COLORADO GEOLOGICAL SURVEY

ROCKTALK

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UNSINKABLE MOLY—COLORADO'S WORLD-CLASS METAL RESOURCE

Molybdenum is a difficult word to pronounce, but one that has had a powerful effect on the economy of Colorado. Just try saying it this way—"mlibdnm"—or better yet just call it moly—just like the famous Coloradan—Molly Brown. Boom towns like Leadville that had declined from the great days of gold and silver mining were resurrected from their ashes by the surge in moly mining that took place in the Twentieth Century and, hopefully, beyond.

What is Molybdenum

Molybdenum is silver to white colored metallic element (Mo on the periodic chart of elements). Molybdenum does not occur in nature as a native element. The word molybdenum has Greek origins and means lead-like. It is hard, malleable, ductile, and has a high melting point (about 2,617° C). Its chief ore mineral is molybdenite (molybdenum disulfide, MoS_2), a soft, shiny, greasy-appearing, blue-gray mineral.

Moly was first recognized in 1778 by a chemist named Carl Wilhelm Scheele but for more than a century there was no known use for the strange metal. At the turn of the Twentieth Century its value as a steel toughener and hardener for armaments was realized during World War I.

Uses of Molybdenum

Today, the primary use of moly is as a hardening agent for steel. Moly along with other alloying elements, such as chromium and nickel, give steel alloys a combination of strength, toughness, and wear and temperature resistance not found in unalloyed steel and iron products.

Molybdenum is mined as molybdenum disulfide; after a concentration process the disulfide is converted to molybdenum oxide by a roasting process. Molybdenum oxide and iron oxide are the compounds added to steel for hardening. For example, only a small amount of moly, 0.5 percent, added to steel gives the gears in your automobile differential the strength to do their job well and for a long time. Chrome–moly steel alloys are used to make extra durable frames for mountain bikes. Molybdenum disulfide is also used as an industrial and automotive lubricant.

CGS Mineral Resource Section at Titanium Ridge in Elbert County; from left: Nicole Koenig, Laura Wray, Jim Cappa, Beth Widmann, Chris Carroll, and John Keller

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"The world's largest underground mine".....

"Colorado supplied 90 percent of the world's molybdenum demand"....

"Moly tax revenues and Moly miners' salaries virtually supported three counties"....

"Colorado contains three of the world's greatest moly deposits"...

It's easy to see why the hard to pronounce mineral molybdenum continues to fascinate any of us who are interested in minerals, mining, or Colorado's boom and bust history of mining. Molybdenum mining has been an important part of Colorado's history and economy throughout the twentieth century. Thousands of people have worked in, with, or around our state's moly industry. These include the geologists who mapped and characterized the giant moly deposits in Colorado and consequently identified new ore-finding techniques, while introducing important new ideas about hydrothermal alteration and igneous processes. These people also include the pioneering entrepreneurs who developed new uses for this

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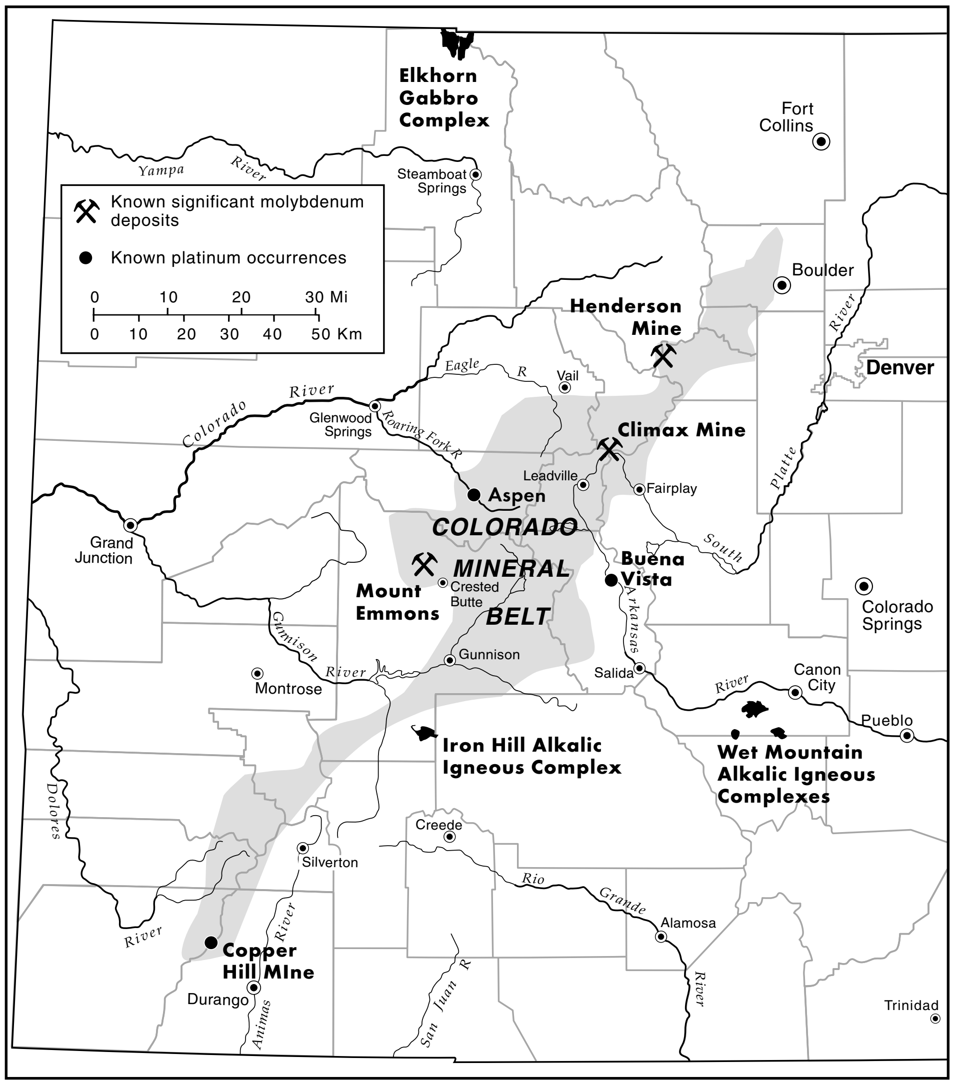
Geology of Molybdenum Deposits in Colorado

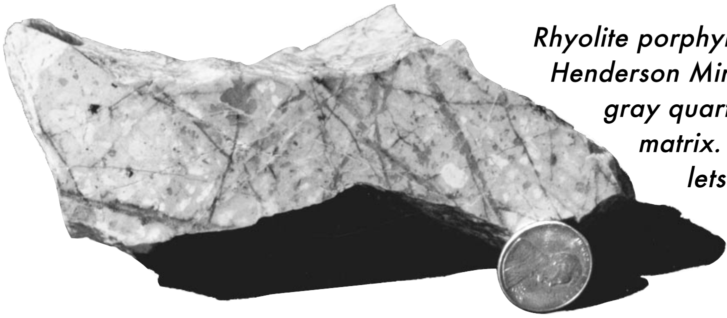
Deposits of molybdenum that can be economically exploited occur throughout the Rocky Mountain west in New Mexico, Idaho, Nevada, and especially Colorado. All the known molybdenum deposits in Colorado occur in a northeast trending zone in the mountainous part of the state, known as the Colorado Mineral Belt (see map below). Molybdenum ore deposits* occur associated with a particular type of igneous rock called porphyry—a rock composed of usually well shaped, large crystals that geologists call phenocrysts set in a very fine-grained matrix—like a raisin pudding. The term porphyry describes the texture of the rock. A name describing the mineralogic composition of the rock precedes the word porphyry, like granite porphyry or rhyolite porphyry. Rhyolite and granite porphyries are the most common host rock for molybdenum ore deposits in Colorado. Rhyolite and granite are mineralogically and chemically similar; however, rhyolite is very fine grained and granite is coarse grained (see diagram on page 9).

Phenocrysts in most porphyritic rocks are usually composed of feldspar, quartz, mica, or in rare cases, other minerals like horn-

*Ore is defined as any rock or mineral that can be produced at a profit.



Map showing outline of Colorado Mineral Belt, molybdenum deposits, and platinum occurrences



Rhyolite porphyry from the Henderson Mine. Phenocrysts of gray quartz in a feldspar matrix. Dark colored veinlets of molybdenite are on right side of rock.

blende or pyroxene. The matrix, which usually can only be seen with the aid of a microscope, can be composed of quartz, feldspar, mica minerals, hornblende, pyroxene or other minerals (see photo above).

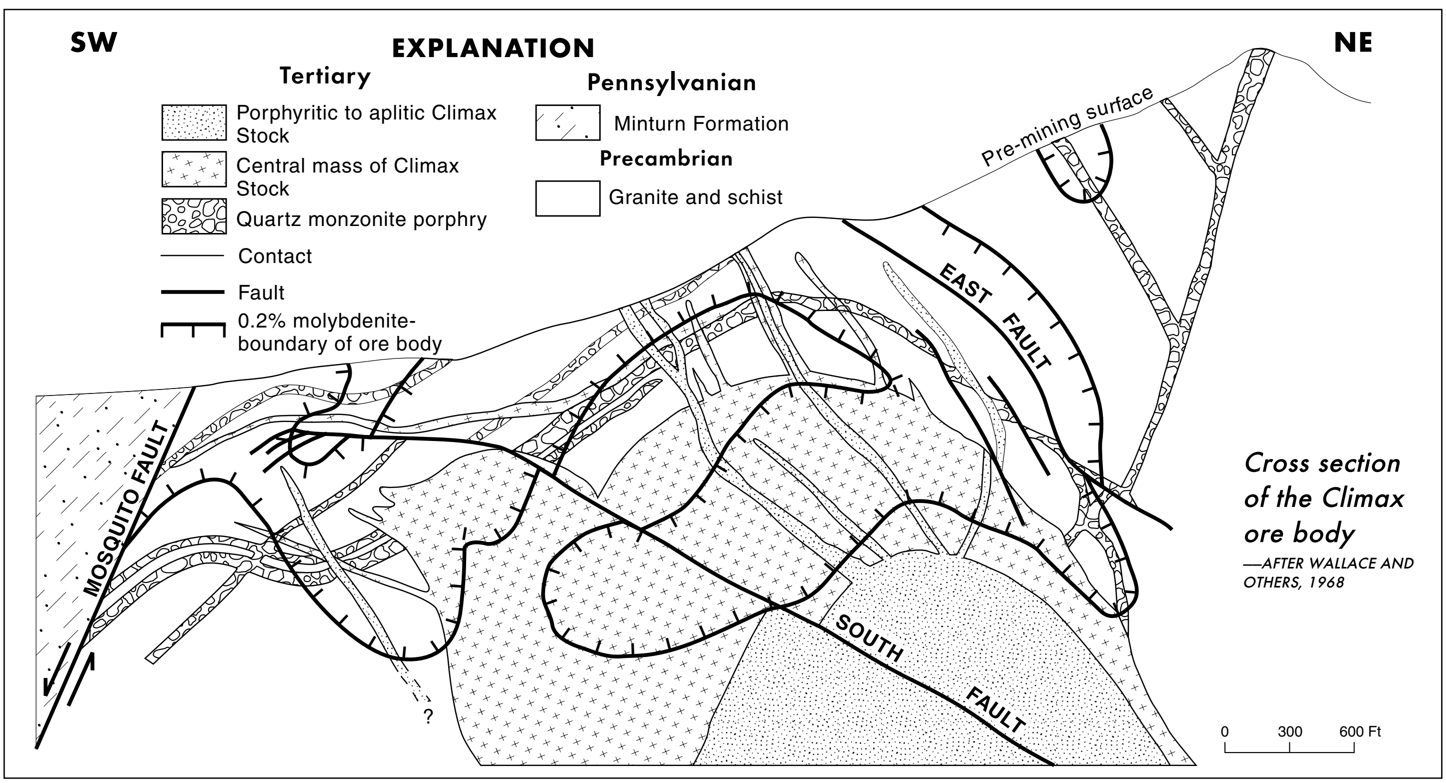
The igneous intrusions that form the three great molybdenum deposits of Colorado, Climax, Henderson, and Mount Emmons were formed during the Mid-Tertiary—about 17 to 30 million years ago. Each of these deposits consists of multiple intrusive stocks*. All three deposits are very similar in characteristics and origin.

*A stock is a body of igneous intrusive rock that has surface area of less than 40 square miles, has steep contacts—generally dipping outward—and is generally discordant with the surrounding rocks.

Climax Deposit

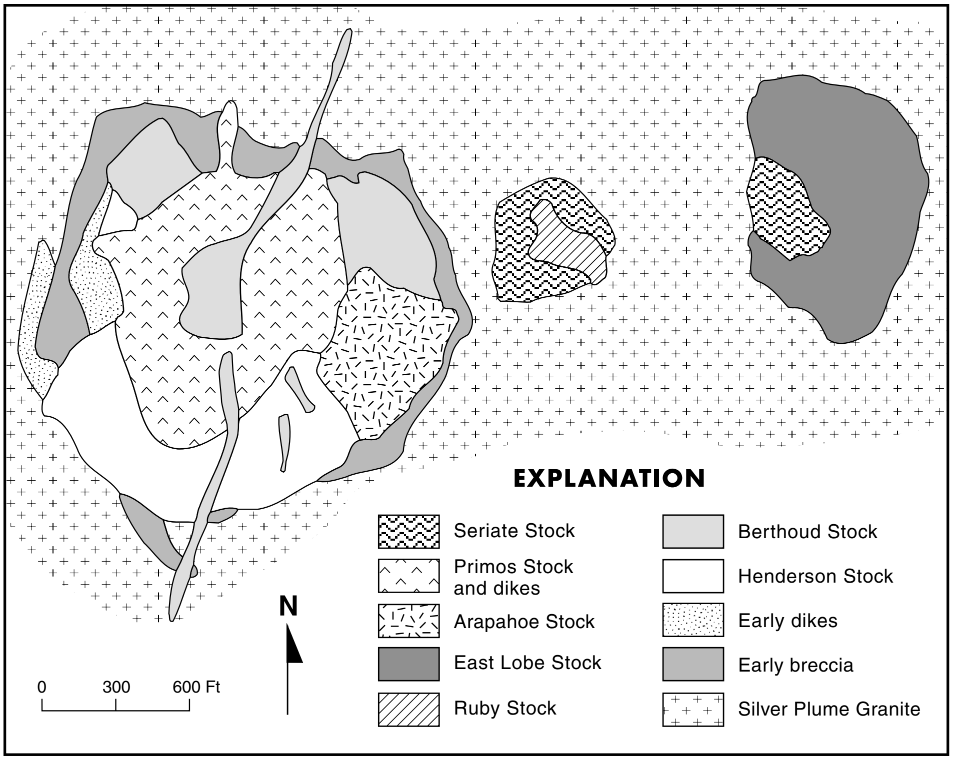
About 30 million years ago a granitic porphyry-the Climax Stock-was intruded into the 1,700 million-year-old metamorphic rocks of the Mosquito Range. Four separate phases of the Climax Stock have been identified. Many of the minerals that make up the granite porphyry of the Climax Stock show evidence of hydrothermal alteration. Hydrothermal alteration is the process of hot fluids, usually briny, acidic water with many dissolved elements, coming in contact with stable minerals and changing the composition or texture of that mineral to another mineral or forming entirely new minerals. For example, hydrothermal alteration can cause feldspar minerals to form new clay minerals, such as sericite, or very fine-grained silica can replace other minerals. Metallic minerals, such as molybdenite, are usually introduced during episodes of high- temperature hydrothermal alteration with the introduction of quartz and potassium feldspar. Most of the molybdenum mineralization occurs as molybdenite in quartz-filled veinlets formed before and during the main event of hydrothermal alteration (see photo at left). Broad halos of pyrite mineralization and small quantities of tungsten and tin minerals occur with and peripheral to the molybdenite mineralization.

The geological cross section of the Climax Stock (see figure below) shows the north trending Mosquito Fault, a major structural feature of the central Colorado Mountains. The Mosquito Fault is thought to be of Precambrian age; however, it also displaced the formations on either side of the fault nearly two miles vertically during



Cross section of the Climax ore body

—AFTER WALLACE AND OTHERS, 1968



Geologic map of the 8,100-foot level of the Henderson Mine
—AFTER CARTEN AND OTHERS, 1988

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new, not well-understood mineral, and the miners, townspeople and railroaders who worked to meet a nervous country's growing demand for a mineral deemed essential for national security, once its applications were documented.

It's hard to predict the future for molybdenum mining in Colorado, but the reality of its history is still worth considering. Another mineral that may be as interesting for Colorado in the future is platinum. Platinum, and related minerals such as palladium have exciting, high-tech applications and command astounding prices in today's world market. Although it has never been mined in Colorado, there are very real possibilities of commercial occurrences.

Read on in this *RockTalk* and think a little bit about Colorado's history of mining, as well as the possibilities for its future.

late Tertiary time-after the intrusion and hydrothermal alteration associated with the Climax Stock because it cuts alteration and mineralization.

Henderson Deposit

The Henderson ore body was discovered by exploration drilling by Climax geologists beneath the Urad molybdenite deposit, which was exposed on Red Mountain near Berthoud Falls in Clear Creek County. The Urad deposit was so named because early prospectors thought the yellow minerals at the prospect were uranium oxide minerals. AMAX completed mining of the Urad deposit in 1974; that deposit yielded 13.7 million tons of ore grading 0.35 percent MoS_2 —about 96 million pounds of molybdenite.

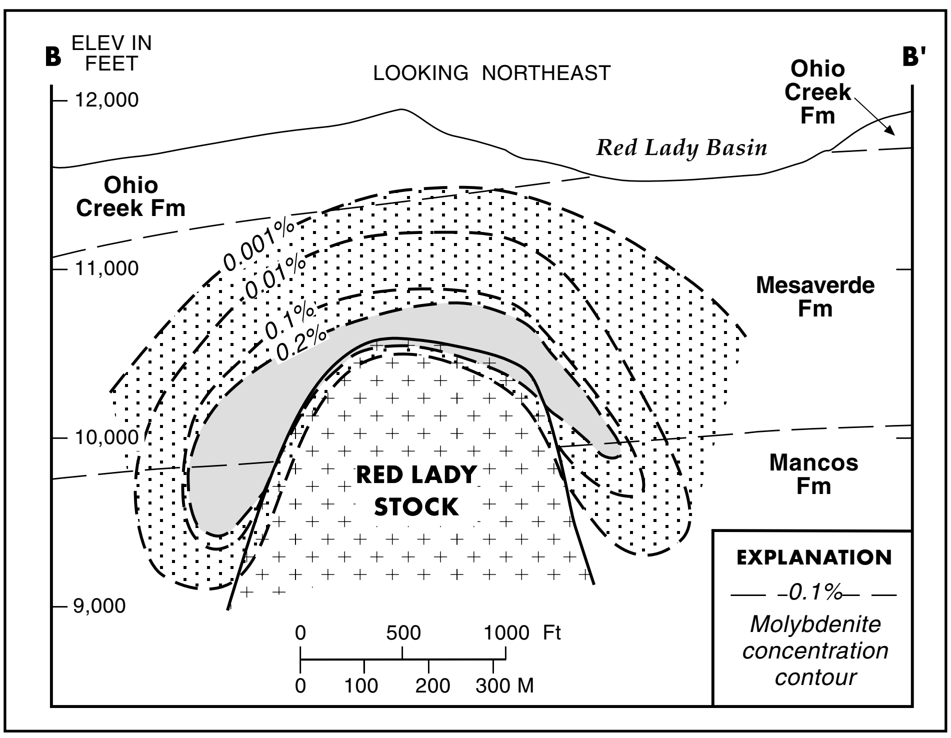
The Henderson molybdenum deposit was formed by the intrusion of at least eleven different porphyritic stocks, mostly of rhyolite composition, into the 1,400 million year old Silver Plume Granite (see map at left). Like Climax, molybdenite mineralization occurs mostly in quartz filled veinlets. Other modes of molybdenite mineralization include disseminated mineralization and coatings on fractures in the porphyry. The veinlets consist of molybdenite and the following gangue minerals (Gangue refers to minerals of non-economic interest that are associated with ore minerals): quartz, pyrite, fluorite, sericite, and potassium feldspar. The age of the mineralization and alteration is between 24 and 30 million years. There were several periods of hydrothermal alteration in and around the Henderson deposit. The alteration event associated with the molybdenite mineralization caused the introduction of potassium feldspar and silica. The original ore reserve estimate of the Henderson ore body at the inception of mining in 1976 was 800 million tons of ore at an average grade of 0.28 percent MoS_2—about 4.48 billion pounds of molybdenite.

Mount Emmons

The Mount Emmons molybdenum deposit was discovered by detailed geological mapping, sampling, and drilling during the period from 1970 to 1976. Early exploration work in the area had focused on the lead-zinc-silver deposits around Mount Emmons (named after a famous U.S. Geological Survey geologist) north of the town of Crested Butte, Colorado. The rocks around Mount Emmons are mostly Cretaceous to early Tertiary age sandstones and shales of the Mesaverde, Mancos, Ohio Creek, and Wasatch Formations.

The Mount Emmons Stock was intruded into the Mancos and Mesaverde Formations and it metamorphosed the sediments to a hard, fine-grained rock called hornfels. There are two recognized igneous intrusion phases associated with the Mount Emmons Stock. The first was a mid-Tertiary phase of rhyodacite and quartz latite porphyry dikes and sills. The second was a composite rhyolite porphyry stock that was intruded in late Tertiary time. Three intrusive events are recognized in the rhyolite porphyry stock. Radiometric age dates of the Mount Emmons Stock indicate an age of 17.7 million years.

The Red Lady intrusive is part of the Mount Emmons stock; it is strongly altered and also contains the lower part of the molybdenum mineralization. (see figure below) Most of the mineralization also occurs in the hornfels of the Mancos and Mesaverde Formations. As at Climax and Henderson the mineralization consists of veinlets of quartz, potassium feldspar, fluorite, and molybdenite. The geological resource at Mount Emmons is 155 million tons averaging 0.44 percent MoS_2. The Mount Emmons ore deposit has been evaluated with feasibility studies but has not been developed.



Section showing molybdenite distribution in relation to the Red Lady stock
—FROM THOMAS AND GALEY, 1982

History of Molybdenum Mining in Colorado

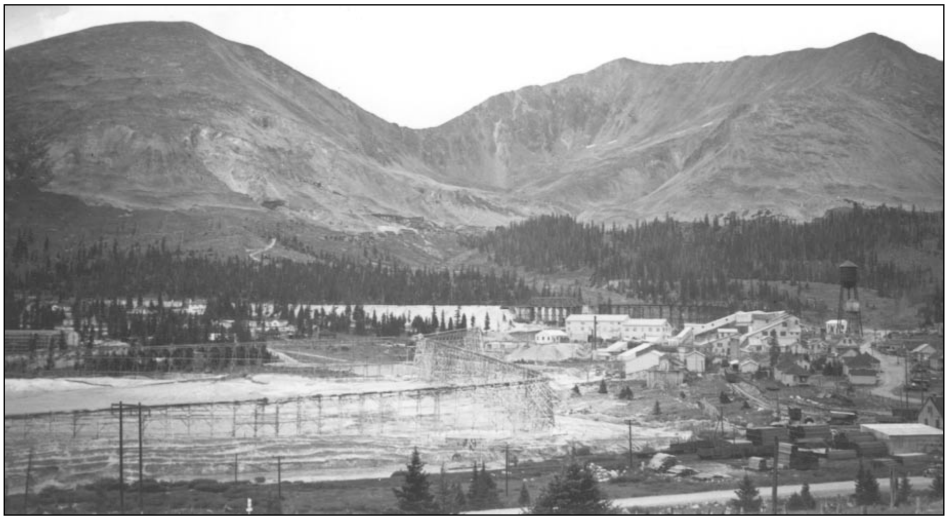
In 1879 a prospector named Charles Senter was searching for gold on Bartlett Mountain, part of the Mosquito Range in central Colorado. He discovered a yellow-stained outcrop, which is usually a good sign of the presence of sulfide minerals and gold. He hiked up to the outcrop and found a crystalline gray rock laced with thin veinlets of a dark bluish-gray greasy mineral and pyrite. Senter staked three claims over this outcrop because of the presence of the pyrite. He thought the gray mineral was some sort of lead or even graphite. It took Senter an additional 14 years to get his samples analyzed. The strange gray mineral was a sulfide of molybdenum, now recognized as molybdenite.

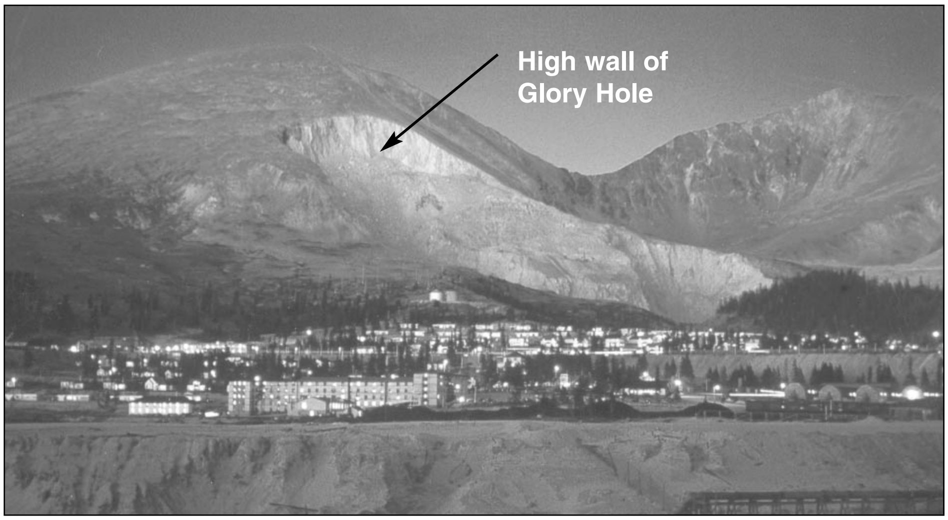
The small settlement of Climax was established at 11,318 feet near Fremont Pass just below Bartlett Mountain in 1884. Blessed with short but spectacular summers and long hard winters, Climax was only a couple of bunkhouses at a railroad siding on the Denver-Leadville rail route.

In the 1890s molybdenum was just starting to be used in industrial processes for hardening steel. The known deposits of molybdenum that were being mined in Norway were small but high-grade vein deposits. Other prospectors and businessmen had heard of the strange metal on Bartlett Mountain near Climax. They staked claims around Senter's original discovery, dug adits (tunnels with only one opening) and in 1911 shipped some ore to a mill in Denver. Although metallurgical processes were improving, the low-grade ores from Climax could not compete with the high-grade vein deposits being mined in Norway.

It was in 1916 with World War I raging in Europe, when a German company with American headquarters in New York became interested in the molybdenum deposits at Climax. Molybdenum's steel hardening properties made moly steel excellent for armaments. The German company's American subsidiary was called the American Metal Company. They conducted test mining and eventually gained control of the deposit. The company was "Americanized" in 1917 as America entered World War I against Germany and Climax Molybdenum Company was formed. A schoolhouse, post office, and residences were established at Climax in 1918. The new Climax Mine produced about 250 tons of ore per day. The first rail cars of molybdenum concentrate were shipped from the Climax Mine in April 1918 beginning the long history of mining and milling at Climax.

When World War I ended in November 1918, the demand for and the price of molybdenum crashed. The industry slowly recovered during the 1920s and 1930s as Climax Molybdenum Company developed new uses for





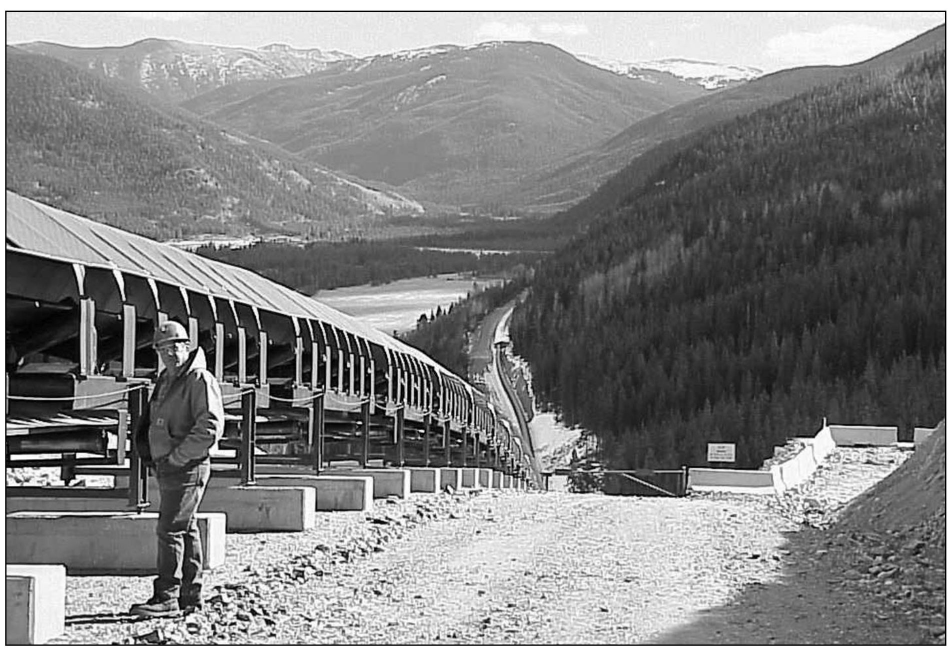
Climax Mine and Mill (top) in the years before WWII and (left) in the mid-1960s. Note the expansion of the Glory Hole in the later photo.
—PHOTOS COURTESY OF THE COLORADO HISTORICAL SOCIETY

moly. In 1929, the Climax Mine instituted a new system of bulk underground mining-the block caving method. The highly efficient block cave method allowed production to climb to over 6,000 tons of ore per day. As the depression of the 1930s came to end, Climax Mine was making its first significant profits and was supplying 90 percent of the world demand for molybdenum (see photos above).

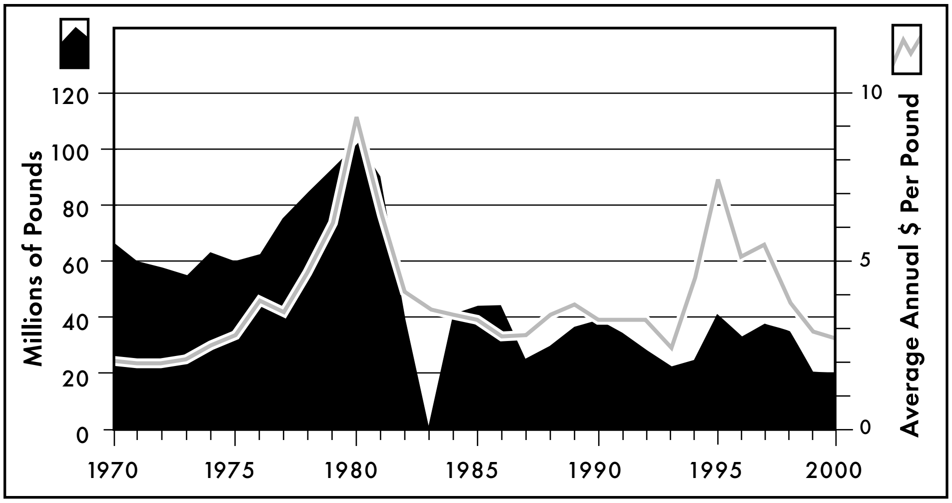
As production increased at the Climax Mine more miners and mill workers were needed. However, the long hard winters and high altitude at Climax caused many miners to quit after only a short period in those harsh conditions. A company town grew up at Climax and families soon settled into the routine of life in the high Rockies.

World War II and the quickly ensuing Korean War fostered new uses for moly in pigments, fertilizers, and high temperature alloy steel for jet engines. Recovery circuits for the small amounts of tin and tungsten—important metals for the war effort—in the Climax ore body were installed in the mill. Production during those war years and the following Cold War years was deemed a high priority by the American government and in 1957 production reached 35,000 tons per day, making Climax the world's largest underground mine. In 1960 the Company expanded the mine and mill workings onto the site of the village of Climax. Most of the miners and other workers moved to the nearby town of Leadville creating a boom in that venerable old mining town.

In 1964 Climax engineers designed and set the world's largest non-nuclear explosion in the Climax Mine. They used 416,000 pounds of explosives to blast 1.5 million tons of ore leaving behind



Portion of the surface conveyor belt between the Henderson Mine and the mill—PHOTO COURTESY OF HENDERSON MINE



Production from Colorado mines and price of molybdenum 1970–2000

a semi-circular depression of broken rock called the Glory Hole. During the boom years of the 1970s production increased to a spectacular 50,000 tons of ore per day. The price for molybdenum rose from $2 per pound to $9.50 and up to $30 per pound on the spot market. An open pit mine was constructed and employment increased to 3,000 persons in the underground and open pit mines and the mill. As profits increased the company, now called American Metals Climax (AMAX), following the 1956 merger of Climax Molybdenum Company with the American Metals Company, opened the new state-of-the-art Henderson Mine in Clear Creek County. However, the storm clouds for moly were growing on the horizon.

Because of the high price of molybdenum in the 1970s, many large porphyry copper mines in Arizona, Chile, and British Columbia installed molybdenum recovery circuits to their mills. Those copper mines produced what is known as by-product molybdenum. A national recession began in the early 1980s. With increasing molybdenum supplies and decreased demand, the mine began a series of painful layoffs that eventually led to the closure of the mine. In spite of these difficulties, mining from Climax continued on a sporadic basis through the early 1990s. The last ore containing about 3 million pounds of molybdenite was mined in 1995.

The Climax Mine produced 500 million tons of ore that yielded about a million tons of elemental molybdenum with a "year-mined" value of $4 billion. There is still ore in the open pit mine—137 million tons with about 500,000 pounds of contained molybdenum.

The more efficient Henderson Mine began to carry the bulk of the molybdenum production load for AMAX in 1976. Like Climax, the Henderson Mine is an underground mine that utilizes the block caving method. The mill for the Henderson Mine is located some 15 miles west of the mine across the Continental Divide in the Williams Fork valley. When the mine was first completed in 1976, a 10-mile underground tunnel was built under the Continental Divide. Ore from the mine was transported by a railroad system to the primary crusher located at the west end of the tunnel. In 2000 the rail line was replaced by a more efficient conveyor system. (see photo on page 6). Also, in 2000 the primary crusher was installed at the conveyor belt pick up point in the mine.

The graph above shows both Colorado molybdenum production and prices. Of note is the tremendous price increase of the late 1970s and the resultant price and production crash in the early 1980s. Production from the Henderson Mine in 2000 was about 20 million pounds of molybdenum disulfide, down from a recent high of 39 million pounds in 1995.

–Jim Cappa

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PLATINUM GROUP ELEMENTS— ENVIRONMENTALLY USEFUL PRECIOUS METALS

When most people think of precious metals, they usually think "gold and silver". The most precious of the precious metals in recent years have been the platinum-group elements (PGEs); these include platinum, palladium, rhodium, ruthenium, osmium, and iridium.

Uses

Of the PGEs, platinum and palladium are the most widely used. The largest use for platinum, palladium, and rhodium is in automotive emission-control systems, where the catalytic properties of the metals are instrumental in reducing emissions of air pollutants. Another use for PGEs is in fuel cells; an emerging alternative-energy technology, which many believe, has the potential to replace the internal-combustion engine in automobiles. Fuel cells produce energy by combining hydrogen or methanol with oxygen in a heat-producing reaction that leaves behind water vapor as its only emission. PGEs act as a catalyst for the energetic reaction. DaimlerChrysler has pledged to have fuel cell-powered electric cars available to the public and on the road by 2004. The PGEs have many other uses such as computer data storage, electronics, and biomedical devices. A major use for platinum, but not the other PGEs, is in jewelry. Platinum jewelry has become popular in recent years as a fashion item.

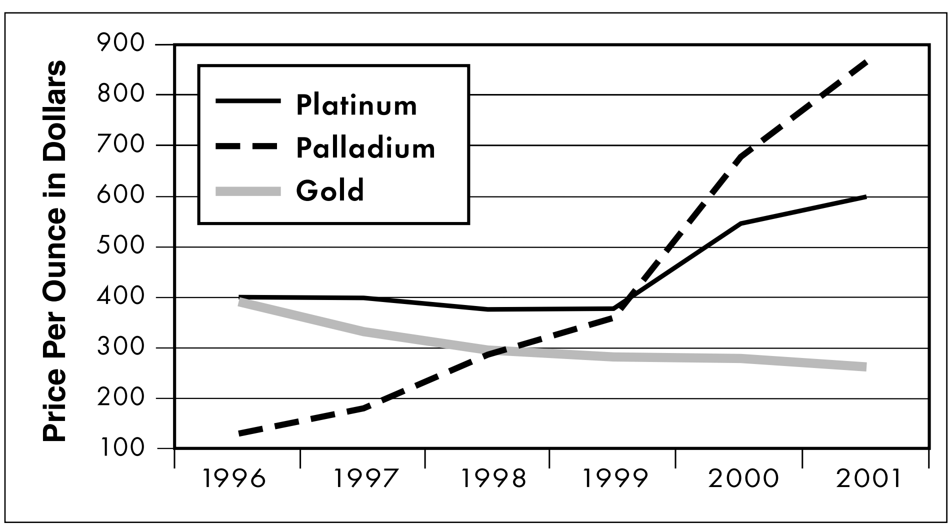
Prices

While other metals languish amidst low prices, mine shutdowns, and slashed exploration activities, the PGEs are enjoying an unprecedented boom in demand, which has led to high prices and accelerated exploration for new sources of supply. The price of both platinum and palladium was over $600 per ounce as of May 2001. The graph below shows how platinum and palladium prices over the last five years compared to the price of gold.

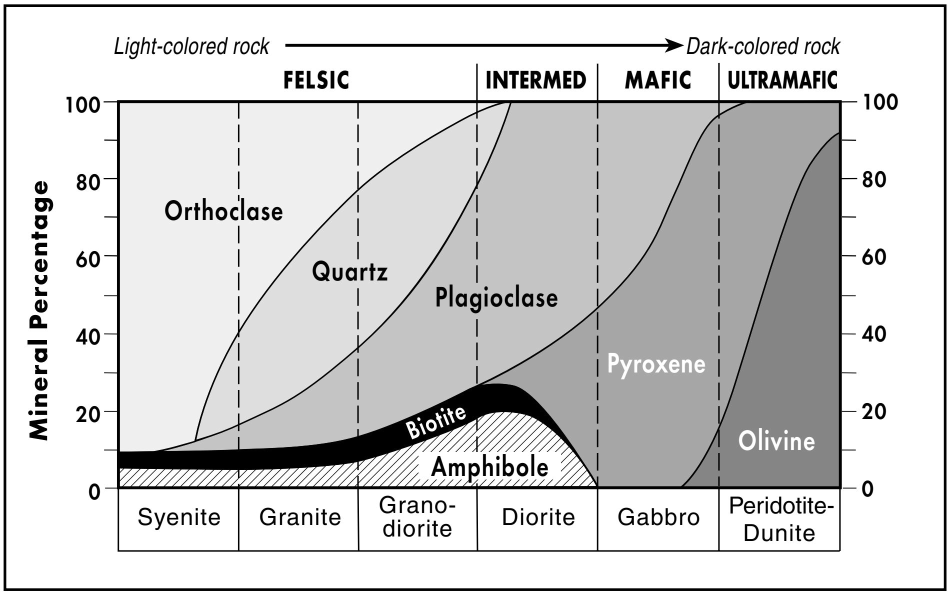
Geology of PGEs

Platinum and the other PGEs usually are found together in specific geological environments. The most common association of PGEs is with layered mafic-ultramafic intrusive igneous rocks (see diagram on page 9). These intrusives are often funnel-shaped, and are generally composed of varying amounts of olivine, pyroxene, hornblende, and plagioclase feldspar. They are formed from the cooling and crystallization of iron- and magnesium-rich molten material (magma) deep within the earth. In these deposits, PGEs commonly occur with chromite, a chromium and iron-bearing oxide mineral, or with iron, nickel and copper sulfide minerals such as pyrrhotite, pentlandite, and chalcopyrite. These minerals often occur in discrete layers within the intrusive mass. These rich layers are thought to be formed by a process called magmatic segregation (Guilbert and Park, 1986). In this process, solid minerals crystallize from the liquid magma at different times based on chemical equilibrium conditions (this is called fractional crystallization). The heavier minerals, including those containing PGEs, have a tendency to crystallize early in the process. These then settle through the remaining magma and form layers called cumulates (see figure on bottom of page 9). As crystallization of the magma progresses, more and more layers of differing compositions are added until the entire molten mass has solidified.

The Merensky Reef is a distinct mineralized layer within the Bushveld Igneous Complex in South Africa and is the largest PGE deposit in the world. The Merensky Reef is a 12 to 36-inch-thick layer consisting mostly of plagioclase feldspar and pyroxene. This nearly horizontal layer is present under an area of over 25,000 square miles. Platinum metals occur mostly with the iron and



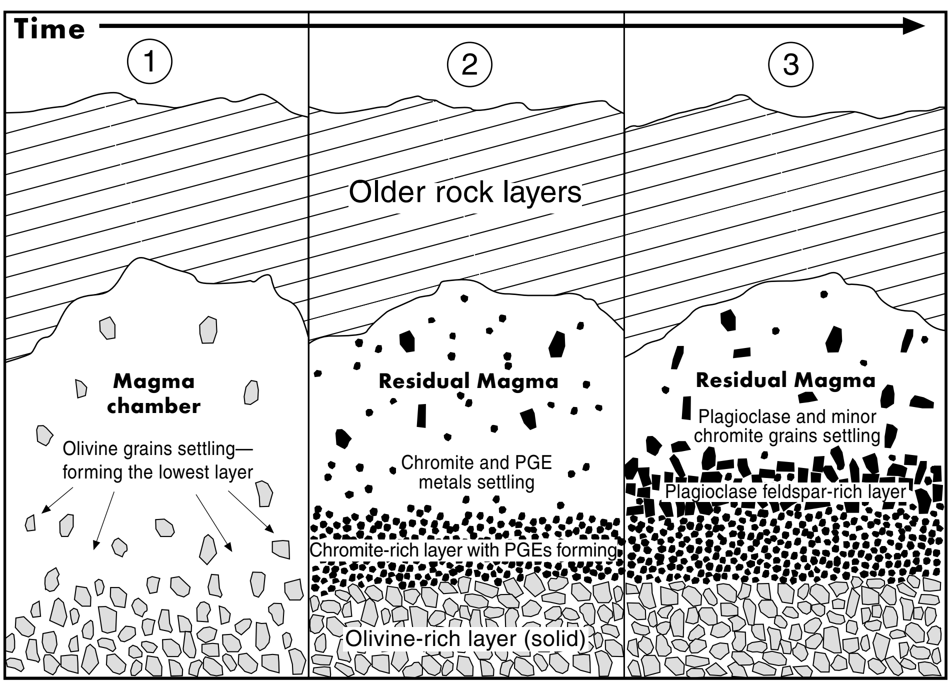
Price of platinum and palladium versus gold, 1996–2001



Simplified classification of intrusive igneous rocks

nickel sulfide minerals pyrrhotite, pentlandite, and pyrite; these minerals make up a only a small percent of the rock as a whole, but the PGEs that they contain make the Merensky Reef very valuable. Chromite cumulate bands are present as well, especially near the bottom of the layer. Geologists estimate that the Merensky Reef contains 17,000 tons of platinum-group elements. Considering that these metals today are valued at over $600 per ounce, the value of this deposit is an astounding $650 billion.

The only active PGE mines in the U.S. are located in the Stillwater Complex of southern Montana. At Stillwater, palladium and platinum are mined from the J-M Reef, an enriched layer within a mafic-



Simplified diagram showing how fractional crystallization and gravitational settling produce cumulate mineral layers

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ultramafic intrusive complex of Precambrian age.

Neither platinum or the other PGEs have ever been found in significant quantity in Colorado. However, Colorado is home to several zoned mafic intrusions that could potentially host concentrations of platinum and other PGEs. Perhaps the most notable of these is the Elkhorn gabbro complex near the Wyoming border in the Park Range of Routt and Jackson counties, north of Steamboat Springs. It is the largest of several zoned mafic-ultramafic intrusions of Precambrian age (about 1,800 million years old) that are exposed in southern Wyoming and northern Colorado. Several exploration companies are actively searching for PGE deposits in the area, especially around the New Rambler and Centennial districts of southern Wyoming (Hausel, 2000). Platinum was actually mined in those areas in the early 1900s. Several mafic-ultramafic intrusive complexes of Cambrian age (about 550 million years old) are present in southern Colorado. Three are in the Wet Mountains and one is in southwest Gunnison County. These intrusive rocks have some geological similarities to others elsewhere in the world that are known to contain PGEs.

Deposits of PGEs also occur in other geologic environments. PGEs and copper sometimes occur together in alkaline intrusive igneous rocks such as syenite. One such deposit is at the Copper Hill Mine in the La Plata Mountains northwest of Durango, Colorado.

PGEs (especially platinum) have also been mined in small quantities from placer (stream gravel) deposits, especially in the Pacific Coast states. Small amounts of PGEs were mined along with gold from the river gravels in much of the famous Mother Lode region of California. A few occurrences of platinum within gold placers have been noted in Colorado (Peterson, 1994). The most notable of these are near Buena Vista in the upper Arkansas Valley, and in the Aspen area. —JOHN KELLER

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DURANGO GEO-CONFERENCE TO BE HELD IN OCTOBER 2001

The CGS will host another of our popular Geo-Conferences in October 2001. This year's conference, "Geologic Issues in Southwestern Colorado," will be held in Durango on October 15–16, with optional field trips on October 17.

The purpose of the conference is to highlight a wide variety of geology-related issues including land use planning, geologic hazards recognition and mitigation, emergency management, post-wildfire hazards, avalanche monitoring, gravel pits, water quality and natural degradation, and coalbed methane. (continued on next page)

The intent of the conference is to raise awareness of these issues and provide for information transfer between various stakeholders, in order to promote safer communities and reduce economic losses. A number of local perspectives will be offered, and the CGS and other government agencies will highlight their map and report resources, expertise and capabilities, and recent activities.

A variety of stakeholders, including planners, realtors, developers, engineers, geoscientists, emergency managers, building officials, landowners, attorneys, college students and educators, and local decision-makers may benefit from attending the Durango Geo-Conference. We anticipate that continuing education credits will be available for realtors.

The optional field trips will visit several sites of interest in southwestern Colorado, to see excellent examples of geologic hazards and other geology-related, land-use issues near Durango and Silverton. The field trips will add significant perspective and understanding to topics discussed at the conference.

The CGS has been hosting Geo-Conferences in Colorado on a regular basis since 1994. The conferences have focused on specific geologic-hazard issues in many parts of the state. Past conference locations include Golden (1994), Colorado Springs (1996), Montrose (1997), Glenwood Springs (1998), and Arvada (2000). The conferences are popular events within the local professional community, and they draw attendance ranging from 150 to 300 people.

There will be limited slots available for attending the 2001 Geo-Conference in Durango. Planning is now underway. Watch for the conference announcement, agenda, costs, registration, lodging, and other information, which will be posted on the CGS Web site by August 1: www.dnr.state.co.us/ geosurvey or contact Betty Fox at (303) 866-3330.

Earth Science Week Field Trips October 6–13

Field trips sponsored by the Colorado Geological Survey

Contact Matt Morgan to register: e-mail–matt.morgan@state.co.us or call–(303) 894-2171

SATURDAY, OCTOBER 6, 2002

TRIP 1: Mineral and Mineral Fuel Resources of Jefferson County

LEADERS: Cappa, Wray, Carroll, and Keller

Coal mines, fossil oil fields, clmay mines, uranium mines, and much more! Come learn about Jefferson County's rich mining heritage.

TRIP 2: Denver's Wonderful World of Geology

LEADERS: Matthews, Morgan, and Wray

Mountain building and destruction, volcanoes, desert dunes, inundation by sea waters, dinosaurs, and tropical rain forests! Come read Denver's ancient history in the rock layers along the mountain front.

SATURDAY, OCTOBER 13, 2002

TRIP 3: Pedal to the Past

LEADERS: Morgan and Matthews

Mountain bike trip into the continent's longest dinosaur trackway. Come pedal to more than 1300 footprints exposed along the banks of the Purgatoire River. Featured in National Geographic.

Upcoming Events Involving CGS

August 6–8
2001 Rocky Mountain Natural Gas Strategy Conference, Denver Convention Center, CGS booth, Mary Johnson, (303) 861-2387

September 14–16
Denver Gem & Mineral Show, Expo Hall—Merchandise Mart, CGS booth, (303) 233-2516, www.denvermineralshow.com

October 6–13
Earth Science Week Field Trips, Matt Morgan, (303) 894-2171 or e-mail matt.morgan@state.co.us

October 15–16
CGS GeoConference, "Geologic Issues in Southwestern Colorado", Durango, check the CGS Web site: www.dnr.state.co.us/geosurvey or call Betty Fox at(303) 866-3330

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THIS ISSUE
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CGS Gives Awards at the State Science and Engineering Fair

Congratulations

to **Evan Burgess** and **Thatcher Heumann**, winners of the CGS Special Award for Outstanding Earth Science Project at the 44th Annual Colorado State Science and Engineering Fair.

Evan Burgess, from Boulder, placed first in the Senior Division with his project: "Dating Paleo-Glaciers with a GIS-Based Analysis of Moraine Erosion." His project consisted of several GIS maps that looked at different attributes (e.g., slope, surface roughness) of moraines in the Wind River Mountains, Wyoming.

Thatcher Heumann, also from Boulder, placed first in the Junior Division with his project: "The Heat is On!" His project consisted of a number of experiments that assessed the heat-retaining capacity of different types of gasses, as applied toward Global Warming.

The Fair was held April 12–14, 2001, at the Lory Student Center, Colorado State University, Fort Collins. The CGS judging team included Dave Noe and the "Alliterative Trio" of Allison Apeland, Chris Carroll, and Matt Morgan.

Evan Burgess (left) and Thatcher Heumann, both from Boulder, are winners of the CGS Special Award for Outstanding Earth Science Project at the 44th Annual Colorado State Science and Engineering Fair at CSU

—PHOTO COURTESY OF COLORADO STATE SCIENCE FAIR

CGS Mission Statement

The CGS mission is to serve and inform the people of Colorado by providing sound geologic information and evaluation and to educate the public about the important role of earth science in everyday life in Colorado.

ROCKTALK

Colorado Geological Survey
1313 Sherman Street, Room 715
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