

The Wagon Wheel Gap

Fluorspar Mine

By James B. Copeland
and Mark A. Vendl

The Wagon Wheel Gap mine is located approximately one mile south of the Rio Grande River along Goose Creek, some ten miles south of Creede in Mineral County, Colorado. The mine operated between 1911 and 1950 and produced only fluorspar concentrates.

Fluorspar is among the important non-metallic minerals which have been developed in Colorado. Fluorspar is the industrial commercial name given to various grades of the mineral fluorite. Although fluorite occurs in at least forty-seven different mining districts within the state, it has only been mined commercially from four districts: Wagon Wheel Gap in Mineral County, Jamestown in Boulder County, Brown's Canyon in Chaffee County, and Northgate in Jackson County.¹

Fluorspar is sold commercially in three principal grades depending largely upon its percentages of calcium fluoride (CaF_2) and silica (SiO_2). The minimum grades for CaF_2 are: Acid Grade, 98 percent; Ceramic Grade, 95 percent; and Metallurgical Grade, 85 percent.² Chemically pure fluorite is 51.1 percent calcium and 48.9 percent fluorine.

While three of the districts hosted a number of different mines, the Wagon Wheel Gap district had only one. Throughout its entire operating life, from 1911 to 1950, the majority of the mine's production was shipped to Pueblo, Colorado, for use as a flux in the open-hearth furnaces at the steel mill of the Colorado Fuel & Iron Company. While total production from the Wagon Wheel Gap mine is unknown, CF&I's shipments of fluorspar concentrates from the mine to the steel mill totaled 118,023 tons between 1924 and 1950. The mine's production in those years is detailed on an annual basis in the table on page 50.³

Early History

The first silver from the Creede District was produced in 1884 and that event sparked a rush to determine the full extent of the Creede silver deposits. The Amethyst vein was one of the richest silver-bearing veins in the Creede District, located ten miles northwest of Wagon Wheel Gap. In 1891, prospectors looking for an extension of the Amethyst vein located the first claims in the Wagon Wheel Gap area. The country rock was similar to that of the Creede area. Creede-area veins often contained purple quartz amethyst, and the first prospectors found a purple mineral at Wagon Wheel Gap similar to amethyst. When they discovered little silver and no gold, however, interest in the deposit faded.

In 1911, Shrive B. Collins, then Mineral County surveyor and a U.S. deputy mineral surveyor, recognized the mineral as fluorite, and not amethyst. He knew of fluorite's importance as a flux in the production of steel, so he organized the American Fluorspar Company and began developing the deposit. In 1913 the company shipped five thousand tons of fluorspar to Pueblo, Colorado. The mine was idle in 1914, but was reopened in 1915.⁴ After 1915 the mine operated intermittently, and from 1911 through 1921 shipped between forty thousand and fifty thousand tons of fluorspar to Pueblo and eastern markets. In 1917 a concentrating mill was constructed at the mine site to separate fluorspar from waste rock.⁵

Wagons originally transported the fluorspar concentrates to the Denver & Rio Grande Railroad siding at Wagon Wheel Gap. In July 1917, the company constructed a surface tram track along the east side of Goose Creek from the mill to the rail siding. Mules pulled small mine cars along this surface tram. At about the same time the company built an aerial tramway from the upper mine adit, probably on the Wilson Level, to transport the ore to the mill.⁶

In 1917 the American Fluorspar Mining, Leasing and Transportation Company was incor-

Annual Production Table
Wagon Wheel Gap Fluorspar Mine
1924 - 1950

Year	Tons Shipped	Tons Mined
1924	2535	na
1925	5770	na
1926	8305	na
1927	5015	na
1928	49	na
1929	1184	na
1930	7878	na
1931	317	na
1932	0	0
1933	0	0
1934	3310	na
1935	3948	10374
1936	4391	9141
1937	2952	5602
1938	0	0
1939	5179	10016
1940	5902	13983
1941	6872	15156
1942	6315	13798
1943	6194	13945
1944	6800	14910
1945	5907	12995
1946	5494	12087
1947	8610	18942
1948	7790	17138
1949	5213	na
1950	2093	na
118023		

na = Figures not available
Mine leased in 1924

porated under the laws of Colorado to operate the mine and mill. This company was capitalized with one hundred thousand shares at a par value of one dollar per share. CF&I took over operation of the mine in 1924, presumably on a lease, and purchased the mine outright on 29 July 1925. The steel company acquired the mine, mill, and six patented mining claims and associated additional lands, totaling 284.2 acres, from the Ameri-

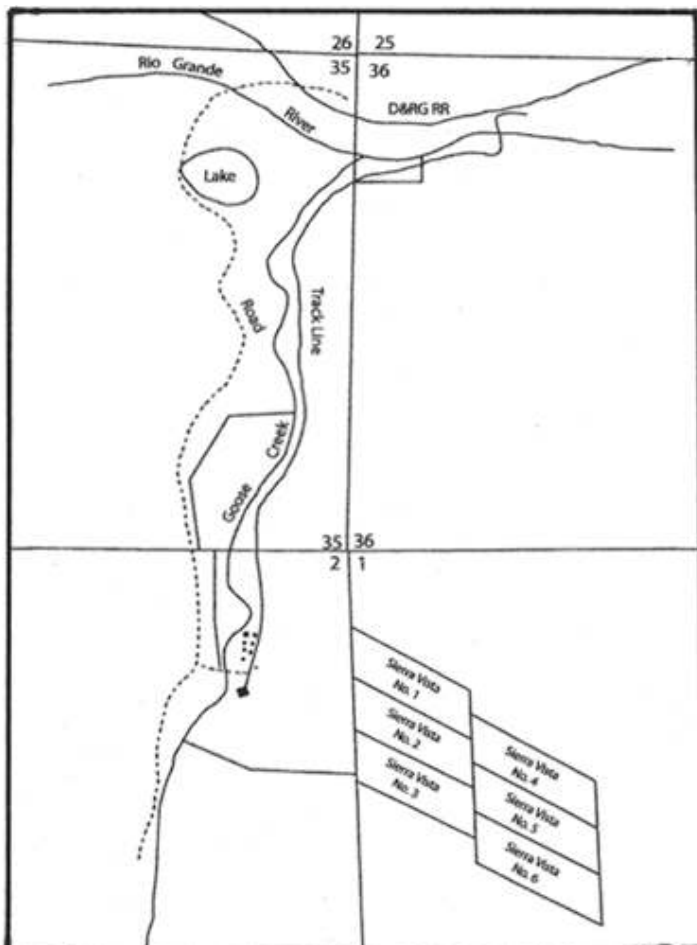
can Fluorspar, Mining, Leasing and Transportation Company for the sum of \$49,442.29.⁷

The six patented mining claims, Sierra Vista No. 1 through No. 6, totaled 100.6 acres. Each claim measured fifteen hundred feet long by six hundred feet wide. These claims were recorded as Survey No. 20278 with the United States General Land Office at Del Norte, CO, which issued the original patents to the American Fluorspar Mining, Leasing and Transportation Company on 25 May 1925. In addition to the six claims, the lands purchased by CF&I included 183.6 acres on both sides of Goose Creek from the mine site to the Rio Grande River.⁸

By the time CF&I purchased the mine property in 1925, the basic mill structure, which remains to the present, already existed. First American Fluorspar and then CF&I also constructed a

number of support structures adjacent to the mill. These buildings included a mule barn, a shop, an office, a change house, six three-room houses, two eight-room houses, a six-room bunk house, and a boarding house. Most of the small buildings were dismantled after the mine closed. Several of the larger ones have been renovated and are owned by the local hot springs ranch.

Some thirty-two years after the mine closed, the Evergreen Land and Resource Company, acting for CF&I's creditors, sold the Wagon Wheel Gap Tract. The surface rights for the entire 284.208 acres were sold on 30 August 1982 for \$284,208. The mineral rights on the six patented mining claims sold for \$8,526 on 1 July 1986, ending CF&I's involvement with the Wagon Wheel Gap mine.⁹



Wagon Wheel Gap Tract, Lands of the Colorado Fuel & Iron Co. in Sec. 1 & 2, T40N, R1E Sec. 35 & 36, T41N, R1E, N.M.P.N. Mineral Co., Colo.

Geology

The fluorspar deposit at Wagon Wheel Gap is comprised of several closely spaced veins in a fault zone on the east side of the Creede caldera. The host rock for the deposit consists of Miocene volcanics including tuffs, tuff breccias, and lava flows. The steeply dipping—up to 80 degrees or more—fluorspar veins can be traced from Goose Creek eastward for about 2,500 feet until they appear to end. The veins vary in width, both vertically and laterally, from a few inches up to fourteen feet, averaging about six feet. Branches and offshoots of the main vein were found in the workings.¹⁰

Geologist H. A. Aurand wrote in 1920 that

the fluorspar occurs in a number of different forms, but (a) mainly as a white, sugary or granular fluorspar forming solid masses across the entire width of the vein;

(b) as yellow-green, green, blue-green, yellow, brown, lilac, violet, blue and purple fluorspar, . . . as an encrusting mineral on fragments of andesitic wall rock; (c) as banded material on the side walls of the veins; (d) as a massive vein-filling material; (e) as a crystalline mineral facing inward along water courses; (f) as a banded material with an apparent botryoidal form; (g) as typical concentric lenses in the ore body; (h) as an aggregate mass with crystalline barite.

Miners found numerous water courses and some large cavities in the mine. Circulating fluorine-rich thermal waters were probably responsible for depositing the fluorspar along the fault zone. Three active hot springs are located near the mine and are probably related to the deposit. Geologists believe that the source for these springs is



The early open cut of the Wagon Wheel Gap mine above the Wilson Level, showing the highly altered and fractured character of the fluorspar vein, 24 July 1926. (Photo EF 1319, U.S. Geological Survey Photographic Library.)



A general view of the Wagon Wheel Gap mill, dump, and camp housing, 25 July 1926. The open cut is at the crest of the mountain. The upper dump and ore bins are those of the Wilson Level. The dump, buildings, and ore bins just below the Wilson Level are those of the Intermediate Level. Aerial tram towers are visible leading from these two levels down to the mill. The buildings in the foreground belong to the 4UR Ranch and Hot Springs. (Photo EF 1325, U.S. Geological Survey Photographic Library.)

a deep-seated cooling igneous rock mass.¹¹

Although fluorite is the most abundant mineral at the Wagon Wheel Gap mine, other minerals found at the deposit include barite, calcite, covellite, creedite, gearsutite, gypsum, hematite, pyrite, and quartz. The mine is the type locality for creedite, a complex calcium aluminum sulfate fluoro hydroxide, discovered in the upper workings in 1915.¹²

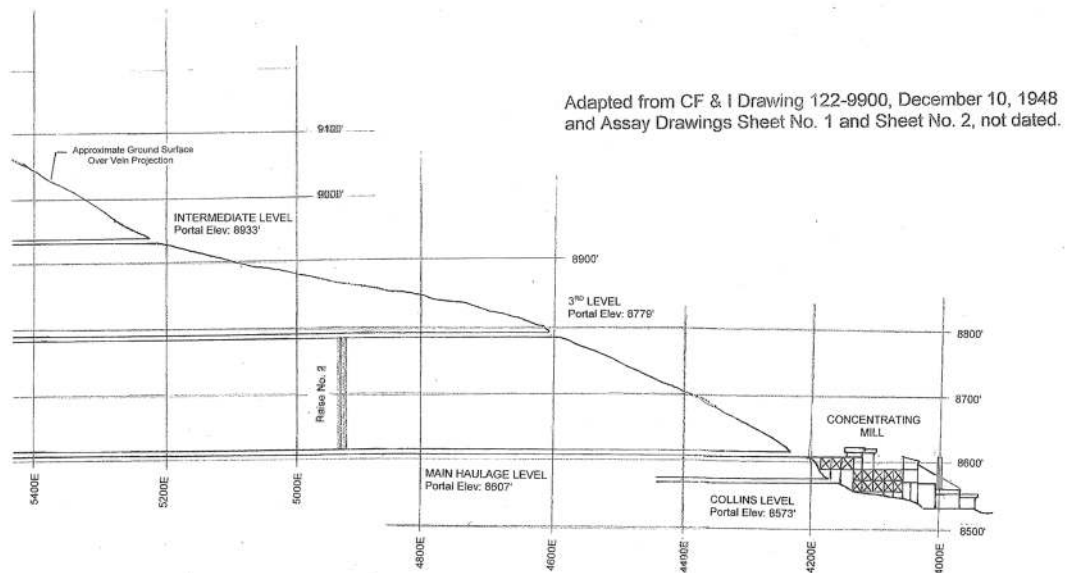
Ore Reserves

Calculations of the fluorspar ore reserves have always varied greatly, undoubtedly due in part to the rather erratic nature of the ore body. In December 1939 a CF&I Mining Department memo stated ore reserves of the Wagon Wheel Gap mine as 66,139 net tons of 85 percent fluorspar con-

centrates. Eight years later in another mining department memo, George Rupp, CF&I's manager of mines, stated that mine superintendent James Whitney believed that, as of 1 January 1948, the mine's reserves totaled 49,980 tons of fluorspar concentrates. But Rupp went on to say that reserves calculated from vertical sections indicated 65,900 tons of concentrates.¹³

Six years after the mine closed, R. R. Williams, who had replaced Rupp, wrote that the crude ore reserves at the mine totaled 90,000 tons of proven ore, 25,000 tons of indicated ore, and 40,000 tons of inferred ore at an average grade of 31 percent fluorspar. Based upon a concentration ratio of 2.5 tons of crude ore to 1.0 tons of concentrate, this amounted to 62,000 tons of concentrate of 80 percent fluorspar.¹⁴

In 1974, Clyde Mathews, CF&I chief ge-

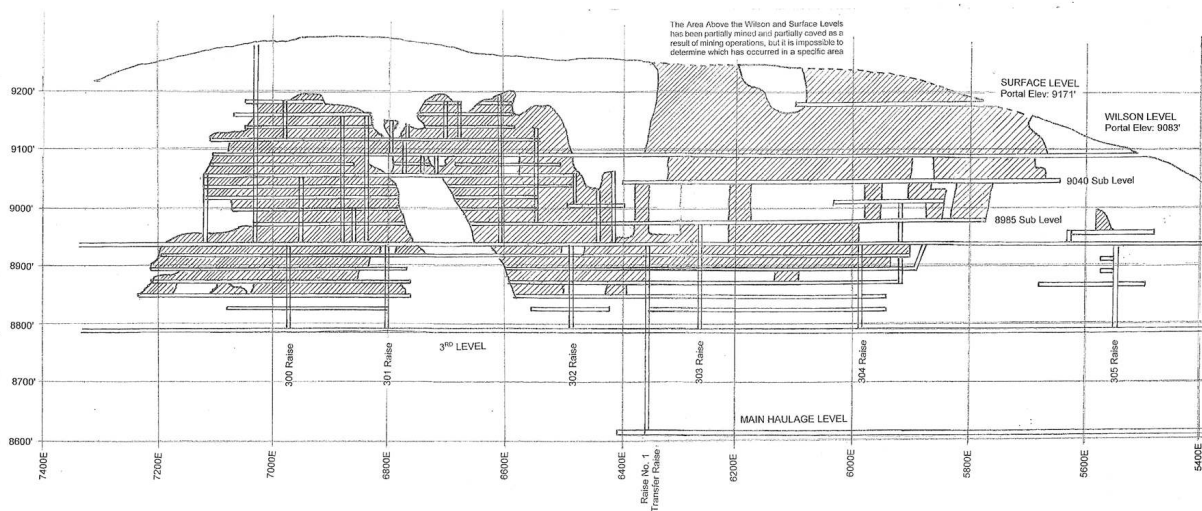


Longitudinal Section - Facing South
Sheet No. 1 - Western Portion

Wagon Wheel Gap Fluorspar Mine
Mineral County, Colorado

Colorado Fuel & Iron Company
1925 - 1950

Scale (feet)

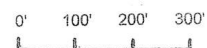


Longitudinal Section - Facing South
Sheet No. 2 - Eastern Portion

Wagon Wheel Gap Fluorspar Mine
Mineral County, Colorado

Colorado Fuel & Iron Company
1925 - 1950

Scale (feet)



ologist, supervised a program consisting of 3,996 linear feet of NX diamond drilling at the mine. Crude ore reserves calculated from this program consisted of 48,700 tons of indicated ore, 162,700 tons of inferred ore, and 98,600 tons of potential ore. No proven ore was included in the calculations. This crude ore would yield about 110,000 tons of fluorspar concentrates.¹⁵

Mine Development

From its initial discovery in 1911 to its closure in 1950, the Wagon Wheel Gap fluorspar deposit was developed by six adits driven from the west side of the mountain into, and generally along, the strike of the vein. Beginning at the top of the deposit, these adits or levels and their approximate portal elevations are:

Surface Level:	9171 feet
Wilson Level:	9083 feet
Intermediate Level:	8933 feet
Third Level:	8779 feet
Main Haulage Level:	8607 feet
Collins Level:	8573 feet

The Collins Level and the Wilson Level were the only adits that had been developed by 1920. At that time the Collins adit had been driven more than six hundred feet along the vein and active stoping was being undertaken, accessed from raises driven from the Wilson Level.¹⁶

The Wilson and Intermediate levels were driven before 1925, when Colorado Fuel & Iron purchased the property. The Third and Main Haulage levels were driven by CF&I in the 1940s. The Third Level is the longest in the mine and it actually extends from departure 4250 East to about 7600 East. The Wagon Wheel Gap mine has no shafts; all ore was extracted through one of the hillside adits. Gravity aerial tramways connected the Wilson and Intermediate levels with the mill until the company drove the Third and Main Haulage levels. In later years, trucks hauled

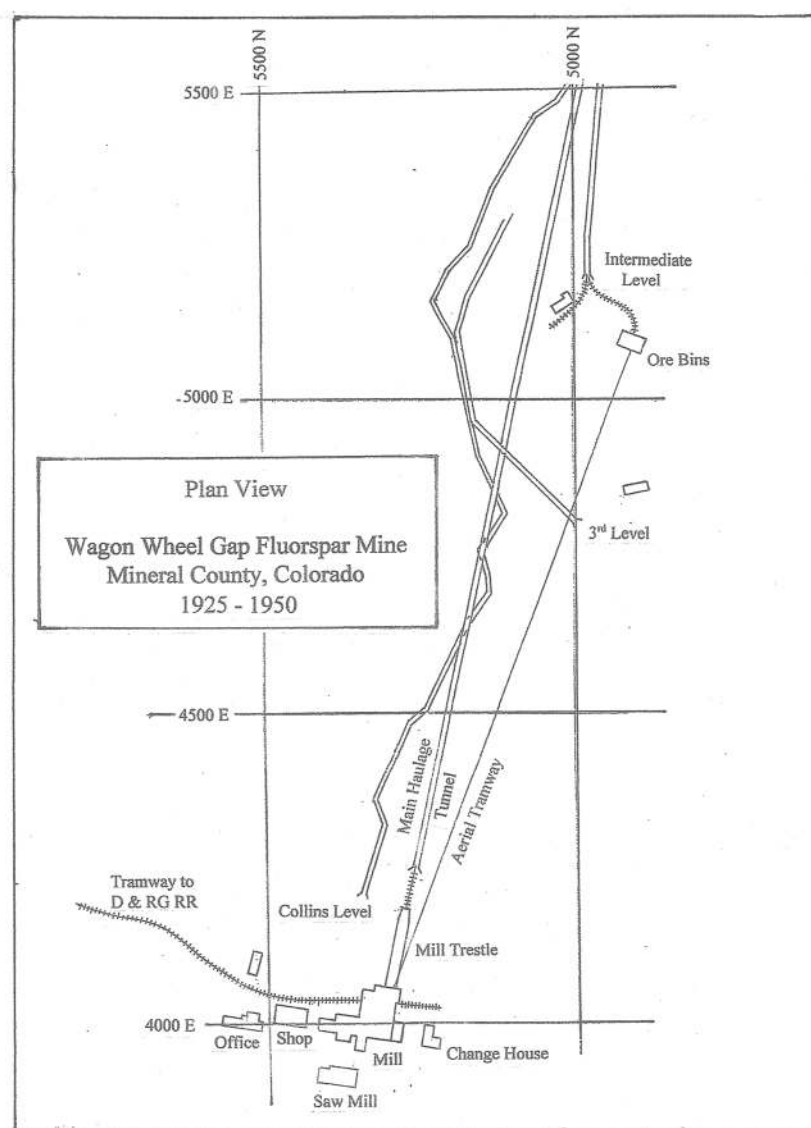
ore from these levels to the mill.

Depending upon the location of the ore encountered, miners drove raises between development levels. These were probably two-compartment raises, one compartment holding a manway ladder and utility pipes, while the other transferred broken ore from the stope to the level below. From available maps, it appears that the development levels were extensively timbered. The raises were generally lined with cribbing and the muck compartments were also lined with heavy timber lagging.

In the 1940s a series of main development raises were driven from the Third Level to the Intermediate Level and these became the main raises from which mining was conducted. These raises were designated as the 300, 301, 302, 303, 304, 305 and 306 raises.¹⁷ Miners also drove a Main Transfer Raise, called Raise No. 1, from the Main Haulage Level to the Intermediate Level.

The Main Transfer Raise was driven eight by fourteen feet, outside timber, timbered using eight-by-ten-inch cribbing, and divided into two compartments. The muck compartment was lined with three-inch-thick timber lagging on all four sides.¹⁸ The cribbed muck compartments of the main transfer raise and the development raises were a continuing source of trouble, as their linings needed repair or replacement on a regular basis due to wear caused by falling broken ore.

After a number of years of experimentation, CF&I finally developed a method which could effectively mine the deposit. This system required driving sub-levels from the development raise along the strike of the ore. These sub-levels were generally driven at approximately twenty-foot intervals in the development raise and thus, as a rule, there would be sub-levels at twenty, forty, sixty, eighty, one hundred, and one hundred and twenty feet above the production level.¹⁹ These sub-levels were usually referred to as, for example: 304 Raise 60 West. This meant the 60-foot sub-level being driven or mined on the west side of the 304 Raise.²⁰



Unfortunately, no information has been found regarding the size of the development levels or sub-levels. The development levels had a single track system using eighteen-inch gauged steel rails. The development drifts were probably approximately seven feet wide by eight feet high, permitting the installation of timber sets.

Mining Methods

The Wagon Wheel Gap fluorspar deposit occurs as a hydrothermal fissure vein which has been subjected to much fracturing, and the wall rocks

and vein itself have been highly altered by hot water solutions. This situation has resulted in both the vein and wall rocks being extremely weak and subject to extensive caving. Much of the wall rock and rock included within the vein structure has been altered to a clay which not only causes caving but also squeezing ground, resulting in timber failure.

The mining methods used prior to CF&I acquiring the mine in 1925 are not known. During the early years of its ownership, CF&I tried a number of different methods, including shrinkage stoping and square-set stoping. Neither proved

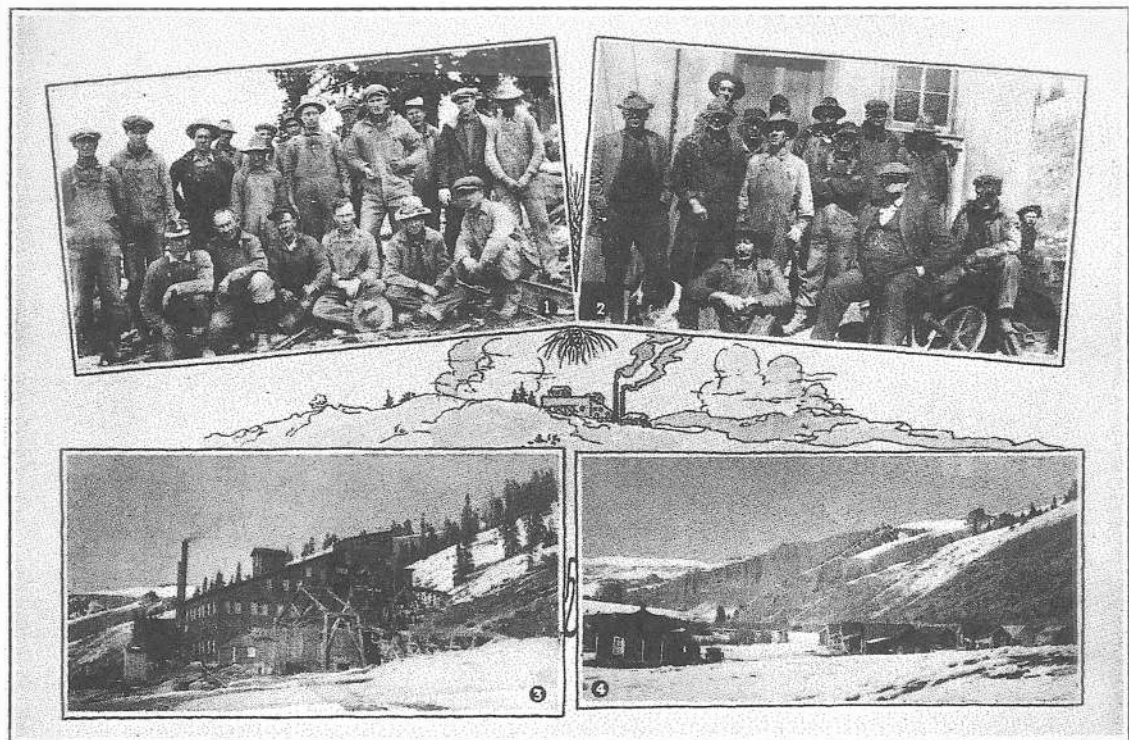
satisfactory. In 1934 CF&I began to use sub-level caving.²¹

Sub-level caving was originally used as a method to mine a narrow ore body that is so weak that even in small headings unsupported ground will collapse only a short time after timber support is removed. In current practice this method is generally used in wide ore bodies, and a number of multiple, parallel sub-level drifts are driven across the ore from an access ramp or drift. Sub-levels are generally established at intervals of between twenty-five and forty feet. Vertical blast holes are drilled to the sub-level above in a fan-shaped pattern. The broken ore is then hauled from the blasted face to a development ramp or drift by diesel-powered load-haul-dump units.²²

Unfortunately, sub-level stopping, as used at the Wagon Wheel Gap mine, resulted in large

amounts of dilution with waste rock and sub-grade ore. Extensive timbering was also required. However, because of the weak nature of the ore and altered wall rocks, there was no alternative method available.

No details of the mine's sub-level stopping methods have been discovered, but the sub-level drifts were probably driven by two-man crews using bar- and column-mounted drifter drills. As they advanced the sub-level from the development raise, the broken ore was transported to the raise's muck compartment using a small, air-powered two-drum slusher and a scraper bucket. Once the sub-level drift reached a point mid-way between two development raises, the miners would start removing the supporting timber, allowing the drift to cave to the sub-level above. This broken material would then be slushed to the develop-



WAGON WHEEL GAP, COLORADO, FLUORSPAR MINE

1. Miners at Wilson Terminal. 2. The Mill force, including Superintendent Botsford at left and Superintendent Spencer seated near the right. 3. The Mill. 4. Some of the homes.

Photos from its Wagon Wheel Gap fluorspar operation that appeared in Colorado Fuel and Iron Company's Industrial Bulletin (X, no. 2, 15 Apr. 1925).

ment raise. In certain areas miners may have had to use stoper drills to make vertical blast holes in order to cave the ore.

Broken ore from above the Third Level was loaded into one-ton-capacity mine cars and hand trammed and dumped into one the raises that connected the Intermediate Level to the Third Level. Ore from Third Level raises was then loaded into similar mine cars and hauled to Raise No. 1, the Main Transfer Raise, using a Mancha Type B one-and-a-half-ton battery locomotive. From the Main Transfer Raise the ore was reloaded into one-ton-capacity mine cars and hauled by mules through the Main Haulage Level to the mill's surface ore bin.²³ At the Wagon Wheel Gap mine's closure in July 1950, the ore body had been mined over a vertical distance of four hundred feet and over a horizontal distance of about fifteen hundred feet.²⁴

The mine's superintendent made weekly written reports to the manager of CF&I's mining

department. A number of the ones that James Whitney made to George Rupp during 1949 and 1950 survive. Some excerpts below, quoted exactly, provide an insight to the mine's ongoing problems and operating conditions:

Feb 11, 1949: 304 Raise 140 West, Mining is at the raise plus 41 feet, the vein is 5 feet wide with fair stocky mill dirt and some spar boulders, all from levels above.

Feb 11, 1949: 301 Raise 40 West, Drifting is at the raise plus 36 feet, no definite vein, some brown spar filled seams in waste.

April 29, 1949: 304 Raise 120 West, Drifting is at the raise plus 84 feet, with the raise up 9 feet, all in waste rock. This is being extended for ventilation.



*The Wagon Wheel Gap Mill, Colorado Fuel and Iron Company, 24 July 1926.
(Photo EF 1324, U.S. Geological Survey Photographic Library.)*



*Ore bins on the Wilson Level,
elevation 9,083 feet. (Aurand,
“Wagon Wheel Gap District,” 65.)*

July 8, 1949: 303 Raise 100 West, Mining is at station 1 plus 12 feet, the vein is 8 feet wide with fair mill dirt and some high grade chunks.

March 24, 1950: 305 Raise 160 East, Drifting is at the raise plus 24 feet, the vein is 5 feet wide, badly mixed with spar, barite and mud and only fair mill dirt.

April 21, 1950: 303 Raise 80 West, Mining was again started after repairing the raise, mining has progress to station 2 plus 32 feet, the vein is 20 feet wide, 15 feet of the center of the vein is mud with some spar chunks and the balance is fair mill dirt.

June 16, 1950: Above the Wilson Tunnel, After moving the loading ramp to a location higher along the cave above the Wilson Tunnel, mining was continued with many spar boulder and fair mill dirt.

These weekly reports were only a page long. In addition to details on mining, they contained comments concerning the mill's operation, particularly delays.²⁵

Although the sub-caving method meant significant ore dilution and high development and timbering costs, it was an effective way to mine ore in difficult ground conditions. Only one fa-

tality occurred during CF&I's operation of the mine, when a man fell down a raise.

Announcing the mine's closure in August 1950, Rupp stated that the operation had received a U.S. Bureau of Mines' safety award for working 1,565,300 man-hours between July 1924 and February 1950 with only the one fatality.²⁶

Milling Operations

The Wagon Wheel Gap mill concentrated fluorspar ore entirely by gravity separation methods; no chemical processes were ever used. The basic design of the Wagon Wheel Gap fluorspar mill was established and the mill constructed prior CF&I's purchase, but between 1925 and the mine's closure in 1950, the steel company made a number of modifications. The mill's design and operation are illustrated in the flow sheet on page 61.²⁷

When CF&I purchased the mine and mill, the entire operation was powered by steam generated by coal-fired boilers. Steam power ran the mine and mill because sufficient electrical power had not been available at the site in 1917. That situation still existed when the mine closed in 1950.

Steam from the boilers powered a Murray Corliss engine with a fourteen-inch bore and thirty-six-inch stroke. The Corliss engine drive pulley was eight feet in diameter and drove the main power shaft's thirty-two-inch-diameter pulley by

means of a rope drive system using seven runs of 1.25-inch diameter hemp rope. The total length of this rope was eight hundred feet. The Corliss rope-driven pulley operated at seventy-eight rpm and the rope had a speed of 1,950 fpm.²⁸

In 1926 CF&I replaced the old boilers with two large Mohr boilers, sixty-six inches in diameter by twenty feet long, which had originally been used at the company's Chicago underground iron mine at Sunrise, Wyoming. Each of these boilers had fifty-four tubes, four inches in diameter, and each was rated as producing approximately 115 hp.²⁹

The main drive shaft was connected to numerous other shafts by multiple rubber belts which drove all of the mill's operating equipment, including crushers, trommels, jigs, pumps, rolls, bucket elevators, and belts. Some shafts simply drove other shafts, while others drove mill equipment. Shafts varied from 2.5 to 4.5 inches in diameter and belts varied from six inches to twelve inches wide and were of either five or six ply.³⁰

The basic technique used to separate fluorspar from waste rock used the difference in their specific gravities. Waste rock's specific gravity is about 2.6, while pure fluorspar, the commercial name for fluorite, is 3.2. Barite has a much higher specific gravity of 4.5.

To start the mill process, crude ore was delivered from the Main Haulage Level tunnel to the mill and dumped onto a grizzly above the seventy-ton-capacity main ore bin. Crude ore less than two inches in size dropped into this primary bin, while the oversized ore passed through a ten-by thirty-inch Tel-smith jaw crusher which discharged into the mill feed bin. An apron feeder discharged material from the primary bin onto a picking belt, where "sorters" picked off pieces of waste rock and high-grade fluorspar. They dropped this hand-sorted material into separate waste and concentrate bins, the high-grade pieces passing through a ten-by fourteen-inch Universal jaw crusher and into a bin for transportation to the railroad. The unsorted ore discharged from

the picking belt into the secondary mill feed bin.

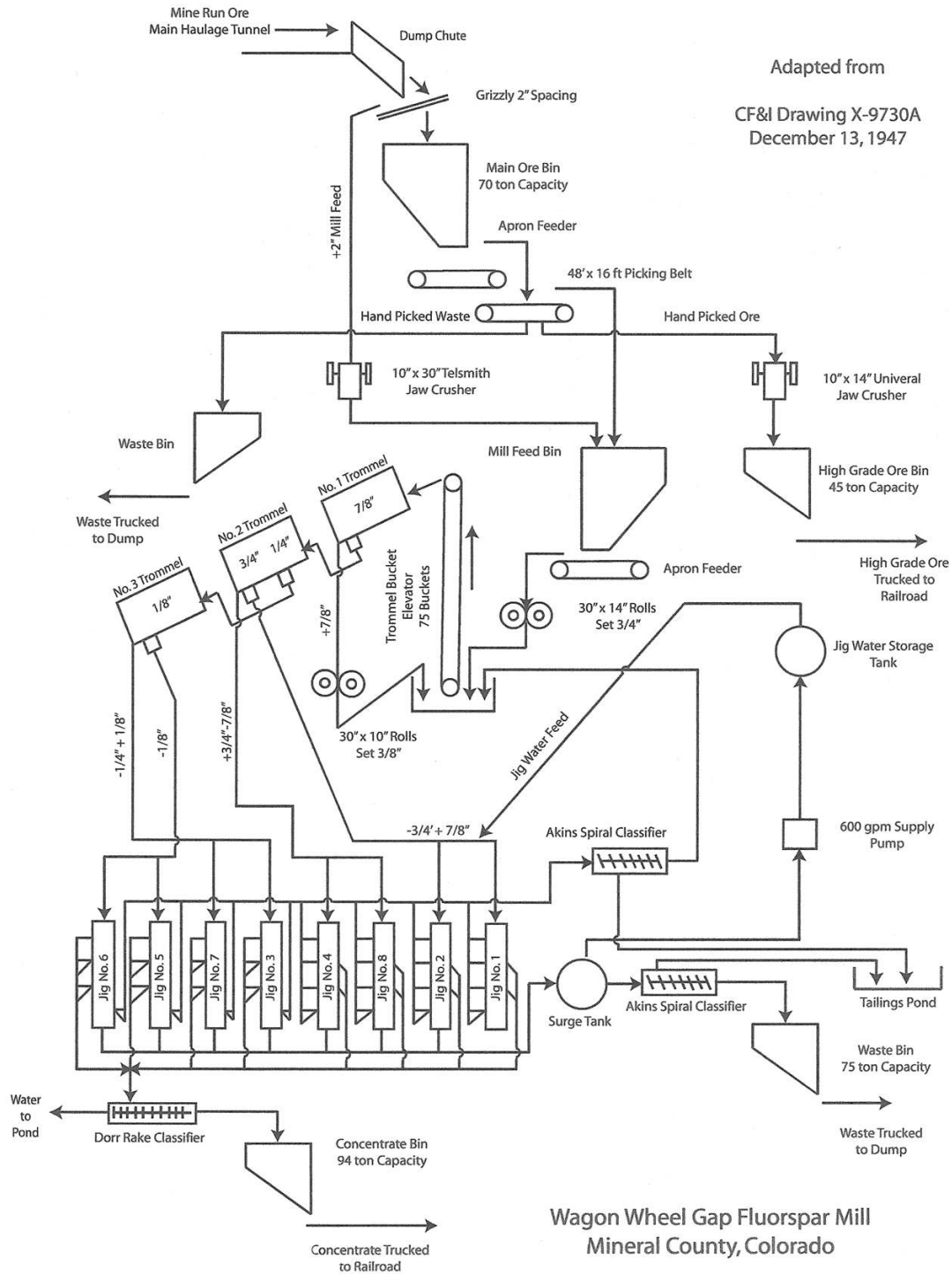
Material from the mill feed bin passed through rolls set at three-quarters of an inch. A belt-bucket elevator lifted the discharged ore from the first set of rolls to mill trommels. Trommels are simply rotating drums, with water sprays and specifically sized holes to wash and size the ore. Ore material larger than seven-eighths of an inch passed through the first trommel and was discharged to be re-crushed by a second set of rolls set at three-eighths of an inch. This material was then re-circulated to the first trommel.

The different sizes of ore sorted by each of the three trommels were each discharged to a specific set of four-compartment, Harz-type jigs. The jigs separated the fluorspar from the waste rock by settling the heavy materials faster than the lighter ones. The jigs used a pulsing action to concentrate the fluorspar and waste rock into separate layers within the jig. These concentrates passed from compartment to compartment, with the highest concentration reached in the last compartment.

Waste rock from the jigs discharged into an Akins spiral classifier for de-watering, then discharged into the waste bin and was trucked to the dump. The middlings from the jigs were de-watered by a separate Akins spiral classifier and the solids returned to the milling circuit by the belt-bucket elevator. The water from the classifiers was also recycled in the mill circuit.

Product-grade concentrate from each of the last jig compartments discharged into a Dorr rake classifier to be de-watered, with the final concentrate dumped into a ninety-four-ton capacity concentrate bin. Trucks carried the fluorspar a mile and a half from the concentrate bins to the railroad siding at Wagon Wheel Gap.

At one time during CF&I's ownership considerable pyrite occurred in the ore body. This pyrite was effectively removed after the installation of two No. 6 Deister concentrating tables and one Butchart concentrating table.³¹ At one time, the company apparently also attempted to recover a separate barite concentrate, but abandoned the



process for unknown reasons.

Although the mill was inexpensive and fairly simple to operate, its jigs were not effective in recovering a high percentage of the fluorspar contained in the crude ore. According to a 1958 memorandum prepared by R. N. Johnson, mining department metallurgist, sampling work done during August 1945 concluded that approximately 50 percent of the fluorspar in the mine's crude ore was finer than ten mesh. Johnson pointed out that to recover this lost fluorspar would require

a much more complex flow sheet, including the use of flotation. Auger test drilling of the tailings pond in 1946 showed an average fluorite (CaF_2) content between 7.2 and 32.0 percent. A number of samples taken from the waste bin in 1950 produced an average of 6.9 percent CaF_2 .³²

Analysis of samples from twenty-nine railroad car shipments from the Wagon Wheel Gap mine, taken between 7 January and 19 July 1950, revealed average percentages of: CaF_2 (fluorite), 82.3; SiO_2 (silica), 7.2; BaSO_4 (barite), 4.8; R_2O_3



Timber portal on the Collins Level, elevation 8,573 feet. (H. A. Aurand, "Wagon Wheel Gap District," Fluorspar Deposits of Colorado [Colorado Geological Survey Bulletin 18, 1920, 64.])



An aerial view of the Wagon Wheel Gap mill, 5 February 1999. Note the results of stoping and caving along the fluorspar vein on the hillside above the mill. (Courtesy of James G. Wark, Airphoto, Photo number 1351.)

(manganese and iron oxides), 2.8; H₂O, 2.5; and CaCO₃ (calcite), 0.4.³³ The effective percentage of CaF₂ is determined by multiplying the silica percentage by 2.5 and subtracting that figure from the original CaF₂ percentage. Thus, for these shipments, the effective percentage of CaF₂ was 64.3.

Operating Costs and Personnel Requirements

Chief Mining Engineer William J. Schendler, CF&I Mining Department, detailed the operation's mining and milling costs in a letter of 20 June 1947.³⁴ That information has been reproduced and summarized on page 64.

Management

Besides the personnel listed in Schendler's letter, the mine and mill employed a superintendent and probably an office clerk. Payroll, purchasing, engineering, geology, and other support functions were provided by personnel from the main office as needed.

George H. Botsford was CF&I's first superintendent, appointed in 1925.³⁵ He also doubled as superintendent of the Orient iron mine near Villa Grove, Saguache County, Colorado, until its closure in 1931. Botsford was reassigned to superintend CF&I's Morley mine, south of Trinidad, Colorado, on 1 August 1938.³⁶ He was replaced at the Wagon Wheel Gap fluorspar mine by Ernest Gustafson in 1939, after the mine had been shut down for a year.³⁷ James E. Whitney was appointed superintendent of the mine in 1947, and remained in that position until the mine's final closure in July 1950.

Wagon Wheel Gap Mine Archives

Information pertaining to the mine and mill is located in a few technical publications, newspaper articles, and government reports. The official records of the mine and mill—consisting of one cubic foot of files and approximately 170 maps and drawings—are held by the Bessemer Historical Society, Pueblo, Colorado. The society is the official guardian of the archives of the Colorado Fuel and Iron Company and successor companies, and the source for the illustrations in this article unless otherwise indicated. For information, contact the society's archivist at (719) 564-9086 or at www.steelworks.us. ■

James B. Copeland is a retired mining engineer and manager. A 1957 graduate of the Colorado School of Mines, he served for more than forty years in various capacities in the industry. His experience includes underground and surface mining of silver, iron, lead and zinc, gold, and coal. He began his career as a miner at the Bunker Hill in Idaho, and ultimately served as superintendent of several mines for CF&I and St. Joseph Minerals. He is a long-time collector of mining stock certificates, and his main historical interests are in mining company history and underground methods, particularly regarding the mines of Colorado and the Comstock Lode of Nevada. Since retiring in 1999, he has been involved in inventorying and archiving the mining documents of CF&I for the Bessemer Historical Society.

Mark A. Vendl is a retired geologist who worked for more than thirty years in the petroleum exploration and environmental fields. He graduated from the University of Illinois at Chicago with B.S. and M.S. degrees in Geological Sciences. His interests include Colorado mining history, especially that of the San Juan Mountains. He has been an active member of MHA since its beginning.

Mining Cost per Ton of Crude Ore Mined:

Breaking Ore:	\$2.00
Tramming:	.75
Ore Sorting:	.30
Timbering	.35
Maintenance and Repairs:	.10
Power:	.30
Mine Management:	.35
Development:	1.00
Total Mining Cost per Ton:	\$5.15
Average Tons Crude Ore per Day: 65	
Average Number of Men in Mine: 30	

Milling Cost per Ton of Concentrates:

Mill Water Supply:	\$0.03
Ore Sorting:	.35
Milling:	1.00
Transportation to Railroad:	.12
Tailings Disposal:	.20
Repairs:	.75
Power:	2.75
Mill Management:	.65
Total Milling Cost per Ton:	\$5.85
Average Tons of Concentrates	
Produced per Day: 26	
Average Number of Men, Mill: 12	
Average Number of Men, Surface: 4	

Estimated Total Cost per Ton of Concentrates:

Mining (\$5.15 x 2.5):	\$12.88
Milling:	5.85
Surface Expense:	.57
Overtime:	.80
General Management:	.35
Vacations:	.12
Group Insurance/Hospital:	.09
General Taxes:	.13
Pay Roll Taxes:	.31
Depreciation:	3.80
Total Cost per Ton:	\$24.90

Daily Wages, Mine, Mill, and Surface**Mine (one shift per day):**

	Each	Total
Mine Foreman (1):	\$13.56	\$ 13.56
Timberman (3):	8.80	26.40
Miners (10):	8.40	84.00
Mule Drivers (2):	7.88	15.76
Trammers (2):	7.72	15.44
Ore Sorters (2):	7.72	15.44
Underground Laborers (8):	7.88	63.04
Motorman (2):	8.08	16.16
Total Daily Wages, Mine:		\$249.80

Mill (two shifts per day):

Day Shift (seven men):		
Mill Foreman:	\$11.40	11.40
Engineer-Fireman:	8.56	8.56
Jig Operator (2):	8.36	16.72
Ore Sorter:	7.72	7.72
Carpenter:	8.56	8.56
Blacksmith:	8.56	8.56
Night Shift (five men):		
Night Fireman (2):	7.80	15.60
Jig Operator (2):	8.36	16.72
Ore Sorter:	7.72	7.72
Total Daily Wages, Mill:		\$101.56

Surface (one shift per day):

Truck Drivers (2):	\$7.88	\$15.76
Carpenter (1):	8.56	8.56
Laborer (1):	7.72	7.72
Total Daily Wages, Surface:		\$32.04

Total Daily Wages, Mine, Mill, Surface: \$383.40

Notes:

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3. CF&I Mining Department, Production Record Tabulations, CF&I Archives.
4. H. A. Aurand, "Wagon Wheel Gap District," *Fluorspar Deposits of Colorado* (Bulletin 18, Colorado Geological Survey, 1920), 61-7.
5. H. L. Scamehorn, *Mine and Mill: The CF&I in the Twentieth Century* (Lincoln: University of Nebraska Press, 1991), 137.
6. Aurand, "Wagon Wheel Gap District," 61-7.
7. American Fluorspar Mining, Leasing and Transportation Company, Articles of Incorporation, Box 3593, Colorado State Archives, Denver; L. B. Weed, "The Wagon Wheel Gap Fluorspar Mine," Colorado Fuel and Iron Company, *Industrial Bulletin* X, no. 2 (15 Apr. 1925): 7; CF&I Steel Corp., Capital Expenditure Request, Form D, 26 July 1982, CF&I Archives. The Colorado Fuel and Iron Company was organized on 21 Oct. 1892 as a merger of the Colorado Fuel Company and the Colorado Coal and Iron Company. Scamehorn, *Mine and Mill*.
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10. Aurand, "Wagon Wheel Gap District," 61-67.
11. W. H. Emmons and E. S. Larson, "The Hot Springs and Mineral Deposits of Wagon Wheel Gap," *Economic Geology*, no. 8 (1913): 235-46.
12. S. L. Korzeb, "The Wagon Wheel Gap Fluorspar Mine, Mineral County, Colorado," *The Mineralogical Record* 24, no. 1 (Jan.-Feb. 1993): 23-9.
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15. CF&I Mining Department Memos, various dates, 1975, CF&I Archives.
16. Aurand, "Wagon Wheel Gap District," 61-7.
17. Drawing 122-9900, 10 Dec. 1948; and Assay Drawings Sheet nos. 1 and 2, undated, CF&I Archives.
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19. Drawing 122-9900, and Assay Drawings Sheet nos. 1 and 2.
20. James E. Whitney, Weekly Reports to Manager George H. Rupp, Mining Department, various dates in 1949 and 1950, CF&I Archives.
21. Myron L. Sisson, Wagon Wheel Gap Mine Report to CF&I Manager of Mines, 27 Dec. 1944, CF&I Archives.
22. E. W. Cokayne, "Sub-Level Caving," Ch. 1, Sec. 4, *Underground Mining Methods Handbook* (New York: Society of Mining Engineers, 1982), 873.
23. W. J. Schendler, letter to Frank H. Madison (outlining mining and milling details of Wagon Wheel Gap mine operations), 20 June 1947, CF&I Archives.
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