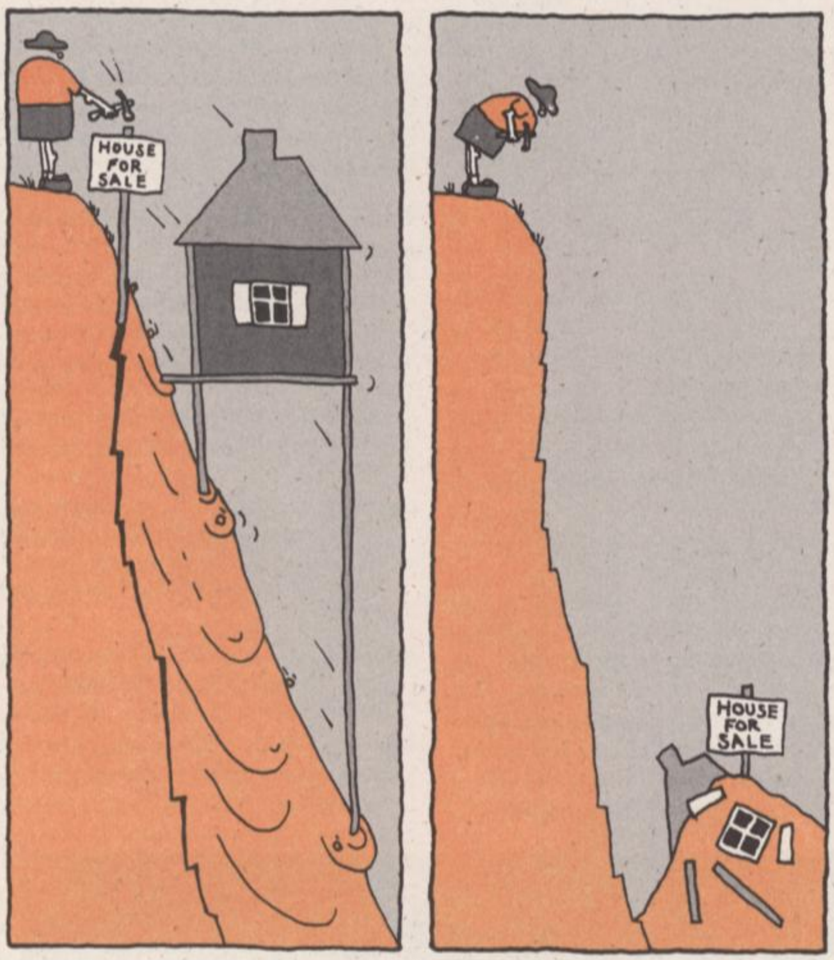
Fall 1995

LITE geology

A quarterly publication for educators and the public—
contemporary geological topics, issues and events

New Mexico Bureau of Mines and Mineral Resources (NMBM&MR)



This Issue:

Earth Briefs

Landslide Potential in New Mexico

William C. Haneberg
Assistant Director and Engineering Geologist, NMBM&MR

October 11, 1995 has been declared **National Landslide Awareness Day** by the Association of Engineering Geologists in order to provide information on landslides, their impacts, and impact mitigation. National Landslide Awareness Day will coincide with the annual celebration of International Decade for Natural Disaster Reduction Day, which was designated by the United Nations in an effort to reduce the vulnerability of people to the effects of natural hazards through information sharing. Public forums are planned across the country as part of National Landslide Awareness Day in order for geologists to share information with the public.

The word **landslide** encompasses a broad range of downslope mass movements that occur when the soil or rock composing a hillslope is not strong enough to support its own weight. Under the influence of gravity, the weak soil or rock begins to move downhill at rates that can range from a few centimeters per year to many meters per second. Strictly speaking, a landslide consists of a more or less intact mass of soil or rock that moves along a fairly well defined **zone of slip**. Other types of slope instability include **earthflows, mudflows, debris flows and rockfalls**. **Flows** are characterized by a fluid mass of soil and rock, whereas **falls** are characterized by a combination of falling, bouncing, and rolling of pieces of rock. All of these processes can be grouped together under the general heading of slope instability.

In 1985, a National Academy of

Sciences panel estimated that in the United States alone, landsliding causes $1 to $2 billion in economic losses and 25 to 50 deaths per year. The panel considered New Mexico to have a landslide problem of moderate severity.

New Mexico landslide activity

In New Mexico, an undiscovered dormant landslide near Costilla Dam, which was reactivated by construction of a new spillway across the toe of the landslide, added almost $5 million to the cost of an otherwise routine project. The Twining landslide near the Taos ski valley has damaged several homes, and small landslides occur along many northern New Mexico highways. Landslides also can deliver large amounts of sediment to river valleys, muddying the water and damaging aquatic ecosystems, especially economically valuable trout fisheries.

There are actively moving landslides in New Mexico along the Rio Grande, the Rio Chama, the Pecos River, US 64 between Tierra Amarilla and Tres Piedras, and other places. Researchers at Los Alamos National Laboratory have even discovered sediments deposited when lakes were formed behind landslide dams along the Rio Grande throughout its geologic history.

Some of the most visible active landslides in New Mexico occur along the Rio Grande, across the river from NM Highway 68 between Rinconada and Pilar. The active landslides stand out as grassy and tree covered oases surrounded by drier piñon, juniper, and chamisa covered slopes. A natural gas pipeline has been constructed across the surface of the landslides, so that the sliding mass can pass below the pipeline without breaking it.

Geologists have identified ancient landslides throughout New Mexico, and believe them to be the legacy of a colder and wetter Pleistocene Epoch. Many of these dormant landslides have the potential to be reactivated as a consequence of climate change, large earthquakes, and human activity.

What causes landslides?

Landslides can be triggered by earthquakes, erosion along rivers, or heavy precipitation. Seismic shaking has the effect of moving surficial deposits away from underlying bedrock, thereby increasing the possibility of sliding. Rivers can erode the toes of landslides, thereby removing the support for the soil or rock upslope. Heavy rainfall does not lubricate landslides; instead, rainwater infiltrates into the earth, increases the water pressure within the underlying soil or rock, and reduces its strength (earthquakes can also increase water pressure).

In many cases, therefore, landsliding is simply part of the cycle of geologic uplift and erosion, over which humans have little or no influence. By preparing geologic maps and analyzing aerial photographs, geologists can identify the places where landsliding is likely to occur as a natural process.

Community leaders and individual citizens can use this information to decide how, or even if, a landslide-prone area is to be developed. In other cases, landslides can be attributed directly to human activity such as logging, conversion of vegetation types, irrigation, or construction on hillslopes. A study conducted in Utah by the U.S. Forest Service showed, for example, that simply changing the vegetative cover from trees and bushes to grass increased landslide activity by 300%. However, human-induced landsliding can be eliminated by allowing for adequate geologic and engineering investigations and incorporating the results into subsequent land-use planning or engineering designs.

For more information about landslides and related hazards, consult the references below, visit your local library, or contact the New Mexico Bureau of Mines & Mineral Resources.

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West of La Cueva on NM–126 in the Jemez Mountains, a landslide in the spring of 1995 caused this road to collapse. The bedrock in the area is of the Permian Abo Formation, which is highly susceptible to landsliding when disturbed.

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a landslide decision...

In the *Great Landslide Case*, Samuel L. Clemens told a story about a practical joke played on a newly arrived U.S. Attorney for the territory of Nevada. The fictitious case devised by the local citizens involved two ranching neighbors who disputed claims to the same piece of property. It seems that a rancher named Mr. Morgan lived on a steep mountainside uphill from a fellow rancher, Mr. Hyde. Well, a terrible landslide transported Morgan's ranch—all of it—downslope and onto the **exact** area occupied by Hyde's place, covering it "to a depth of about thirty eight feet." Mr. Hyde was able to escape the horrible event. When he returned to the site of his interred ranch he discovered a happy Morgan, who refused to leave, laying claim to his newly placed cabin, fences, cattle, and barns. He said he was just occupying what was his, and "he's going to keep it—likes it bettr'n he did when it was higher up the hill."

Lawyers were engaged on both sides of the complaint, the U.S. Attorney taking Mr. Hyde's case. The judge listened to an onslaught of witnesses who overwhelmingly supported the side of Hyde.

What was the verdict? The judge, who was part of the ruse, conceded that although the bulk of evidence favored Mr. Hyde, he ruled ..."Heaven in it's inscrutable wisdom, has seen fit to move this defendant's ranch for a purpose. We are but creatures, and we must submit. If Heaven has chosen to favor the defendant Morgan in this marked and wonderful manner; and if Heaven, dissatisfied with the position of the Morgan ranch upon the mountainside, has chosen to remove it to a position more eligible and more advantageous to the owner, it ill becomes us, insects as we are, to question the legality of the act or inquire into the reasons that prompted it. No—Heaven created the ranches, and it is Heaven's prerogative to rearrange them, to experiment with them, to shift them around at its pleasure. It is for us to submit, without repining...Gentlemen, it is the verdict of this court that the plaintiff, Richard Hyde, has been deprived of his ranch by the visitation of God! And from this decision there is no appeal."

Hyde's lawyer, incensed at the foolish verdict, visited the judge that same night to negotiate a modification of the verdict. After pacing the floor and pondering for more than two hours, the judge smiled and told the lawyer that Hyde's title to his land underneath Morgan's was still as good as it ever has been...and therefore he was of the opinion that Hyde had a right to dig out from under there and..."

The U.S. Attorney "never waited to hear the end of it. He was always an impatient and irascible man, that way. At the end of two months the fact that he had been played upon with a joke had managed to bore itself, like another Hoosac Tunnel, through the solid adamant of his understanding."

—from Samuel L. Clemens, *Roughing It: The Great Landslide Case*

The Iron Trail to Fierro

An historic vignette—one of a continuing series of photo essays highlighting New Mexico's colorful mining past

Robert Eveleth
Senior Mining Engineer, NMBMMR

You won't find Hanover, Fierro, or Union Hill mentioned in any travelog or list of exotic vacation spots. Perhaps these places are too remote for the average traveler, although picturesque Silver City is located just 15 miles west. Some might consider the tourist facilities to be inadequate but that shouldn't deter the more adventurous. The fact is, very little is left today, particularly at Fierro and Union Hill, to indicate this area once was the thriving center of New Mexico's iron-mining industry. However, it is still possible to piece together a story of the people and events that shaped this mining district near Silver City, New Mexico.

Unusual place names

Union Hill lies in Grant County in southwestern New Mexico, almost in the heart of the Fierro-Hanover mining district. This district is bounded roughly on the south by New Mexico state highway 90 and by the Shingle Canyon mine four miles to the north (Fig. 1).

How were these names derived? *Union Hill* is easy; the property occupies the patented Union mining claim that covers the steep hill on the west side of the gulch. But the names *Hanover* and *Fierro* are more obscure and therein lies part of our tale that begins in the middle of the nineteenth century.

Sofio Hinckle, a German metallurgist trained in Saxony, immigrated to old Mexico, obtaining employment at the Mexican mint. Herr Hinckle soon became familiar with some of the very high-grade copper shipped to the mint from deposits far to the north, in Nuevo Mexico. Striking out on his own, he ventured north where he ultimately located a very rich copper deposit on the southern flanks of a prominent mountain almost four miles north of Santa Rita del Cobre (the other famous mine that had provided copper to the Mexican mint since ca 1804). Hinckle named his discovery in honor of his native home in Hanover, Germany. The ores produced from his mine were extraordinarily rich and attracted much attention prior to the Civil war. The mine actually outproduced the Santa Rita del Cobre (now Chino mine) up through early 1861.

But Hinckle's success was interrupted rudely when Confederate soldiers appeared on the scene and confiscated or destroyed nearly everything of value, including 187,000 pounds of copper bullion awaiting shipment (Raymond, 1870, p. 403; Lindgren, and others, 1910, p. 306). Perhaps as a result of the notoriety, the name Hanover mine was given not only to the mountain north of the mine, but also to the south-flowing creek, and to more than a few corporate entities.

Iron for the United States

In 1864, Richard Owen, geologist, and E. T. Cox, geologist and chemist from Indiana State University, visited the Hanover mine. They noted the high-grade copper ores as well as the "immense deposits of magnetic and brown oxide[s] of iron [magnetite and limonite], laying in great blocks..." They concluded that "good workable ore...exists in sufficient quantity to furnish iron for the whole United States." (Owen and Cox, 1865, p 54–55). Later investigators, who spent more time evaluating the deposits, would be more conservative in their reserve estimates, but the iron deposits were indeed extensive and rich.

These deposits were a curiosity, but remained undeveloped until two events occurred. First, blast furnaces for reducing iron oxide (magnetite) to iron metal were erected at Pueblo, Colorado by the Colorado Fuel and Iron Company, creating a potential market for the iron ore. Second, railroad construction reached the vicinity of the Hanover district in 1883, when the Silver City, Deming & Pacific Railroad arrived at Silver City. Some trial shipments of iron ore were hauled by ox teams from Fierro to Silver City and shipped by rail to Pueblo but this proved to be too laborious and unprofitable. The more valuable copper bullion could absorb the high freighting costs but the iron ore could not. These first trial shipments did provide a name for the little mining camp that appeared along the banks of Hanover Creek. The miners were predominately Spanish speaking and they simply called it Fierro (Sp. for iron) for obvious reasons.

Activity increased rapidly after the rails of the Silver City & Northern Railroad reached Hanover in late 1891 (rails were extended north to Fierro eight years later). John W. Brock and a group of eastern businessmen acquired control of most of the better iron properties and formed the Hanover Bessemer Iron Ore Association on August 1, 1894 (Hanover Bessemer, 1894). The Fierro–Hanover iron deposits are very low in phosphorus and ideally suited to the "Bessemer" steel making process—thus the inclusion of Bessemer in the name. The Association soon leased its properties to the Colorado Fuel and Iron Company, which immediately set out to develop the Union Hill and adjoining properties—the Republic, Anson S, and Continental—on a grand scale. New Mexico's iron-mining industry was finally born.

During 1914, the Association determined to take advantage of the increasing amounts of copper occurring with the iron and incorporated as the Hanover Bessemer Iron and Copper Company. This, in turn, attracted the attention of the United States Smelting, Refining & Mining Co. (USSR&M), which acquired a controlling interest in

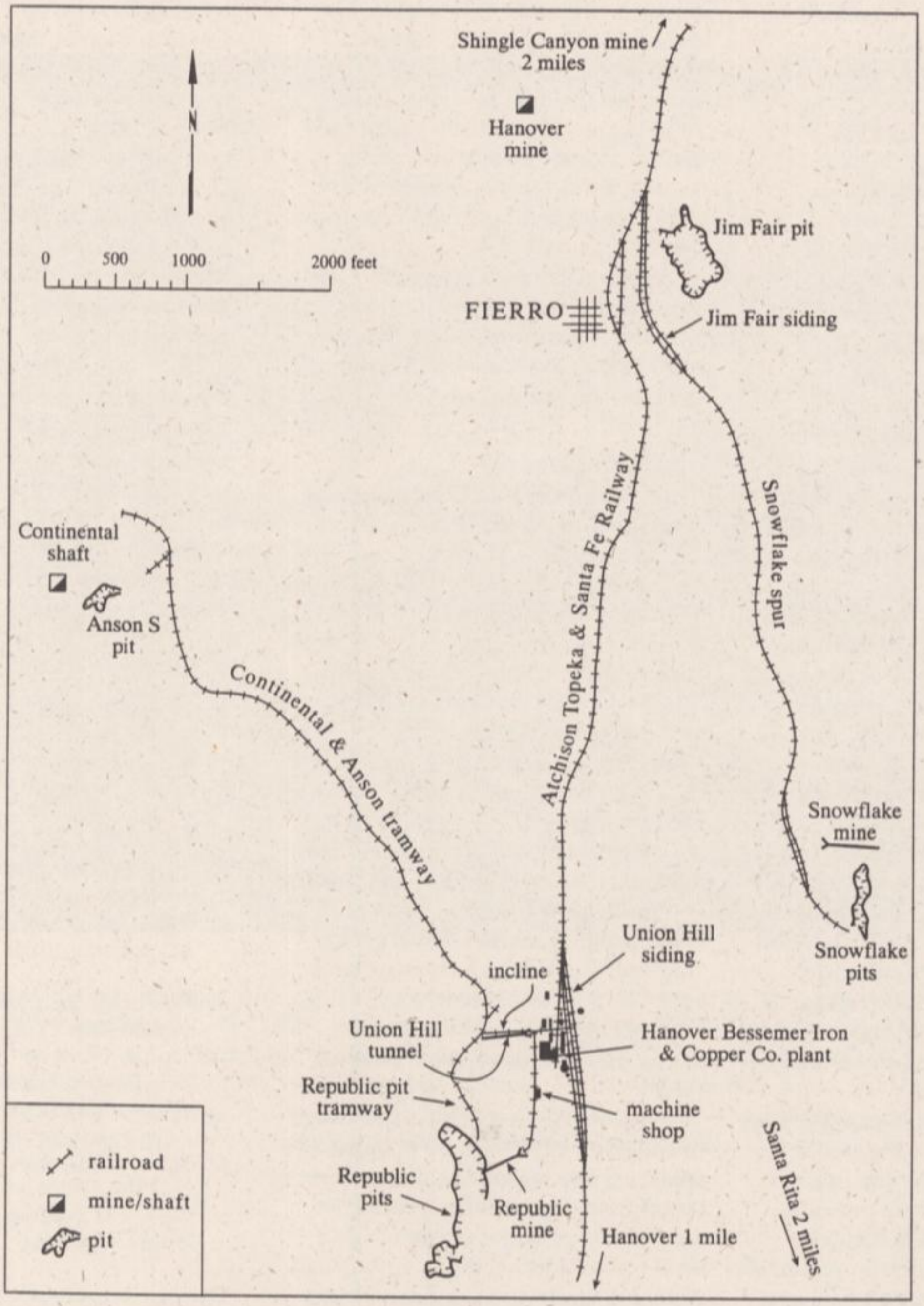

Figure 1—Sketch map of the Union Hill area showing relative positions of towns, railroad spurs and sidings, rail tramways, mines, and plant facilities of the Hanover Bessemer Iron & Copper Co. (After Kniffin, 1930, Fig. 3).

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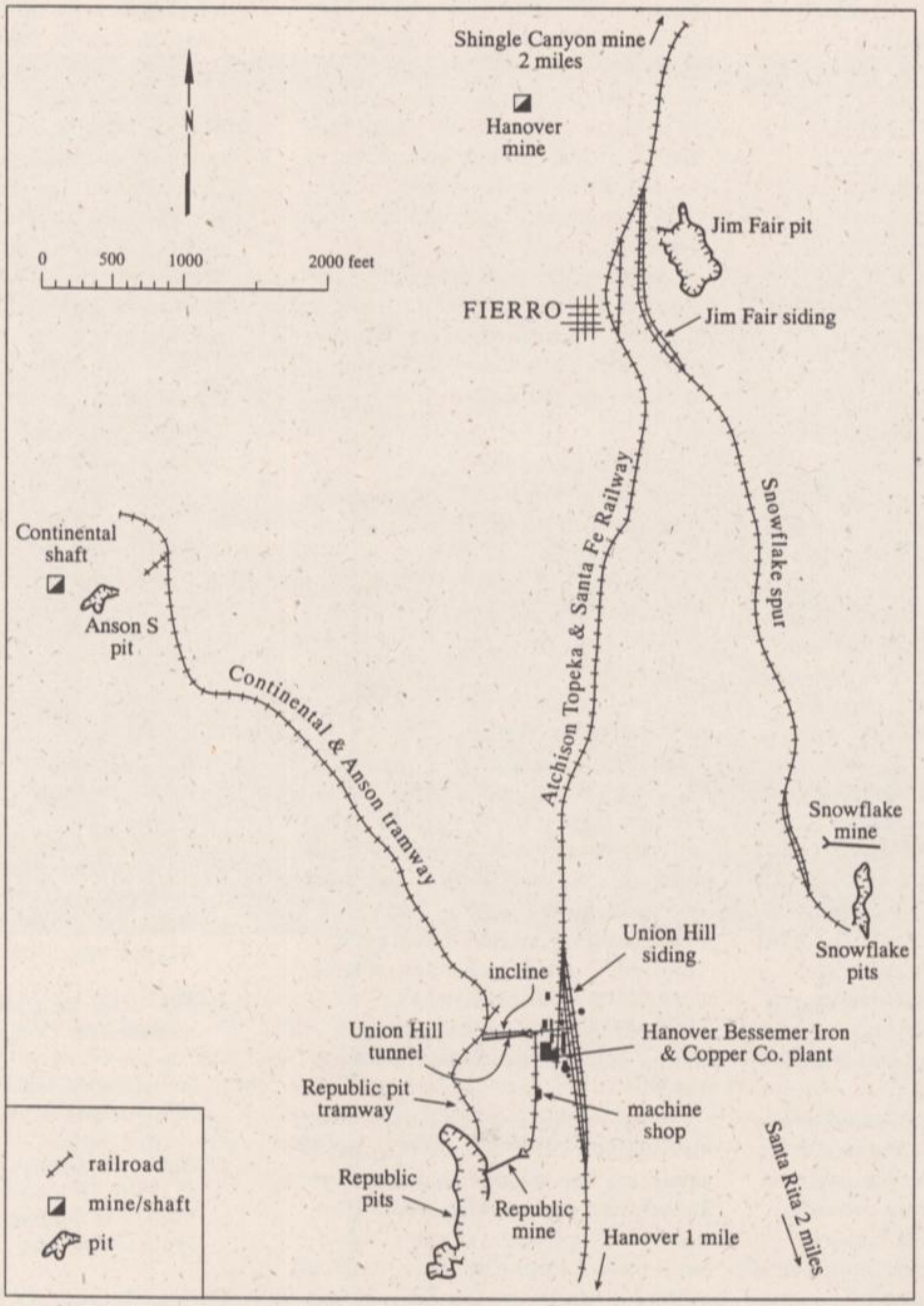

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Hanover Bessemer in 1919. USSR&M produced nearly 2½ million tons of iron ore through 1931 when operations ceased (Kelly, pp. 18–20, 87). Fierro-Hanover is by far the leading iron producing district in New Mexico, credited with nearly 5 million long tons (6 million st) through 1946. This figure does not include the more than 2 million st of by-product magnetite produced from the Continental underground mine since about 1969 and continuing to the present day.

Rails around Union Hill

From the very beginning of operations, the influence of the Colorado Fuel & Iron Company was apparent. Colorado engineers depended heavily upon rail haulage for moving ore and supplies in all their industrial facilities and Fierro was no exception (Fig. 2).

Soon the district was traversed by a variety of standard gauge (4 ft 8½ in) tracks and spurs, and narrow gauge (3 ft) rail tramways and inclines that would have gladdened the heart of the most discriminating rail fan. At the height of operations during the 1920s, Union Hill siding included two "house" tracks more than 1600 ft in length (Fig. 2) terminating on the north by a steeply-graded spur leading to the Hanover Bessemer mill yard. The yard was served by both standard and narrow gauge tracks. The 3-ft gauge is still the gauge of choice in the Continental underground mine today, (Fig. 3).

A trestle extended the tramway rails to ore bins located above the two house tracks to facilitate loading the iron ore on standard gauge rail cars provided by the Atchison, Topeka & Santa Fe Railroad (AT&SF). This trestle remained in place until the end, but it's function was replaced during the mid-1920s by a similar, all-steel facility on the southern end of the plant (Fig. 4).

The inclined tramway extended some 600 ft up Union Hill were it connected with one of the longest rail tramways in New Mexico. This linked the Republic iron pits to the south with the Union Hill, Anson S., and Continental pits to the north—a distance of greater than a mile. The earliest incline, ca 1905, served tramways on two levels, extending south; the lower was approximately ½ mi in length. The narrow gauge rails also provided haulage and access to the equally extensive underground workings tapped by Union Hill Tunnel (Fig. 5).

Another standard gauge spur left the AT&SF main line at Fierro and meandered southeast more than a mile to the Snowflake Canyon iron mines on the east side of Hanover Gulch (Fig. 6).

Ironic ending

Although the Fierro iron deposits never were depleted (Fig. 7), several factors contributed to the cessation of operations at the end of 1931. The long rail haul to Pueblo (nearly 700 miles) was always a problem. Then, as time passed, the working stopes and faces at the various pits and mines advanced to well beyond a mile from the Union Hill Plant. The costs of mining this far from the portal could not be overcome without massive investment and relocation. Increasing copper content made Fierro's iron ore less desirable to steel mills now forced to keep up with ever-changing market demands for "high-tech" steels, which must have very low copper content. As a result, high quality iron deposits were discovered and developed closer to Pueblo.

It is ironic (!) that USSR&M entered the district in 1919 for the purpose of *producing iron ore* and a small amount of by-product copper. Fifty years later, after developing the Continental underground mine, the company had come full circle; the Continental was the largest *copper producing mine* in the Fierro–Hanover district and produced iron ore (magnetite) as a by-product. The Continental mine now is owned and operated by the Cobre Mining Co.

Sofio Hinckle might have been awed by the scale of operations at the Continental property but he would have noted proudly that his Hanover mine started it all. Today the rails still wind their way up Hanover Gulch to Fierro and on to the Continental mine and mill. But at Union Hill only a concrete retaining wall, some heavy timber cribbing, and a few very carefully graded roadways remain to remind us of this once-busy industrial site. A small handful of carefully preserved photographs kept at New Mexico Bureau of Mines and Mineral Resources show us Union Hill in it's heyday, before 1931.

Caution:

Before deciding to visit the Fierro area, please be aware that the properties are privately owned and the mine workings dangerous! Observations and site-seeing should be done **only** from the main road with the aid of a good pair of binoculars.

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Figure 2—Hanover Bessemer Iron and Copper Company's crushing, magnetic separation, and power plant facilities at Union Hill, near Fierro, New Mexico, ca. 1920. This was about the time the United States Smelting, Refining & Mining Company acquired control. The Union Hill incline is clearly visible at right of center, while the AT&SF main line and Union Hill siding is in the foreground. The north (right) side of the double-tracked incline soon would be dismantled (compare to Fig. 5). NMBM&MR photo collection #1467; courtesy of Socorro Historical Society.

Figure 3—These 5-ton Griffith-type rocker-bottom dump cars were designed specifically to transport magnetite ore from the mine to the crusher but here they appear to have been pressed into service to haul the waste rock (primarily marble, white crystalline calcium carbonate) to the waste dump. This view, looking south toward Hanover, shows the upper mill level yard tracks (3-ft gauge) and the machine shop in the background. NMBM&MR photo collection #1791; courtesy of the author.

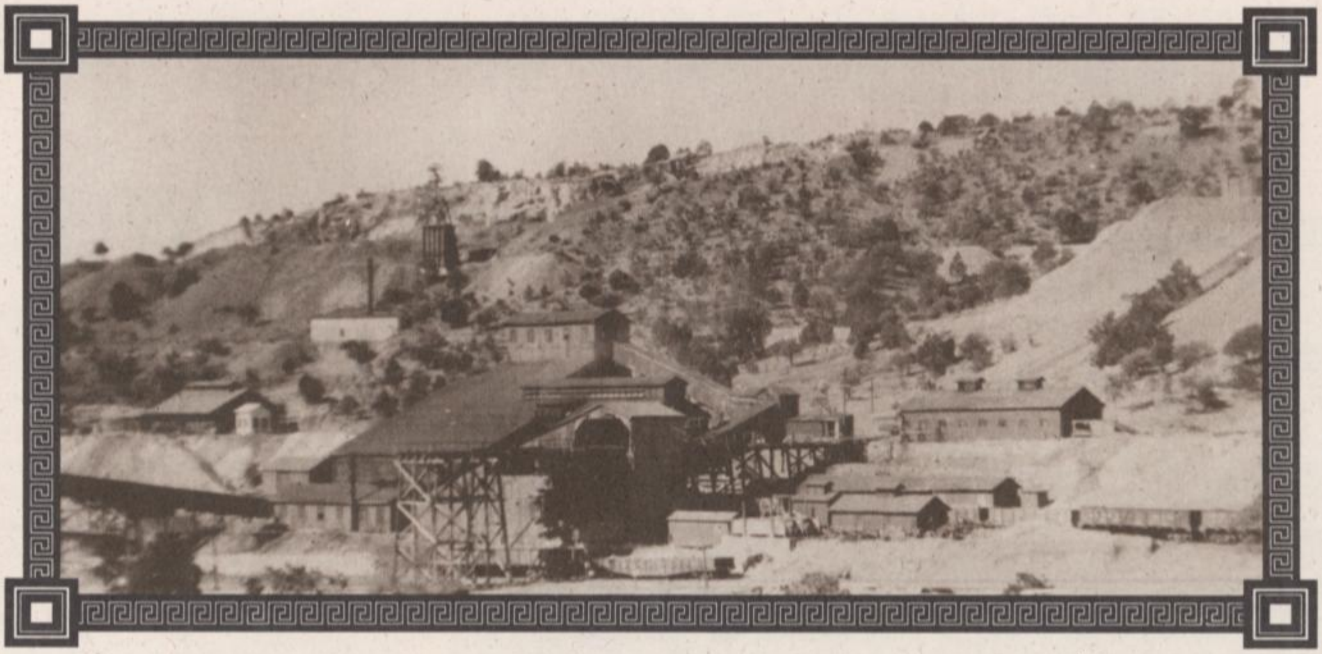


Figure 4—This overall view of the Union Hill facilities, ca. 1925, shows the single-tracked incline (far right), the Republic Shaft (left center), and the new, all-steel loading conveyor (extreme left). Ore from either the iron pits (via the incline) or the Union Hill tunnel was delivered to a hopper feeding a gyratory crusher. The crusher discharged to the covered inclined conveyor (center, background) which directed the crushed ore over a series of magnetic separators. The separators produced a magnetite concentrate containing about 51% iron and a little less than ½% copper. NMBM&MR photo collection #154; courtesy of the author.

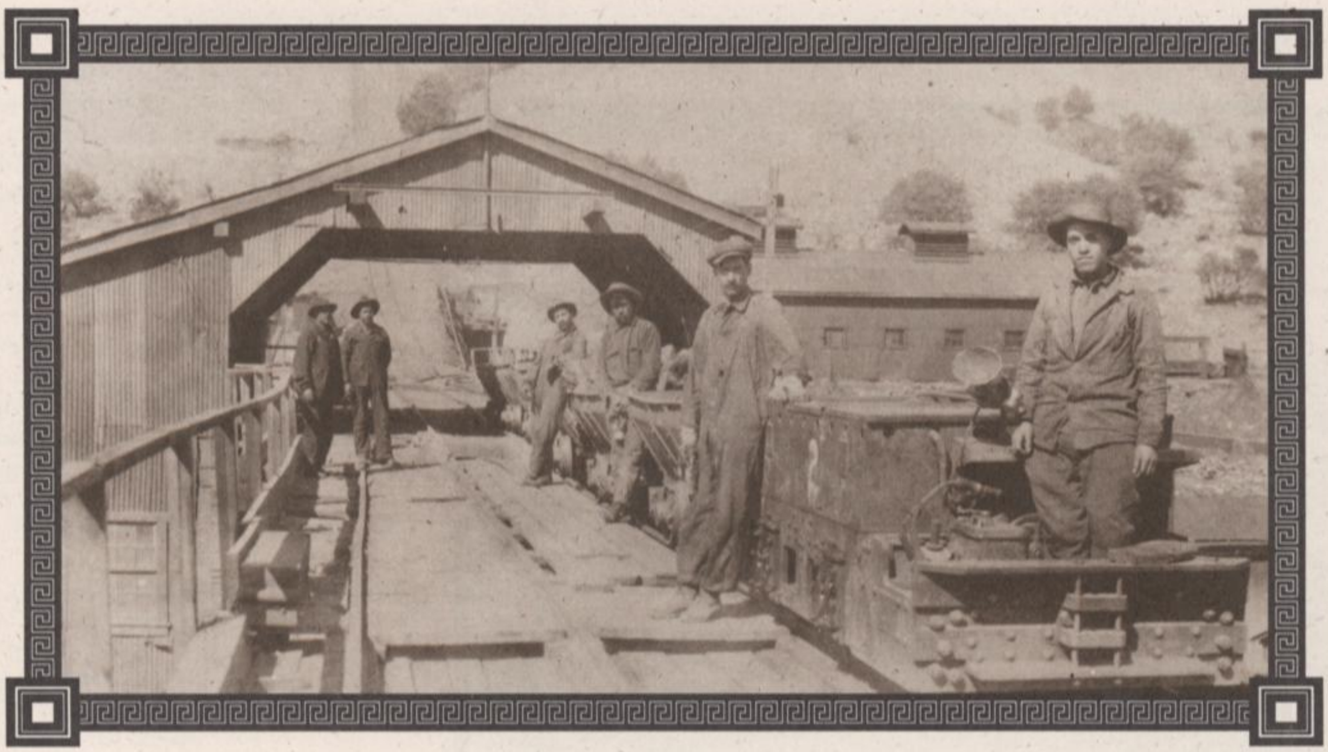


Figure 5—The tramming crew has just delivered a trainload of ore to the crusher (out of view, to left) and is preparing to re-enter the Union Hill tunnel (behind last car) for another load. Note the first three crewmen are equipped with carbide lamps. The lack of protective headgear reflects a time when men's heads were harder and rocks were softer. Battery locomotive No. 2 is on the head end of today's consist (train configuration). Compressed air locomotives were used by Hanover Bessemer prior to the 1920s. NMBM&MR photo collection #153; courtesy of the author.

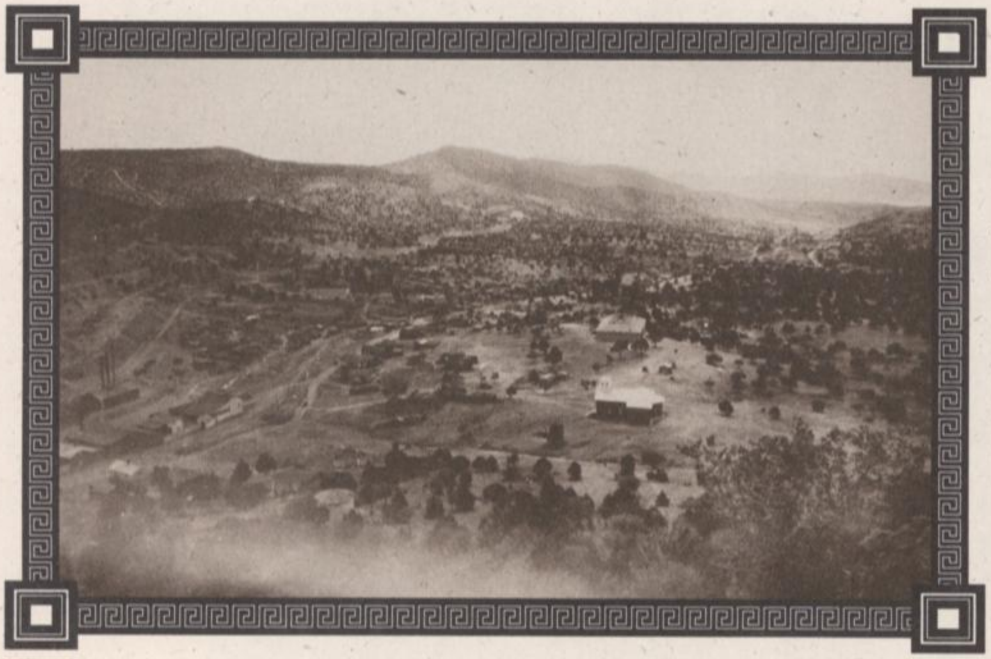


Figure 6—View, looking southeast, of Fierro, New Mexico, one mile north of Union Hill, during the peak of operations, ca. 1925. Much of the town was adjacent to the tracks of the AT&SF, which are just visible in this view, along Hanover Creek. The Snowflake Canyon spur can be seen, upper center. Jim Fair pit is just out of view, left center. The two larger structures are the school house and Catholic church (the latter is still standing today). Hanover Bessemer was a very progressive company for its day, providing such amenities as tennis courts and a golf course for its employees. NMBM&MR photo collection #1790; courtesy of the author.

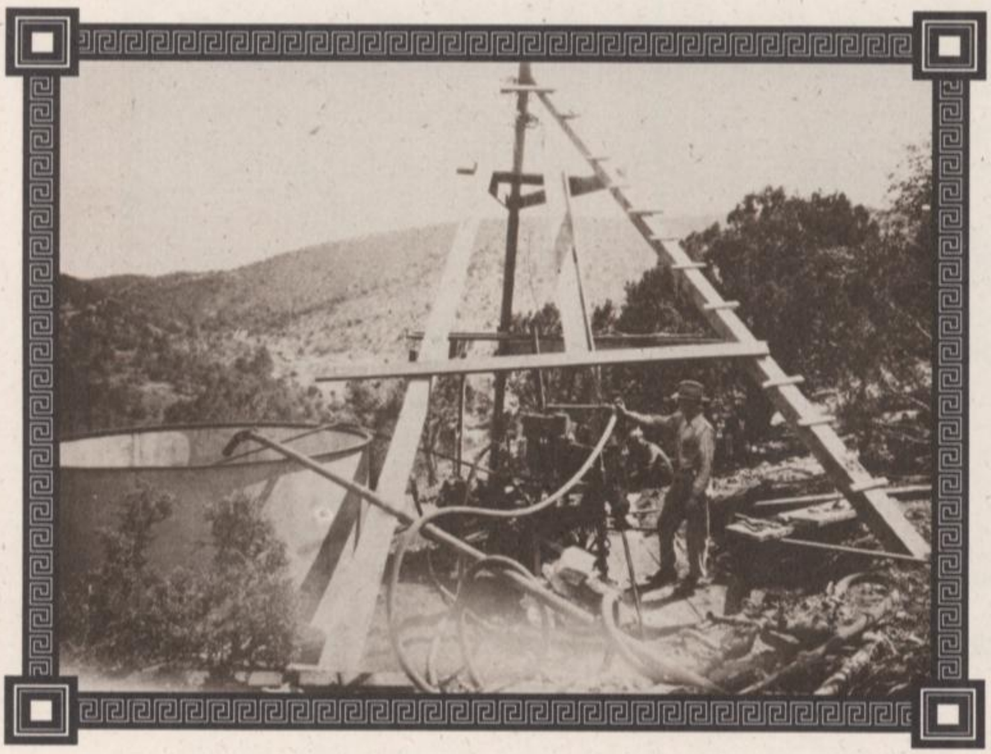


Figure 7—Diamond drilling for iron ore near Fierro, 1929. Developing new ore reserves is vital to the future of any mining operation. The diamond drill is among the most valuable of the exploration techniques because it recovers an actual cylindrical sample of the rock it penetrates. These samples, called cores, are analyzed for ore content and are carefully examined by the exploration geologist to determine which rock formations have been drilled. This early-day rig was driven by steam or compressed air. Note the pipe at lower right, leading to either a boiler or a compressor. NMBM&MR photo collection #1788; courtesy of the author.

Sources for Earth Science Information

Teachers can receive free materials including curricula, student handouts, and reference materials for school resource media centers by contacting:

U.S. Bureau of Mines
Guy Johnson, Staff Engineer
Building 20
Denver Federal Center
Denver, CO 80225–0086

A free teacher's packet including a poster, lesson plans, activities, and a list of mineral resource information can be obtained by calling or writing to:

Mineral Information Institute
Jackie Evanger
475 17th Street; Suite 510
Denver, CO 80202
(303) 297–3226

Information on Earth Science programs, projects, reports, products and their sources is available from:

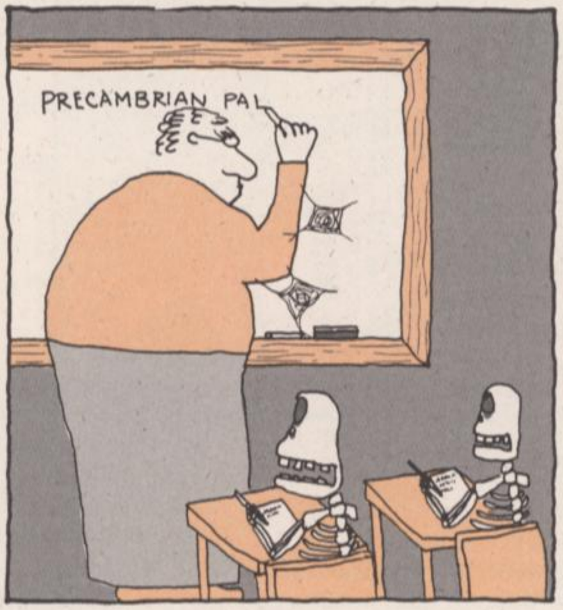
US Geological Survey
Earth Science Information Center
(USGS ESIC)
Call 1–(800) USA–MAPS

or in New Mexico, contact:

Amy Budge
Earth Science Information Center
Earth Data Analysis Center
University of New Mexico
Albuquerque, NM 87131
(505) 277–3622

Information on earthquakes in New Mexico is available by contacting:

Bob Redden
Program Manager
New Mexico Earthquake Preparedness Program
Department of Public Safety
P.O. Box 1628
Santa Fe, NM 87504
(505) 827–9254



Professor Gilbert developed a reputation of getting things done on a geologic time scale pace.

***Lite Geology* evolves:**

Lite Geology began as a small Earth-science publication designed and scaled for New Mexico. Our subscription list has grown tremendously during the past two years, and now includes a large number of out-of-state readers. In order to keep up with the demand for this publication from outside of New Mexico, we will charge **$4.00 per year for out-of-state readers**, which covers the cost of printing and mailing *Lite Geology*. The subscription year begins with the Fall issue, and ends with the Summer issue to correspond with the academic year. **If you reside outside of New Mexico and wish to keep your subscription active, please return this form with a check for $4.00.** We thank all of our readers for their enthusiastic support, and hope that all of you will continue to subscribe. If you have questions about your subscription, please call Theresa Lopez at (505) 835-5420. Thanks! —ed.

Lite Geology

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what's on-line?

Have you visited our World Wide Web site yet? It's **http://geoinfo.nmt.edu/**. We have a *geolinks* page that provides links to geologic information. Here are some examples of links and their URL addresses:

Volcano World
http://volcano.und.nodak.edu/

Seismic Surfing the Internet
http://www.geophys.washington.edu/seismosurfing.html

In *Volcano World*, you can explore volcanos by viewing photos of eruptions around the globe. There are lesson plans, a volcano mall, and information on how to become a volcanologist. *Seismosurfing the Internet* is a comprehensive source for information on seismic activity, with links to many seismological observatories. Current data on earthquakes around the world is posted by the National Earthquake Information Service of the U.S. Geological Survey in cooperation with the Council of the National Seismic System. Teachers, if you are not yet able to access the Internet from your school, why not seek out a mentor or partner at a university, government agency, or business who will support you in accessing the Net from their location? Happy surfing! —S. Welch

LITE geology

is published quarterly by New Mexico Bureau of Mines and Mineral Resources (Dr. Charles E. Chapin, *Director and State Geologist*), a division of New Mexico Tech (Dr. Daniel H. Lopez, *President*).

Purpose: to build Earth science awareness by presenting educators and the public with contemporary geologic topics, issues, and events. Use *Lite Geology* as a source for ideas in the classroom or for public education. Reproduction is encouraged with proper recognition of the source.

Lite Geology **Staff Information**
Editor: Susan J. Welch
Geological Editors: Dr. Dave Love, Dr. Charles Chapin, and Gretchen Hoffman
Educational Coordinator: Barbara Popp
Graphic Designer: Jan Thomas
Cartoonist: Jan Thomas with inspiration from Dr. Peter Mozley
Editorial Assistant: Toby Click
Creative and Technical Support: NMBM&MR Staff (Thanks Nancy!)

Mailing Address
New Mexico Bureau of Mines and Mineral Resources, Socorro, NM 87801. Phone (505) 835-5420. For subscription information, please call or write. *Lite Geology* is printed on recycled paper.

LITE geology
New Mexico Bureau of Mines
and Mineral Resources
New Mexico Tech
801 Leroy
Socorro, NM 87801

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