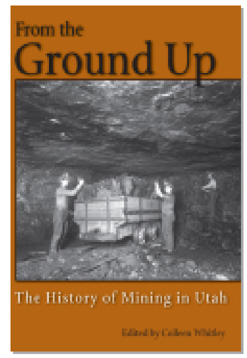
8. Beryllium Mining



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8

Beryllium Mining

Debra Wagner

Brush Resources Inc., formerly Brush Wellman Inc., mines beryllium-bearing ore from the company's Topaz Mining Properties. Discovery of beryllium ore occurred in 1959. The find created much excitement within the mining industry. As time unfolded, these deposits proved to be a valuable resource, opening the door for the beryllium industry to grow. This ore source permitted the company to become fully integrated with a controlled supply and a production capability for all major commercial beryllium products.[1]

The first pit opened in 1968, and the mill near Lynndyl began operation in 1969. Since that time, the open-pit mining operations have been continuously active. The value of this project was demonstrated dramatically in the growth of the industry that followed. Many new and varied products came to the market as a result of the Utah venture.

The Topaz Mining Properties are located in Juab County, Utah, and are approximately 47 miles west/northwest of the company's mill near Delta. Access is by Highway 174 west from U.S. Highway 6. The company owns fee-simple title to the surface of the mine property.

Geology

The mining properties are located in the Spor Mountain/Topaz Mountain area in western Juab County. This region has been a commercial source of uranium, fluorspar, and beryllium. The beryllium district lies on the west and southwest slopes of Spor Mountain. Bertrandite, a hydrous beryllium silicate ($Be_4Si_2O_7(OH)_2$), is the ore mined. Until 1969 the beryllium industry in the United States had been dependent upon imported beryl ore for its only source. Beginning in 1969, the company's extraction plant near Lynndyl has been in constant production, using bertrandite ore feed from the mining properties. Beryllium is classified as a "strategic metal" by the United States Department of Defense.

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The Spor Mountain area is part of the Thomas Mountains/Tintic Mountains subdivision of the Basin and Range physiographic province. The mining properties are made up chiefly of westward-tilted and intricately faulted Paleozoic sedimentary rocks that have been locally intruded by volcanic rocks of Tertiary age. Flows and tuffs of Tertiary age also overlie the Paleozoic rocks, creating pronounced angular unconformity. The area is extensively faulted. Most of the faults trend northeast/southwest and have displacements ranging from 50 to 800 feet. They have played a major role as conduits for the beryllium-mineralized solutions.

Tertiary volcanic rocks of the Spor Mountain formation consist of two informal members: the beryllium tuff and an overlying porphyritic rhyolite. The formation dates at 21 million years (Lower Miocene). The two members occur together in most places and are restricted to the vicinity of Spor Mountain. The porphyritic rhyolite member breaks out as flows, domes, and small plugs.

The beryllium tuff rests unconformably on older volcanic rocks of Tertiary age and sedimentary rocks of Paleozoic age. It is an important stratigraphic unit because all beryllium production in the district originates from it (see figure 1). Mining operations within the beryllium tuff by the company have encountered many variations in particle size and composition of the ore zone. Hydrothermal (epithermal) fluids have partially altered the beryllium tuff deposits to a fine-grained mixture of montmorillonite-kaolinite clay, potassium feldspar, silica minerals, and fluorite. Distinctive zones of argillic and feldspathic alteration enclose the actual deposits. The bertrandite ore mineral of beryllium is submicroscopic, disseminated in the tuff, and concentrated in fluorite nodules.

Many authors have published information on beryllium mineralization in the tuff, including several publications by David A. Lindsey.

Land Use

Before mining, the land was used for grazing primarily winter and spring sheep and wildlife habitat. Currently some sheep and cattle still graze on the mine property. The wildlife in the area is confined to small mammals, birds, and antelope, which range there throughout the year.

Public safety is provided in compliance with the company's policies as well as Mine Safety and Health Administration (MSHA) rules. The mining properties are on private land. Unescorted public access is limited to county roads that travel through the property. Signs notify visitors to register at the mine camp when entering the area. No unescorted access is permitted in either existing or proposed mining areas.

Mine Operations

The unique bertrandite ore bodies within the company's mining properties are geographically and geologically separated. They occur as stratiform tuff deposits of widely varying thickness and inconsistent grade that dip steeply underneath massive rhyolite flows. Ongoing mining operations have provided mill feed continuously since 1969.

The method for removing the rock overburden from the ore is known as "open-pit prestripping." Traditionally an earth-moving contractor removed the rock from the open-pit area to expose a three- to five-year supply of bertrandite ore. This method was used exclusively from 1968 through 1997, when the last prestripping occurred. Overburden was placed adjacent to the stripping area according to the approved mining and reclamation plan at the time.

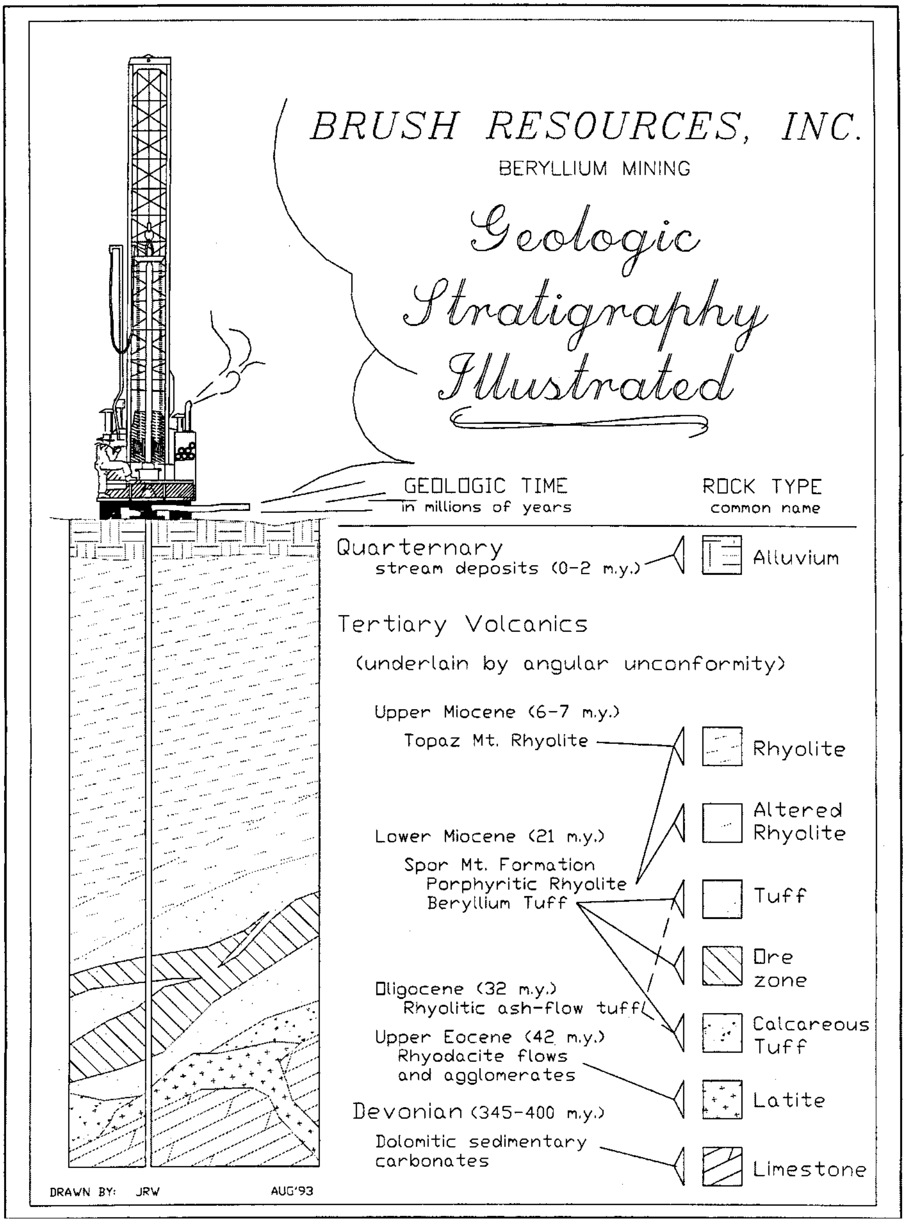
The ore is mined using a modified bench system, where the bench generally follows the ore body's strike and migrates down-dip as mining advances. The beryllium mineralization in the host tuff is visually indistinguishable from unmineralized material, widely disseminated, and relatively low grade. These characteristics require a unique, highly sophisticated approach to determine the beryllium grade and control the ore. The ore is sampled extensively, mapped meticulously, and dressed and lifted to the stockpile with the utmost care. All engineering and mining efforts revolve around the ability to detect the beryllium with a neutron-activated beryllium analyzer (the berylometer). The laboratory berylometer assays the drilling samples to enable detailed mine planning, and the field (portable) berylometer determines the exact cutoff point in mining.

The ore is lifted from predetermined areas within the open pit and placed on a designed stockpile pad. During stockpile construction, the ore is carefully spread into relatively thin and intermingling layers. This method creates a fairly homogeneous blend that is acceptable for mill feed.

In compliance with the Utah Mined Land Reclamation Act of 1975, the company filed a complete Notice of Intention and Mining and Reclamation Plan with the Division of Oil, Gas and Mining in March 1977. The division granted tentative approval for this plan later in 1977. The company submitted revised plans to the division in 1981 and 1988.

Topsoil and overburden are handled carefully to ensure the best possible use of the soil. Sufficient soils are salvaged at each site to topsoil the dumps and backfilled pits. These sites can then be seeded to provide a vegetative cover similar to the native plants in the area.

The company designed a test-plot program to evaluate varying topsoil thicknesses and fertilizer rates for revegetating future dumps. Another test-plot program evaluated the use of growth media other than topsoil for revegetating dump tops. Results from these studies indicate that existing topsoil and growth media substantially increase the area available for revegetation. During this same time, the company began using innovative techniques in dump construction, seedbed preparation, and reseeding. The company was subsequently awarded the division's 2000 Earth Day Award for its efforts.



Courtesy Brush Resources.

Milling Operations

The company's Delta mill is capable of processing two types of ore—bertrandite ore from the mine and imported beryl ore. Different processes are used to solubilize the two ore feeds. The resulting aqueous steams, both of which contain beryllium in a common form, are blended together. An organic solvent then extracts the beryllium from the blended stream.

Beryllium Products

Beryllium metal offers an unmatched combination of physical and mechanical benefits. At one-third less density than aluminum, beryllium is one of the lightest structural materials available, yet pound-for-pound it offers nearly seven times the stability of steel. Beryllium has a very high heat-absorbing capacity and is an excellent thermal conductor. Dimensional stability is outstanding over a wide range of temperatures. Standard machines and methods can handle the metal. Beryllium is the preferred material for many complex, high-performance parts for aerospace structures, military systems, medical components, and audio and computer systems.

Beryllia ceramic, the oxide form of beryllium, offers a combination of performance features unmatched by any other ceramic material, such as excellent thermal conductivity, electrical insulating properties, and a low dielectric constant. Because beryllia ceramic dissipates heat, many designers of electronics use it to remove potentially damaging heat from dense circuitry. Beryllia ceramic is an ideal choice for a variety of products used in wireless telecommunications and the automotive industry and is often part of power circuits for motion control.

Beryllium alloys (copper and nickel based) offer many advantages, including high electrical and thermal conductivity, corrosion resistance, durability against stress and wear, extra strength and hardness, and good formability. Beryllium alloys are preferred for a wide variety of both consumer and industrial products. They are highly used for computers, telecommunications, automotive electronics, energy systems, appliances, plastic molds, and other thermal-management devices.

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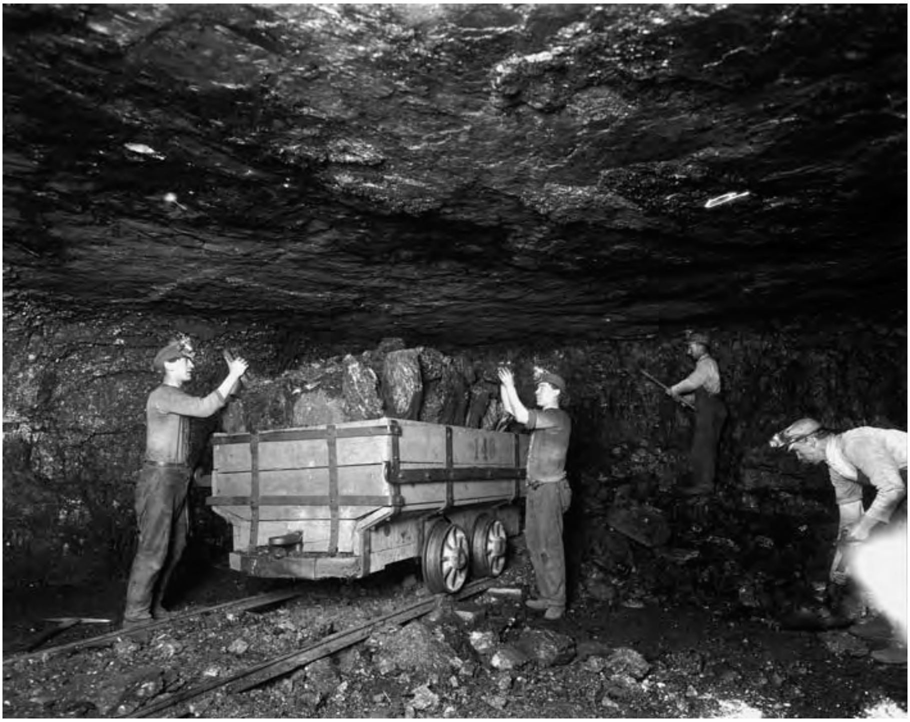
Courtesy of L. Tom Perry Special Collections, Harold B. Lee Library, Brigham Young University.

The mining camp home of the John Westenskow family in Sunnyside had a horseshoe hung with the open end up, to hold good luck, over the door and a box swing for the baby.



Courtesy Utah State Historical Society.

Miners load coal onto an ore car for the Lion Coal Company. The size of the rocks and the tight area where the miners are working give some indications of the difficulty of coal mining. Photo by William H. Shipler (9 March 1921).

Courtesy L. Tom Perry Special Collections, Harold B. Lee Library, Brigham Young University.

These miners spent long hours digging with picks and shovels to extract coal from deep inside Utah's mountains.

Courtesy L. Tom Perry Special Collections, Harold B. Lee Library, Brigham Young University.

In 1892 miners relied on horsepower to work this mine in Huntington Canyon.

Courtesy *Deseret Morning News* from copy donated by Robert Edwards. Glass plate in L. Tom Perry Special Collections, Harold B. Lee Library, Brigham Young University.

On 1 May 1900 coal gas ignited in the Winter Quarters Number-Four Mine at Scofield, killing more than two hundred miners. The blast knocked cars off their tracks outside of the mine.

Courtesy *Deseret Morning News*. Glass plate in L. Tom Perry Special Collections, Harold B. Lee Library, Brigham Young University.

One of the 107 women widowed and 4 of the 268 children left fatherless by the Scofield mine disaster sit in the foreground of the burial services in Scofield Cemetery. Photo by George Edward Anderson.

Courtesy Utah State Historical Society.

This Castle Valley Coal Company store and office building was located at Mohrland. Photo by William H. Shipler (taken 25 April 1911).

Courtesy Utah State Historical Society.

The interior of the Castle Valley Coal Company store shows the range of products for sale. Photo by William H. Shipler (22 February 1911).

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Courtesy Utah State Historical Society.

The Castle Valley Coal Company tram waits with its load at the top of the hill. Photo by William H. Shipler (22 February 1911).

Courtesy Utah State Historical Society.

Officials of the Independent Coal and Coke Company pose in front of their office. Photo by William H. Shipler (15 September 1910).

Courtesy Utah State Historical Society.

The Independent Coal and Coke Company built housing for the miners who worked for them. Photo by William H. Shipler (1 December 1907).

Courtesy Utah State Historical Society.

The Independent Coal and Coke Company hotel stood out in Kenilworth, the company town. Photo by William H. Shipler (15 September 1910).

Courtesy Utah State Historical Society.

The store, market, and bakery were part of Independent Coal and Coke Company operations. Photo by William H. Shipler (15 September 1910).

Courtesy Utah State Historical Society.

Miners line up along the side of a mountain at the Lion Coal Company in Wattis. Photo by William H. Shipler (9 March 1921).

Courtesy Utah State Historical Society.

Loaded coal cars descend on the Kenilworth Independent Coal and Coke Company tram to the unloading station at the bottom of the hill. Photo by William H. Shipler (15 September 1910).

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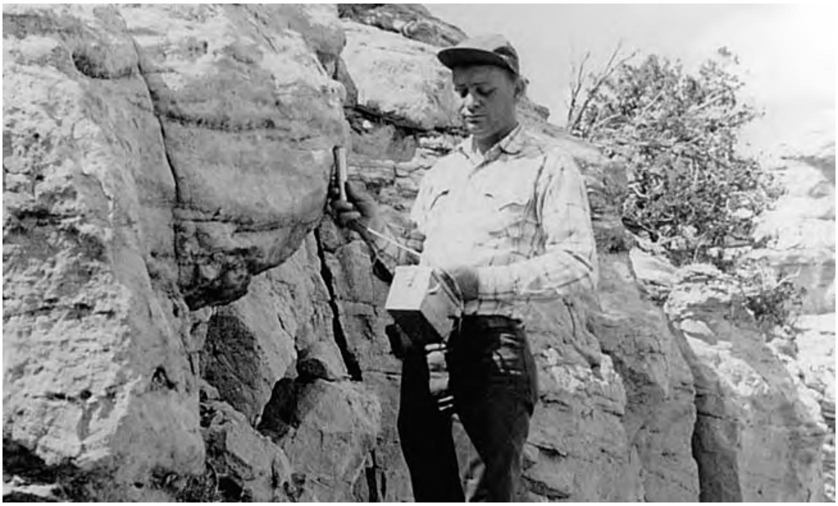
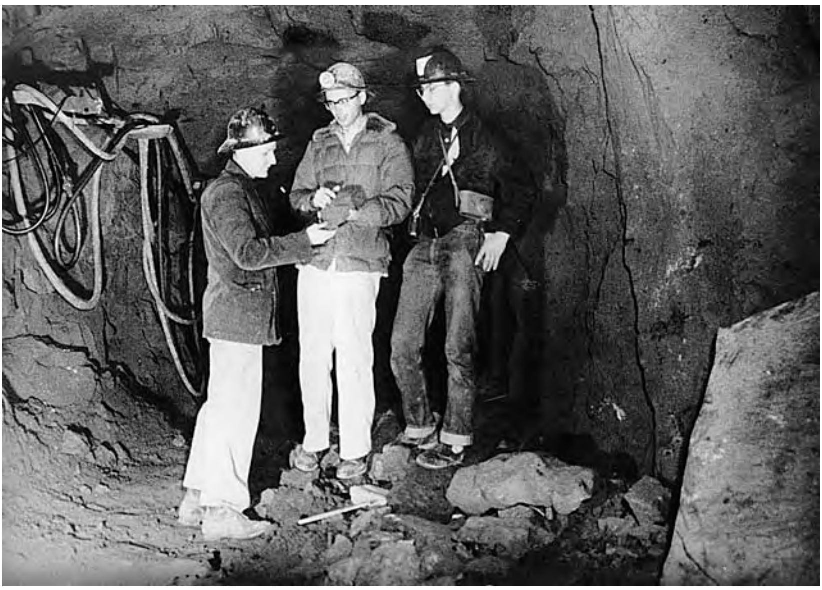


Courtesy Museum of Western Colorado.

A prospector checks the radiation reading on his Geiger counter.

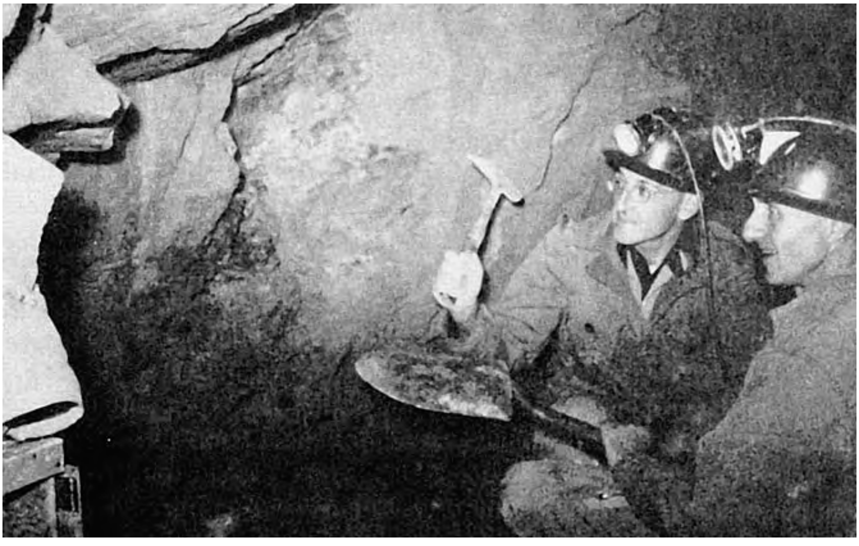


Courtesy Western Mining and Railroad Museum.

Charlie Steen and companions examine ore samples underground.

Vernon Pick turned to prospecting after his auto-repair shop burned down.

Courtesy Sheldon A. Wimpfen.



Courtesy Duncan Holaday.

Duncan Holaday and Dr. W. F. Bale inspect a uranium mine.

Courtesy U.S. Department of Energy.

Shot Harry, part of Operation Upshot-Knothole and known as "Dirty Harry," was a 32-kiloton, weapons-related device fired from a tower.

Lindsay Hill Pit near Iron Springs is now used as the Iron County landfill. Photo by York Jones.

Blowout Pit (1961) on the south side of Iron Mountain, mined by Utah Construction from 1947 to 1968, is now locally known as the "toilet bowl" because it is half filled with turquoise-colored water. Photo by York Jones.

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Frame scaffolding remained in 1996 at the Jennie Mine in the Gold Springs District on the Utah/Nevada border. Photo by Janet Seegmiller.

Courtesy Special Collections, Gerald R. Sherratt Library, Southern Utah University.

Iron County Coal Company reopened the Corry Mine on Lone Tree Mountain east of Cedar City in 1913. Photo by R. D. Adams.

Courtesy Kennecott Utah Copper.

Enos Wall recognized the possibilities of mining for copper in Bingham Canyon and organized the Utah Copper Company.

Courtesy Kennecott Utah Copper.

Daniel Cowen Jackling realized that mining in Bingham could become productive by removing large quantities of overburden.

Courtesy Utah State Historical Society.

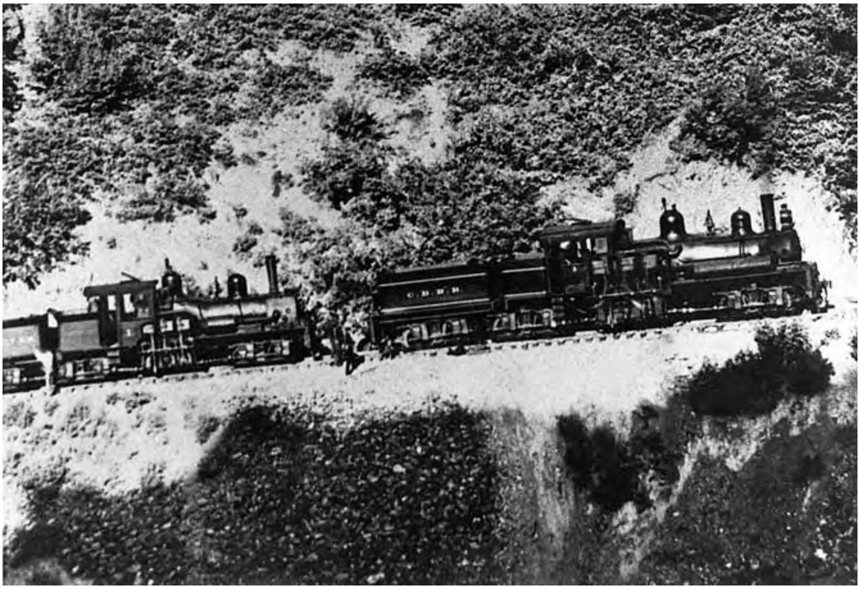
The town of Bingham in 1903. In the center of the picture is the mountain that was known as Copper Hill. That mountain no longer exists; today the Bingham Canyon open-pit copper mine has taken its place.

Courtesy Kennecott Utah Copper.

This early smelter, under construction near the Great Salt Lake, was completed in 1908 by American Smelting and Refining Company.


Courtesy Kennecott Utah Copper.

Social opportunities in early Bingham Canyon were limited. But Bingham's White Elephant Saloon offered some alternatives. This 1907 photo shows players at the faro table, and the stacks of chips indicate the stakes were high.


Courtesy Kennecott Utah Copper.

Early equipment for moving copper ore included Shay steam engines, used between 1900 and about 1912. Here a pair chugs up an incline in 1907. Miners said a man could walk up the hill faster than the engines moved, and the trip downhill with loaded cars was very scary.

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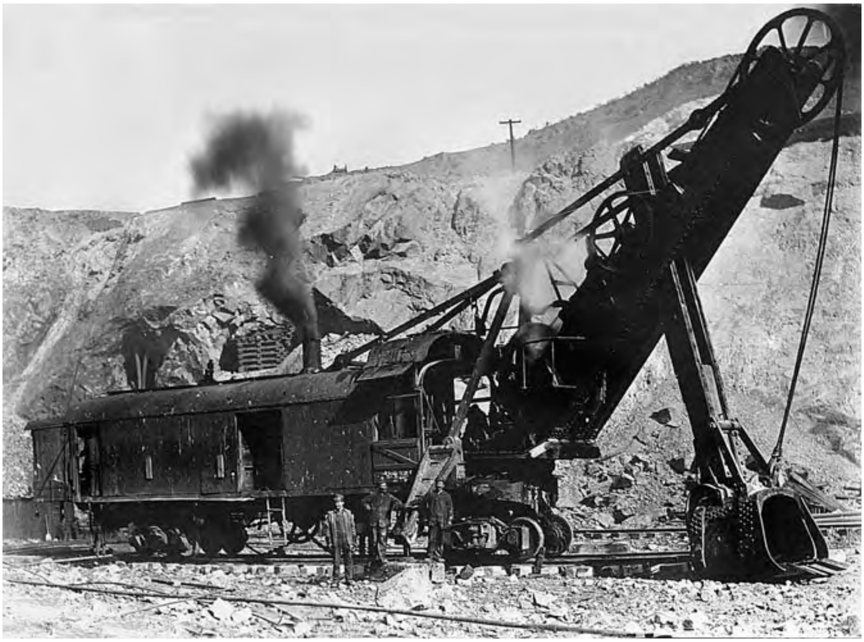


Courtesy Kennecott Utah Copper.

Steam shovels began operating in Bingham Canyon in 1906. This Marion shovel awaits the arrival of ore cars on one of the early mine terraces.

Courtesy Kennecott Utah Copper.

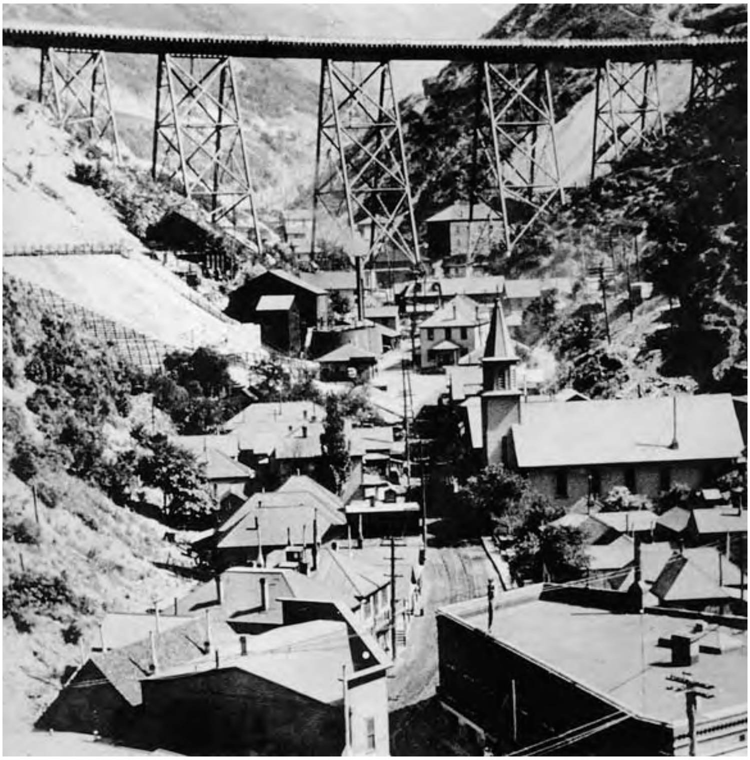
Getting around in Magna in the early days was not easy. This 1915 photo of Main Street shows at least one grocery store, two automobiles, and the rough and rutted road they had to travel.

Courtesy Kennecott Utah Copper.

Bingham Mine operators used a smaller engine for shorter hauls. Called a Dinkey, it weighed about 20 tons. This 1916 photo shows a Dinkey moving wooden ore cars into position for loading. The cars could carry about 12 tons of copper ore.

Courtesy Kennecott Utah Copper.

The town of Bingham appears in the lower left of this 1919 photo, as the now-terraced Copper Hill is being slowly mined away.



Courtesy Kennecott Utah Copper.

The town of Carr Fork was located above Bingham. This 1925 photo shows its railroad viaduct, which in its day was considered an engineering and construction marvel.

Courtesy of Kennecott Utah Copper.

In 1947 as electric power took over, this Mallet "110" engine was the last of Kennecott Utah Copper's steam-powered locomotives.

Courtesy Kennecott Utah Copper.

In 1940 an ore train crosses Dry Fork railroad viaduct in Bingham Canyon.

Courtesy Kennecott Utah Copper.

Environmental concerns and the Clean Air Act of 1970 prompted modernization of Kennecott's smelter, including this huge stack, completed in 1978, which stands 1,215 feet high.

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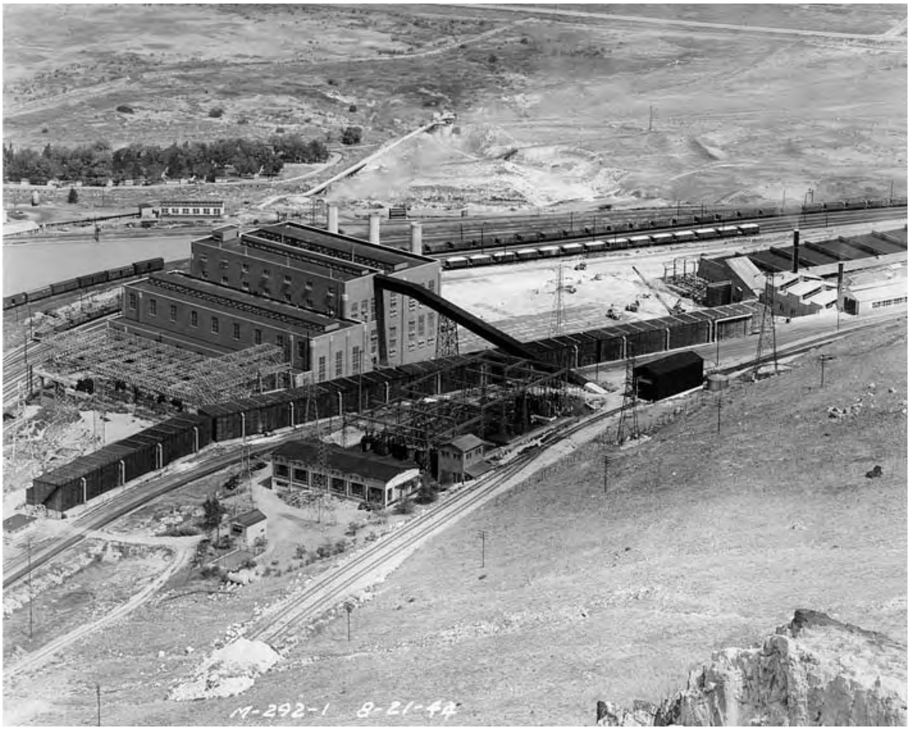
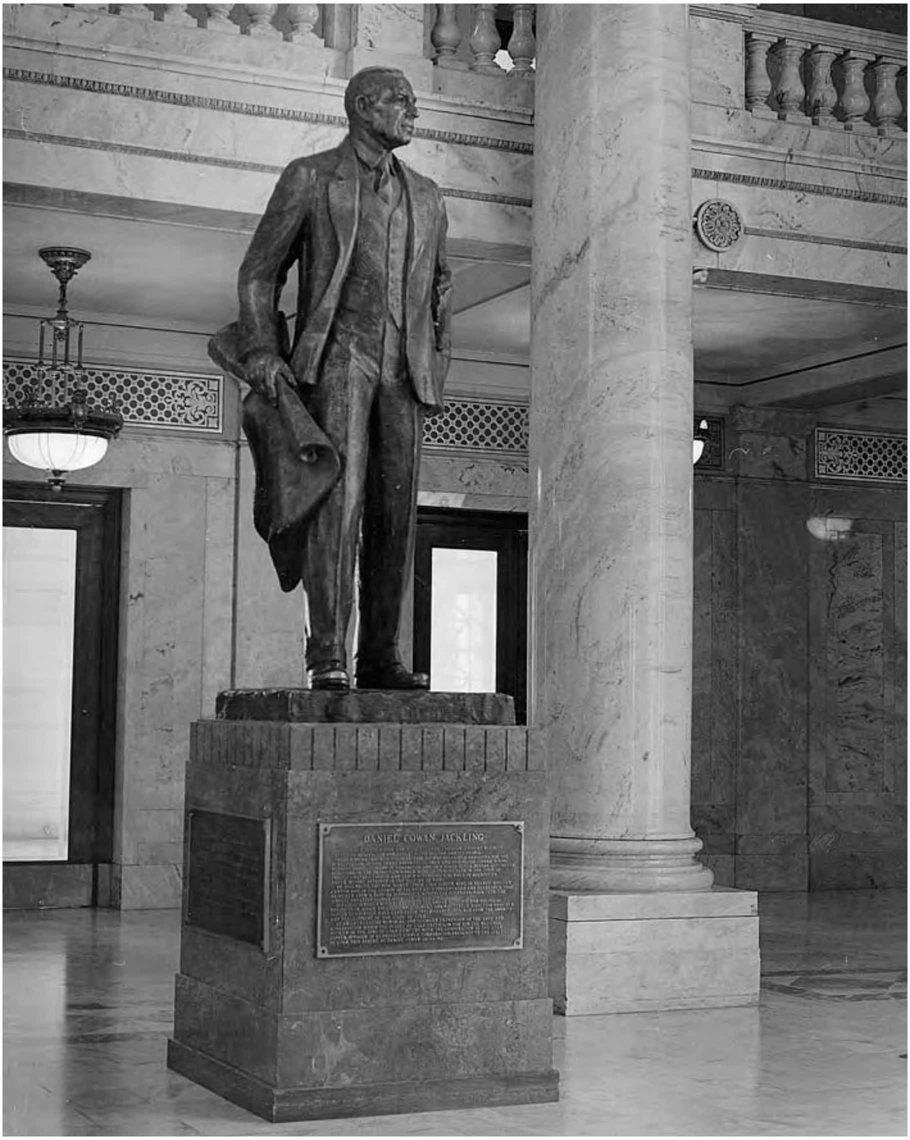


This 1944 photo shows construction of a new giant power plant for Kennecott, ultimately rated at 175,000 kilowatt-hours. Modernization saw electric locomotives pulling huge trains of cars, electric shovels moving 16 tons of rock in one bite, and efficient electric processing centers.

By the mid-1980s rail haulage in the Kennecott mine was phased out and replaced by huge-capacity diesel-electric trucks. This ore truck could carry 255 tons.



Courtesy Kennecott Utah Copper.

In 1954 the State of Utah observed Kennecott Utah Copper's 50th anniversary. On August 14, Daniel C. Jackling's 85th birthday, the state placed this bronze statue in the Utah State Capitol Building rotunda.

Courtesy Kennecott Utah Copper.

This recent photo shows the vast topographical changes due to the Kennecott Utah Copper mine and its milling operations. The original Copper Hill, where mining began, along with a huge surrounding area, is today the world's largest open-pit mine, more than three-quarters of a mile deep and two-and-a-half miles wide. At the lower center of the photo is Kennecott's Copperton concentrator. The open pit is so large it is easily spotted by astronauts.

Courtesy Kennecott Utah Copper.

During World War II, many women took over jobs traditionally held by men who left for the armed services. These women are working in Kennecott's mines and smelters.

Courtesy Kennecott Utah Copper.