a response to a student petition at the recent SEG Conference held in Keystone, Colorado, to provide more support for field trips to important mining districts.

The course starts at the Reno airport at 2:00 pm on Tuesday the 12th at the Reno airport baggage claim area. We will depart from the airport at 2:15. We will drive in two vans to Winnemucca where we will stay the first night at the Gold Country Inn. An orientation meeting will be held following dinner. The next day we will visit the Phoenix deposit south of Battle Mountain and travel to Elko, NV, where we will be based for several nights. Other districts and deposits that will be visited include, Carlin District, Chukar deposit, Pipeline/Cortez District, Cortez deposit, Midas Deposit, Twin Creeks mine, Rochester mine and deposits in the Turquoise Ridge /Getchell district. The field trip course ends in Reno on the evening of Thursday the 20th with participants departing Reno on Thursday the 21st.

Entrance to the mine sites usually follows a specific protocol; please be patient. At the mines we will receive safety training and a geological/engineering presentation. Do not take any pictures of the presentations unless and until we clear this point with company personnel. We will ask, but in general, participants can take pictures and collect samples on company property. Participants are responsible for their own samples (be aware of weight limits if you plan to take samples back with you). See itinerary for hosted meals, but be aware that last minute changes are possible.

We will have VERY LIMITED . . . REPEAT: VERY LIMITED . . . . space for luggage, so you should bring clothing and field gear ONLY IN DUFFLE BAGS - NO HARD-SIDED LUGGAGE. See you in Reno.
Acknowledgements

This field trip is generously supported through the Society of Economic Geologist Foundation through the **SEGF Student Field Trip Fund**. We also wish to thank the companies that provided access to their operations in Nevada and the many company representatives that gave generously of their time to make this trip a success. Special thanks are due to Pat Donovan, Rachel Burgess, Nancy Richter, Fred Breit, Keith Wood, Gabriel Graf, Henry Follman, Robert Loranger, Susan Abbott, Anita Brown, Jake Margolis, Jennifer Hanson, and John Thoms.

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The Society of Economic Geologists Foundation

Newmont Gold Company

Newmont Mining Corporation

Barrick- Turquoise Ridge Mine

Barrick- Cortez Gold Mines

Redstar Gold Corporation

Kennecott Minerals

Coeur d’Alene

Erich U. Petersen

William X. Chávez, Jr.

Jacob Margolis

Cover: Crystal Hammer, Twin Creeks Mine
# SEG Foundation Student-Dedicated Field Trip

**May 12 – 20, 2009**

<table>
<thead>
<tr>
<th>Date</th>
<th>Itinerary</th>
<th>Overnight</th>
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<tr>
<td>12 May</td>
<td><strong>2:00PM</strong>: Assemble at Reno Airport Baggage Claim Area</td>
<td>Best Western Gold Country Inn</td>
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<tr>
<td>Tuesday</td>
<td>Depart for Winnemucca, Nevada via I-80.</td>
<td>Winnemucca, Nevada</td>
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<tr>
<td></td>
<td><strong>Lodging</strong>: Best Western Gold Country Inn, Winnemucca</td>
<td>Contact: Patricia</td>
</tr>
<tr>
<td></td>
<td>921 W. Winnemucca Blvd</td>
<td></td>
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<tr>
<td></td>
<td>Winnemucca, Nevada 89445-3638</td>
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<tr>
<td></td>
<td>(775) 623-6999 transfer to 501</td>
<td>Fax: 775-623-9190</td>
</tr>
<tr>
<td>13 May</td>
<td><strong>6:30AM</strong>: Visit <strong>Phoenix Cu-Au porphyry property</strong></td>
<td>Thunderbird Motel</td>
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<tr>
<td>Wednesday</td>
<td>Discuss characteristics of porphyry-style hydrothermal systems.</td>
<td>Elko, Nevada</td>
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<tr>
<td></td>
<td>Late afternoon departure for Elko, Nevada.</td>
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<tr>
<td></td>
<td><strong>Lodging</strong>: Thunderbird Motel</td>
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<tr>
<td></td>
<td>345 Idaho St</td>
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<tr>
<td></td>
<td>Elko, Nevada 89801</td>
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<tr>
<td></td>
<td>P: 775-738-7115</td>
<td>F: 775-738-2694</td>
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<tr>
<td>14 May</td>
<td><strong>6:30AM</strong>: Visit <strong>Carlin District</strong> – review of stratigraphy and structure</td>
<td>Thunderbird Motel</td>
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<tr>
<td>Thursday</td>
<td>of Paleozoic sequences; discuss mineralization styles with core review</td>
<td>Elko, Nevada</td>
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<tr>
<td></td>
<td><strong>Contact</strong>: Rachel Burgess, Project Geologist</td>
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<tr>
<td></td>
<td>Newmont Mining Corp, Carlin Operations</td>
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<tr>
<td></td>
<td>Phone 775.778.2034</td>
<td>F: 775.778.4038</td>
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<tr>
<td></td>
<td><a href="mailto:rachel.burgess@newmont.com">rachel.burgess@newmont.com</a></td>
<td></td>
</tr>
<tr>
<td>15 May</td>
<td><strong>7:00AM</strong>: Visit <strong>Chukar underground mine, Carlin District</strong></td>
<td>Thunderbird Motel</td>
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<tr>
<td>Friday</td>
<td>Review structural settings of some Carlin systems.</td>
<td>Elko, Nevada</td>
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<tr>
<td>16 May</td>
<td><strong>7:00AM</strong>: Visit <strong>Pipeline/Cortez District</strong>: review history of</td>
<td>Best Western Gold Country Inn</td>
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<tr>
<td>Saturday</td>
<td>discoveries in northern Nevada. Travel to Winnemucca</td>
<td>Winnemucca, Nevada</td>
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<tr>
<td></td>
<td><strong>Contact</strong>: Bob Leonardson, Chief Exploration Geologist</td>
<td>Also: Kevin Creel: 775-468-4489</td>
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<tr>
<td></td>
<td>Cortez Gold Mines</td>
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<tr>
<td></td>
<td>HC66 Box 1250</td>
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<tr>
<td></td>
<td>Crescent Valley, Nevada 89821-1250</td>
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<td></td>
<td>Telephone: 775-468-4430</td>
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<tr>
<td></td>
<td>&lt;<a href="mailto:leonardson@barrick.com">leonardson@barrick.com</a></td>
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<td></td>
<td><strong>Lodging</strong>: Best Western Gold Country Inn, Winnemucca</td>
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<td>(775) 623-6999</td>
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17 May  
**6:30AM – Visit Midas high-sulfidation epithermal system**  
Discuss characteristics of high-sulfidation hydrothermal systems.  
Best Western Gold Country  
Winnemucca, Nevada

**Contact:** Gabriel Graf, Mine Geologist - Midas Operations  
Newmont Mining Corporation  
Midas, Nevada 89414  
Work: 775.635.6560  
Cell: 775.304.7393  
E-Mail: Gabriel.Graf@newmont.com

18 May  
**6:30AM – Visit Twin Creeks Mine.**  
Discuss Getchell Trend ore deposits, Basin and Range structures  
Best Western Gold Country  
Winnemucca, Nevada

**Contact:** Patrick J. Donovan  
Newmont  
Twin Creeks Mine Geology Manager  
Golconda, Nevada  
775-635-4649 office  
775-304-0780 cell  
pat.donovan@newmont.com

**Contact:** Sue Abbott  
P.O. Box 208  
Winnemucca, NV 89446  
775-304-8188  
sue.abbott@newmont.com

**Evening:** 6:30PM Safety Presentations for Getchell Mine visit

19 May  
**6:45AM – Depart for visit to the Getchell Mine.**  
Discuss high-As systems, importance of volatiles, paragenesis of As and structural controls of precious metals mineralization.  
Best Western Gold Country  
Winnemucca, Nevada

**Contact:** Karl Marlowe  
Chief Exploration Geologist  
Turquoise Ridge / Getchell Trend  
HC66 Box 220  
Golconda, NV 89414  
Office: 775 529-5001 ext. 2329  
Mobile: 775 934-3871

20 May  
**6:00AM – Visit Rochester Ag-Au system; discuss volcanic-hosted precious metals systems; Ag-dominant systems**  
Best Western Airport  
Reno, Nevada

**Contact:** Mike Maslowski: <MMaslowski@coeur.com>  
Don Birak: <DBirak@coeur.com>

At Reno: **Evening Farewell Dinner**

**Lodging:** Best Western Airport Inn, Reno Airport  
1981 Terminal Way, Reno  
Telephone: 775/348-6370  
F: 775-348-7596

21 May  
Course ends, participants return.
Timing
♦ 2:00 PM, Tuesday, 12 May: Assemble at the Baggage Claim area at the Reno Airport; discuss safety and logistics, course itinerary.

♦ 2:15 PM: Load vans, depart for three-hour drive to Winnemucca, Nevada.

Logistics and Field Gear Checklist

♦ YOU MUST BRING THE FOLLOWING REQUIRED FIELD GEAR! DO NOT PLAN TO OBTAIN THIS GEAR WHILE ON THE COURSE AS THERE WILL BE NO TIME TO DO SO.

♦ Hardhat ♦ Reflective red or orange vest ♦ Gloves ♦ Steel toe boots ♦ Protective Eyewear

♦ Weather in northern Nevada in May is quite variable, so please bring:
  • Long pants (required; several pair)
  • Long-sleeve shirts (required)
  • Jacket/windbreaker; rain/snow possible, as are very sunny days
  • Cap or hat for sun protection
  • One nice set of clothing for company-sponsored dinners
  • Field/hiking boots for our field days
  • Sunscreen and lip balm
  • Sunglasses

♦ For our field work:
  • rock hammer
  • hand lens
  • hardness tester (scratcher)

♦ We will be traveling in two vans, with very limited space; use a duffle bag or soft-sided luggage for your clothing and personal effects; no hard-sided luggage.

♦ Remember to bring any prescription medicines and your insurance card/proof of insurance. You should also bring any medical information that would be important in case of an emergency.

♦ Cameras are permitted, although we ask permission to take photographs at each mine site. Be sure to bring extra film/cards.

♦ For underground mine tours – bring cool comfortable clothes to wear under coveralls, and bring a bottle of water to take underground.

♦ SEGF and our mine hosts will provide lodging and transport for students; students should bring money for snacks/meals, incidental expenses, phone calls, and the like.
<table>
<thead>
<tr>
<th>PARTICIPANTS</th>
<th>UNIVERSITY</th>
<th>COUNTRY</th>
<th>EMAIL</th>
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<td><a href="mailto:erich.petersen@utah.edu">erich.petersen@utah.edu</a></td>
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</table>
R = Reno, W = Winnemucca, B = Battle Mountain, E = Elko
1, Phoenix Project; 2, Carlin; 3, Cortez Joint Venture; 4, Leeville, Chukar; Twin Creeks; 6, Tourquoise Ridge
COPPER CANYON (PHOENIX)
TECTONOSTRATIGRAPHIC COLUMN

May 2005

Qa1  Alluvium/colluvium
Tb/Tts  Pliocene basalt and interbedded tuffaceous siltstone + sandstone 0-400 ft thick.
Tc  Caetano tuff Oligocene 33 Ma crystal-rich lithic tuff 0-200 ft thick.
Tgp  Eocene 38 Ma granodiorite porphyry of Copper Canyon and Wilson-Independence laccolithic stocks up to 1,500 ft thick. Variable argillic, sericitic, secondary biotite and propylitic alteration.
PPh  Pumpernickel sequence >5,000 ft thick allochthonous argillite + chert with minor sandstone, siltstone, limestone and metavolcanic units. Lower LU-1 and upper LU-2 units (Murchoy 1990). LU-1 formerly Pumpernickel Fm of Roberts (1964). Altered to biotite and siliceous hornfels. Golconda thrust = basal contact.
Pem  Edna Mountain Fm 60-120 ft thick lower siliceous pebble conglomerate and upper coarse-grained sandstone and calcareous siltstone. Altered to diopside+siliceous hornfels.
Pap  Antler Peak Limestone 140-220 ft thick medium-bedded micritic and bioclastic limestone with minor shale and conglomerate near lower contact. Altered to marble+actinolite-pyroxene skarn.
Pbu  upper unit of Battle Fm 120-220 ft thick siliceous pebble conglomerate with interbedded shale, siltstone and silty limestone. 0.5-2-inch diameter clasts of angular to subrounded quartzite and chert in sandy matrix. Altered to biotite+siliceous hornfels.
Ptm  middle unit of Battle Fm 40-125 ft thick thin-bedded calcareous siltstone and shale with minor sandstone. Altered to actinolite+diopside skarn.
Pbl  lower unit of Battle Fm 220-300 ft thick massive siliceous pebble conglomerate with minor sandstone + siltstone. 1-6-inch diameter clasts of angular to subrounded quartzite and chert in sandy hematic matrix. Altered to actinolite+diopside+epidote skarn + siliceous hornfels.
Eh  Harmony Fm >1,200 ft thick allochthonous micaceous sandstone and arkose with minor shale, siltstone and conglomerate. Altered to biotite hornfels + sericite in matrix. Dewitt thrust = basal contact with Scott Canyon Fm.
Ov  Scott Canyon Fm > 2,000 ft thick allochthonous chert+argillite (Dsc) with basalt/greenstone (Dsg), limestone (Dsl), and olistostrome (Dso) with olistoliths of limestone, sandstone and chert (Doebrich, 1994).

Ov  Valmy Fm lower quartzite and upper cherty argillite 300-1,000 ft thick.
General Stratigraphic Column for Northern Carlin Trend

DEVONIAN POPOVICH FM

MICRITIC MEMBER
Massive to laminated micritic to calcareous mudstone turbidites with mud lenses

SSD MEMBER
Thin bedded micritic limestone with zones of soft sediment deformation

PLANAR MEMBER
Laminated calcareous mudstone turbidites with a graptolite layer near top

WISPY MEMBER
Bioturbated calcareous mudstone to silty limestone

SILURIAN-DEVONIAN ROBERTS MOUNTAINS FM

APRON FACIES
WISPY/DEBRIS FLOW UNIT
Bioturbated debris flow

LAMINATED MICRITIC/WISPY/DEBRIS FLOW UNIT
Interbedded turbidites with bioturbated intervals and debris flows

LAMINATED MICRITIC/DEBRIS FLOW UNIT
Interbedded laminated calcareous mudstone and debris flows

BOOTSTRAP AND LAMINATED MICRITIC LIMESTONE MEMBERS
Equivalent massive fossiliferous to peloidal carbonate/dolomitic grainstone and laminated calcareous turbidite mudstone to siltstone

ORDOVICIAN VININI FM
Interbedded chert, sandstone, limestone, mudstone, and siltstone

DEVONIAN RODEO CREEK FM

UNDIFFERENTIATED
Calcareous mudstone, minor argillite, sandstone, limestone, siltstone, and chert

ARGILLITE MEMBER
Mudstone and argillite

BAZA SAND MEMBER
Sandstone, calcareous argillite, minor calcareous sandstone, argillite or mudstone

ARGILLITE MUDSTONE MEMBER
Argillite, mudstone and minor calcareous mudstone

ORDOVICIAN HANSON CREEK FM
Sandy Dolomite
Glossary

Brief definitions of terms as used in Nevada (and other places)

Decalcification—A type of alteration in typically occurring in silty limestone in which the carbonate is removed by dissolution. Generally this leads to increased porosity in the rock.

Pyritization—A type of alteration in which sulfur and possibly iron has been added to the rock mass and lead to the conversion of Fe-bearing minerals to pyrite and/or addition of pyrite.

Carbonaceous matter—A type of alteration in which organic matter is added to the rock mass. This process may complicate gold recovery as gold may adsorb on the organic matter making it difficult to separate later (see preg-robbing).

Restite—A rock that has been decalcified generally consists of clays and quartz.

Jasperoid—A rock mass, formerly limestone, which has been completely silicified. Some have applied this term to any silicified rock.

Preg-robbing—Characteristic of a rock mass that contains organic matter that strongly adsorbs gold.

Carbon-in-pulp—Granular coconut shell activated carbon, is widely used for recovery of gold from cyanide solutions. Gold cyanide is adsorbed into the pores of activated carbon, resulting in a process solution that is devoid of gold. The loaded carbon is heated by a strong solution of hot caustic and cyanide to reverse the adsorption process and strip the carbon of gold. Gold is then removed from the solution by electrowinning. Stripped carbon is returned to adsorption for reuse. Carbon-in-pulp operation is a variation of the conventional cyanidation process. Ore is crushed, finely ground, and cyanide leached in a series of agitated tanks to solubilize the gold values. Granular activated carbon is added to the leached slurry. The carbon adsorbs the gold from the slurry solution and is removed from the slurry by coarse screening. In practice, this is accomplished by a series of five or six agitated tanks where carbon and ore slurry are contacted in a staged countercurrent manner. The opening size of the CIP tank screens is such that the finely ground ore particles will pass through the screens, but the coarse carbon will not.

Roasting—A metallurgical process by which carbonaceous ores (see carbonaceous matter) are heated in air to 1000°F to oxidize the carbon. SO₂ is produced from pyrite, which is a common constituent of the ore and captured to make sulfuric acid.

Auto clave (pressure oxidation)—A metallurgical process by which sulfides (pyrite) is converted to an oxide at high temperature and pressure. It involves a reaction between gas (O₂) and solid. SO₂ is produced and captured to make sulfuric acid.
Sulfide refractory ore without carbonaceous matter is treated by pressure oxidation in an autoclave.

**Minerals**

<table>
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<th>Mineral</th>
<th>Chemical Formula</th>
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<tr>
<td>Orpiment</td>
<td>As$_2$S$_3$</td>
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<tr>
<td>Realgar</td>
<td>AsS</td>
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<tr>
<td>Galkhaite</td>
<td>$(\text{Cs, Tl})(\text{Hg, Cu, Zn})_6(\text{As, Sb})<em>4\text{S}</em>{12}$</td>
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<tr>
<td>Arsenopyrite</td>
<td>FeAsS</td>
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<tr>
<td>Pyrite</td>
<td>FeS$_2$</td>
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<tr>
<td>Dolomite</td>
<td>CaMg(CO$_3$)$_2$</td>
</tr>
</tbody>
</table>

Realgar from Turquoise Ridge, Getchell District, NV (Width = 2 cm); Photo: Erich U. Petersen
References

Many of the articles listed below are available in electronic format on the following website: http://www.mines.utah.edu/pyrite/SEGFnevada2007/index.htm


Cary, J. et al., 2000b, Geology, Skarn Alteration, and Au-Cu-Ag Mineralization of the Phoenix Project, (Battle Mountain Mining District), Lander County, Nevada, Geology and Ore Deposits 2000: Great Basin and Beyond, Proceedings Volume 2, 1021-1045.

Chevillon et al., 2000; Geologic Overview of Getchell Gold Mine Geology, Exploration and Ore Deposits, Humboldt County, Nevada. Geological Society of Nevada Symposium, Geology and Ore Deposits 2000: Great Basin and Beyond, 113-121.


Foo et al. 1996a, Geology and Mineralization of the South Pipeline Gold Deposit, Lander County, Nevada. Geology and Ore Deposits of the American Cordillera Proceedings. Volume 1, 111-121.

Leavitt, E.D., Spell, T.L., Goldstrand, P.M., and Arehart, G.B, 2004, Geochronology of the Midas Low-Sulfidation Epithermal Gold-Silver Deposit, Elko County, Nevada,
Economic Geology, 99, 1668-1686


Orpiment and Realgar from Leeville Mine, Carlin, NV (Width = 15 cm); Photo: Erich U. Petersen
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At the end of the trip, and as soon as possible, please send a brief e-mail to either John Thoms with a copy to Brian Hoal describing your experience on the trip and acknowledging the support of the Society of Economic Geologists. This is very important, as the feedback received by SEG is critical for the planning of future field course trips. You will also find that maintaining contact in this manner will greatly benefit your career whatever course you may follow. Your note may be in your native language.