Brown's Canyon's

Fabulous Fluorite Fling

By
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Most people do not have a clue about how the metal bound up in rocks in the ground turns into the steel in their cars. The processing and production of metals requires many secondary materials. One of the most essential is fluorite, the source of the important element fluorine.

Fluorine in hydrofluoric acid was the main ingredient of fluorochlorocarbons, the now-outlawed refrigerants. It is an ingredient in insecticides, is used in the manufacture of aluminum, and is added to one hundred-octane gasoline. Industrial applications such as the open-hearth process of steel making, glass and ceramic enamel manufacturing, and the creation of some medicines all require fluorine. In minute quantities, fluorine strengthens bones and teeth in organisms that have them.

Mineralogy and Geology

The mineral fluorite, composed of calcium fluoride (CaF_2), is the primary source of fluorine. Other rare minerals that carry some fluorine in their matrix include topaz, bertrandite, creedite, and phenakite. Fluorite has a hardness of 4 on the Mohs' hardness scale, crystallizes in the isometric system, and breaks four directions into octahedrons. Its color varies from crystal clear to white, green, blue, purple, yellow, brown, and even brilliant pink. Some fluorite crystals from the South Platte district near the old Top-of-the-World campground in the Rampart Range of Colorado were raspberry-red with a sugary coating of white fluorite over the top.[1]

Fluorite can be banded and fibrous, forming what has been called "ribbon spar" or "bacon spar." Other growth forms include columnar or fine-grained to microgranular forms, as well as reniform and botryoidal deposits. Like topaz, a fluorine-bearing silicate mineral, fluorite is very heavy (dense). Fluorite gave its name to the property of minerals called "fluorescence"—glowing in the presence of ultraviolet light. Some fluorite "phosphoresces"—glowing after the black light is turned off. Fluorite also exhibits another physical property, "thermoluminescence"—glowing when heated. Some fluorite contains rare-earth elements that exhibit radioactivity.[2]

The term "fluorspar" describes a mineral aggregate containing enough fluorite to be of commercial interest. Such a deposit is usually classed as strategic or critical because of fluorite's importance to the steel industry. Its importance in smelting and refining led the various "war agencies"—the War Production Board, the Atomic Energy Commission—and the uranium industry to include studies of fluorite resources in their economic mineral surveys.[3]

Much of the information for this article came from Ralph Van Alstine's "Geology and Mineral Deposits of the Poncha Springs NE Quadrangle, Chaffee County, Colorado," a USGS professional paper published in 1969, and Doak Cox's "General Features of Colorado Fluorspar Deposits," published in 1945 in *Proceedings of the Colorado Scientific Society* under the auspices of the USGS and funded by the Colorado Metal Mining Fund.[4]

In Colorado, fluorite occurs in "primary" pegmatitic ore deposits and in "secondary" hot spring deposits. Primary crystalline fluorite occurs throughout Colorado. At Lake George collectors find crystals up to ten inches square in the Pikes Peak granite. Sometimes delicate purple fluorite crystals sit on amazonite or smoky quartz crystals from the mining claims north of Florissant. The Sweet Home Mine in Park County is famous for its exquisite multi-faced purple fluorite crystals on plates with clear quartz, cherry red rhodochrosite, and brown tetrahedrite. Fluorite crystals also come from Mt. Antero and Shavano Peak, and other granitic primary deposits in the Sawatch Range.

Colorado molybdenum mines often produce fluorite crystals along with the rare fluorine-bearing mineral creedite ($Ca_3AI_2(SO_4)(F,OH)_{10}\cdot 2H_2O$), originally named from the deposit at Wagon Wheel Gap. Fluorite from the Climax Mine at Fremont Pass is some of the finest from Colorado; purple octahedrons, purple dodecahedrons with blue apatite, blue cubes with rhodochrosite, and green and purple bi-colored cubes all have come from the old molybdenum mine. In the North Amethyst vein at Creede, green fluorite lines vugs and occurs with purple amethyst. Pegmatites of Trout Creek Pass on the west side of South Park and of the South Platte River District along the Rampart Range produce massive crystalline fluorite usually in association with rare-earth minerals.[5]

Colorado also has had many sources of fluorspar—the massive secondary form of fluorite. In 1872, mining engineer Robert Old reported "Fluor Spar" in "massive white, green, pink, and purple metalliferous veins near Bear Creek," "in the silver mines of Argentine and Griffith Districts," and "in extensive beds near James Creek and in small purple and white crystals in Virginia Cañon."[6] The earliest fluorspar mined in Colorado came from west of Boulder at Jimtown (now Jamestown), and from pegmatites near Bear Creek (now Evergreen) in Jefferson County.[7] Nathaniel P. Hill and other early smelters used the fluorite in their processes.

Most Colorado fluorspar formed at relatively low temperatures under epithermal or perhaps partly mesothermal conditions as probably exist in hot springs that were not closely related to metalliferous deposits. In such deposits, the fluorspar takes a columnar shape or leaves behind fine-grained to microgranular fluorite called "sugar spar." Often reniform or botryoidal masses agglomerate around cores of country rock.[8]

Almost anywhere there once were hot springs in Colorado there were fluorspar mines—at Wagon Wheel Gap near Creede, in the Brown's Canyon District in Chaffee County, at St. Peter's Dome along the south side of Pike's Peak in what is sometimes called the Cheyenne Mountain District, at Poncha Hot Springs in Chaffee County, and in North Park near Northgate. Mines produced three grades of fluorspar: acid-grade (98 percent calcium fluoride), ceramic-grade (95 percent calcium fluoride), and metallurgical-grade (85 percent calcium fluoride with a maximum of 5 percent silicon dioxide).[9] This raw fluorspar required processing. Fluorite mills used a combination of jigs and gravity separators to produce metallurgical-grade concentrates. Some mills used flotation processes to produce ceramic-grade fluoride.[10]

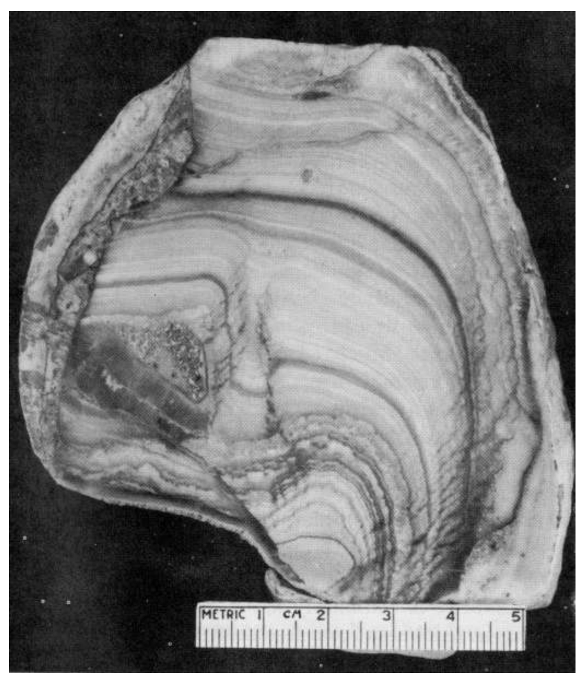
This article focuses on fluorite deposits in the Brown's Canyon area, Chaffee County, in central Colorado along the Arkansas Rift zone. The three main fluorspar districts in Chaffee County were at Poncha Springs, near the top of Poncha Pass, and in the Brown's Canyon District. None of the deposits were discovered or developed until the 1920s.

The Brown's Canyon Fluorite District, about eight miles northwest of Salida, covered an area of about nine square miles and was bounded on the east by the Arkansas River and on the west by U.S. Highway 285, now called the Collegiate Peaks Scenic Byway. Most of the district lies on the west side of the Arkansas River across from the junction of the old Calumet Branch of the Denver and Rio Grande Western Railroad with the main line, the original Hecla Junction was in a region where the maximum relief is only about five hundred feet.

The bedrock of the southern portion of the Brown's Canyon District is coarsely banded hornblende gneiss and schist of Precambrian age cut by granite and many pegmatite dikelets and quartz veinlets. These Precambrian rocks are locally covered by Tertiary volcanic rocks and Tertiary gravels. The fluorspar occurs as epithermal fissure veins along faults in Precambrian granite and metamorphic rock, in Tertiary rhyolite porphyry, and between rocks of these ages.

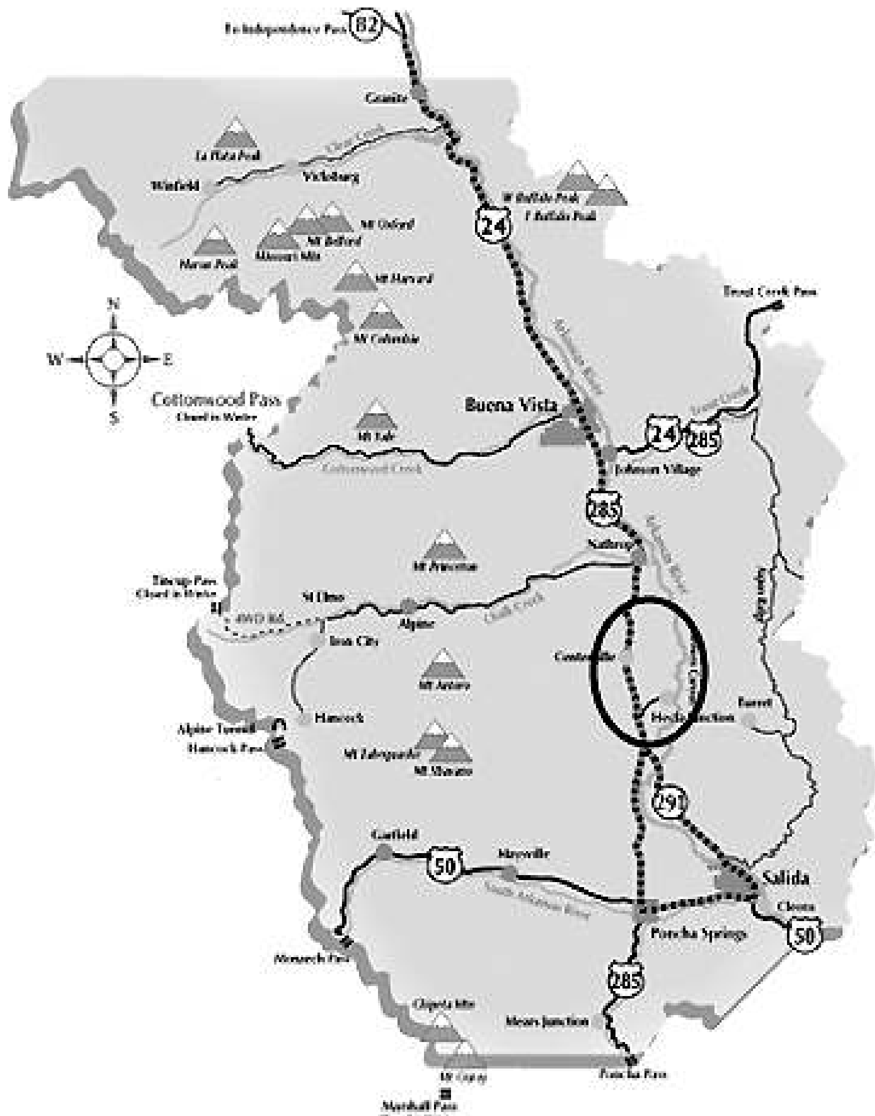
In some deposits fluorspar replaced fault breccia extensively enough to form ore bodies. Some partly mineralized faults were more than a mile long; ore shoots as much as fifteen hundred feet long and six feet in width branched off the main veins. Sometimes the vein width exceeded forty feet. The greatest vertical distance through which any of the veins was exposed was about four hundred feet. A pair of north-south veins at the Colorado Fluorspar and American mines and their branches at the Snowflake deposit, and at the Kramer and other mines on the northern ends of the veins provided the bulk of the ore from the Brown's Canyon district.

Most of the fluorspar of the Brown's Canyon District is white, fine-grained like sugar, and occurs mainly as large irregular masses and bands along faults. Surfaces of the masses commonly are botryoidal, mammillary, and locally stalactitic. Some of the ore is nodular and is composed of fluorite almost concentrically banded about a nucleus of country rock. Some fluorite specimens collected at the Snowflake deposit glow purple

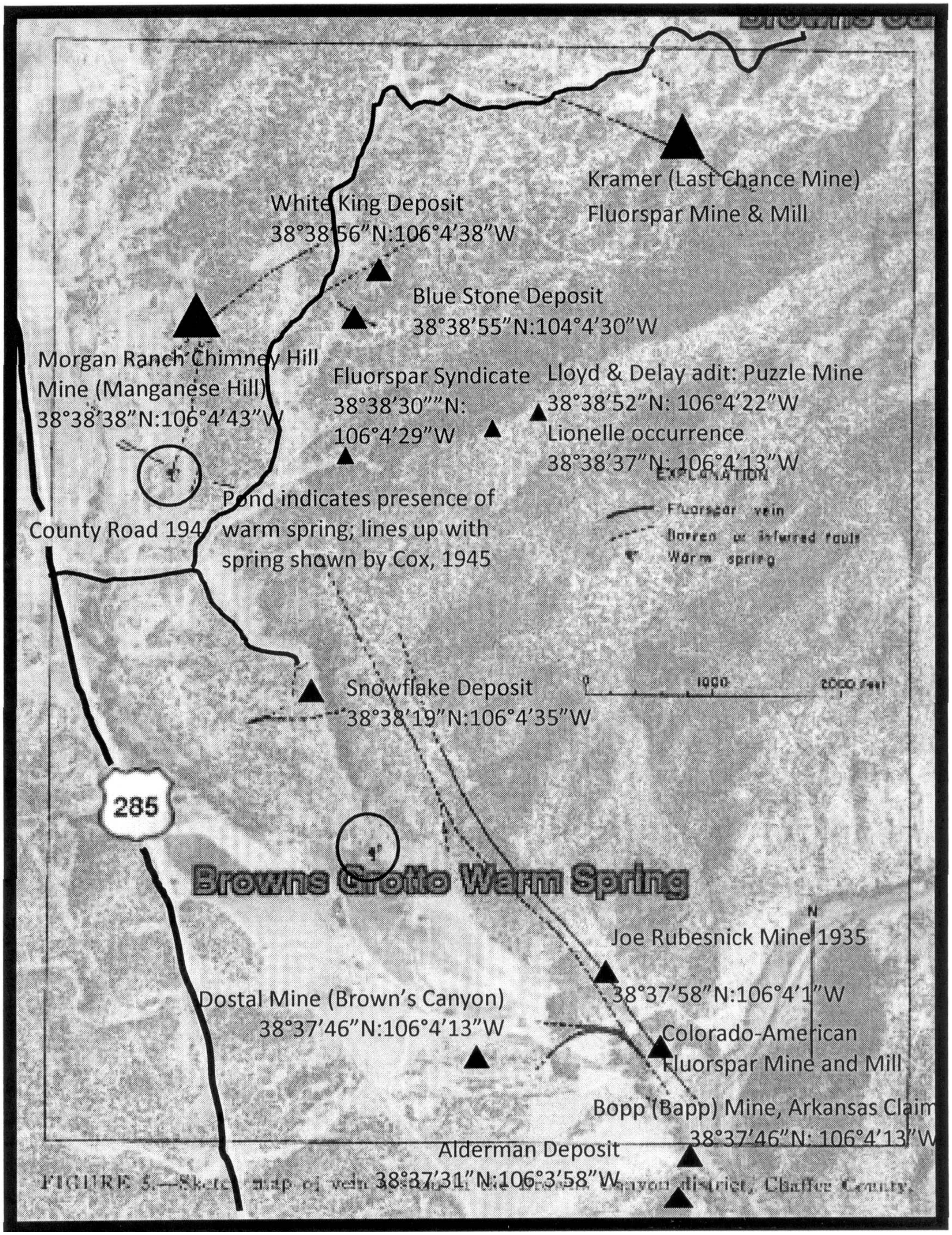


Banded fluorite from the Last Chance fluorite deposit of the Kramer Mine. Scale in centimeters. (From Van Alstine, "Geology and Mineral Deposits of the Poncha Springs NE Quadrangle," 1969.)

Chaffee County (highlighted) in Colorado.



Brown's Canyon Fluorite District (circled) in Chaffee County, Colorado.



Doak Cox's 1945 map overlain by John Ghist on a 2009 Google Earth satellite image. Mine names and positions obtained from www.Mindat.org. Fluorspar veins appear as solid or dotted lines.

under long-wave ultraviolet light.

The most abundant impurity in the veins of the Brown's Canyon District, silica, occurs chiefly as grains, veinlets, and in large bands of chalcedony. Some of this silica is intimately intergrown with fine-grained fluorite and created headaches for mill men trying to purify the fluorspar. Other impurities—small quantities of calcite, aluminum oxide, and iron oxide—were usually found in analyses of the fluorspar. Manganese oxides locally formed veinlets and lined vugs in the veins. Accompanying minerals included pyrite, goethite, hematite, manganite, opal, pyrolusite, quartz, calcite, barite, kaolinite, montmorillonite, and psilomelane.

From 1924 through 1944 about eighty-five thousand tons of fluorspar, chiefly of metallurgical and ceramic grades, worth over $5 million left this district. Eventually, Colorado Fluorspar Mines controlled most of the mines. American Fluorspar Corporation, United States Fluorspar, Inc., and the Kramer Mines company's Last Chance Mine were also major producers during Brown's Canyon's fabulous fluorite fling, which lasted until about 1960.

Ore Bodies and Mines

Early in the district's mining history, two main veins, the Eastern and Western, provided most of the ore. Two adits accessed several large ore bodies exposed on the Eastern vein, about eight feet thick for a distance of about sixteen hundred feet. The vein contained 50 percent calcium fluoride. The Trefone Adit penetrated the Eastern vein through a mill adit, two sublevels, stopes, the American shaft, and open cuts in the smaller Branch or Collins vein. One section of fluorspar in the Trefone adit was about six feet thick and averaged 70 percent calcium fluoride. In 1935, the Joe Rubesnick Mine worked the two veins just to the north of the Trefone, in what later became the Colorado Mine.

The Colorado Mine excavated the Western vein underground through the mill adit. Near the intersection with the Branch vein where the vein widened out to eight feet thick, the mine ran southeast through about seventy feet of low-grade breccia. The smaller Branch vein, a split from the Western, contained the thickest fluorspar body in Brown's Canyon.

A fault localized the Western vein; the fault was readily apparent underground and eventually exposed in the open pit mine. The forty- to fifty-foot thick deposit consisted largely of shells of fluorite that coated rounded blocks of rhyolitic welded tuff. In 1948, the mill feed from the Branch vein contained 35 to 40 percent calcium fluoride. The Bopp Prospect, also called the Bapp Mine and Arkansas Claim, worked the Branch vein extension southwest of the Colorado Mine in 1945. In 1949, the Dostal Mine was operating just north of the Bopp.

South and east of the Colorado and American mines, James Bopp worked the Alderman deposit about 1945.[11] There, steep northwest-trending faults transected altered volcanic ash. One fault separated the ash from the rhyolitic volcanic rocks on the northeast. Locally, the faults were mineralized with calcite and some fluorite. The fluorite cemented loose blocks of rhyolitic welded tuff several feet in diameter, along with chalcedonic quartz and black manganese oxide. Vugs between the blocks were as wide as three feet and were lined with botryoidal and columnar white to yellowish fluorite that ran from less than one inch to several inches thick. When examined later, the dump yielded botryoidal fluorite that contained seven different isometric crystal microscopic forms. Many specimens even consisted of alternating layers of fluorite and psilomelane.

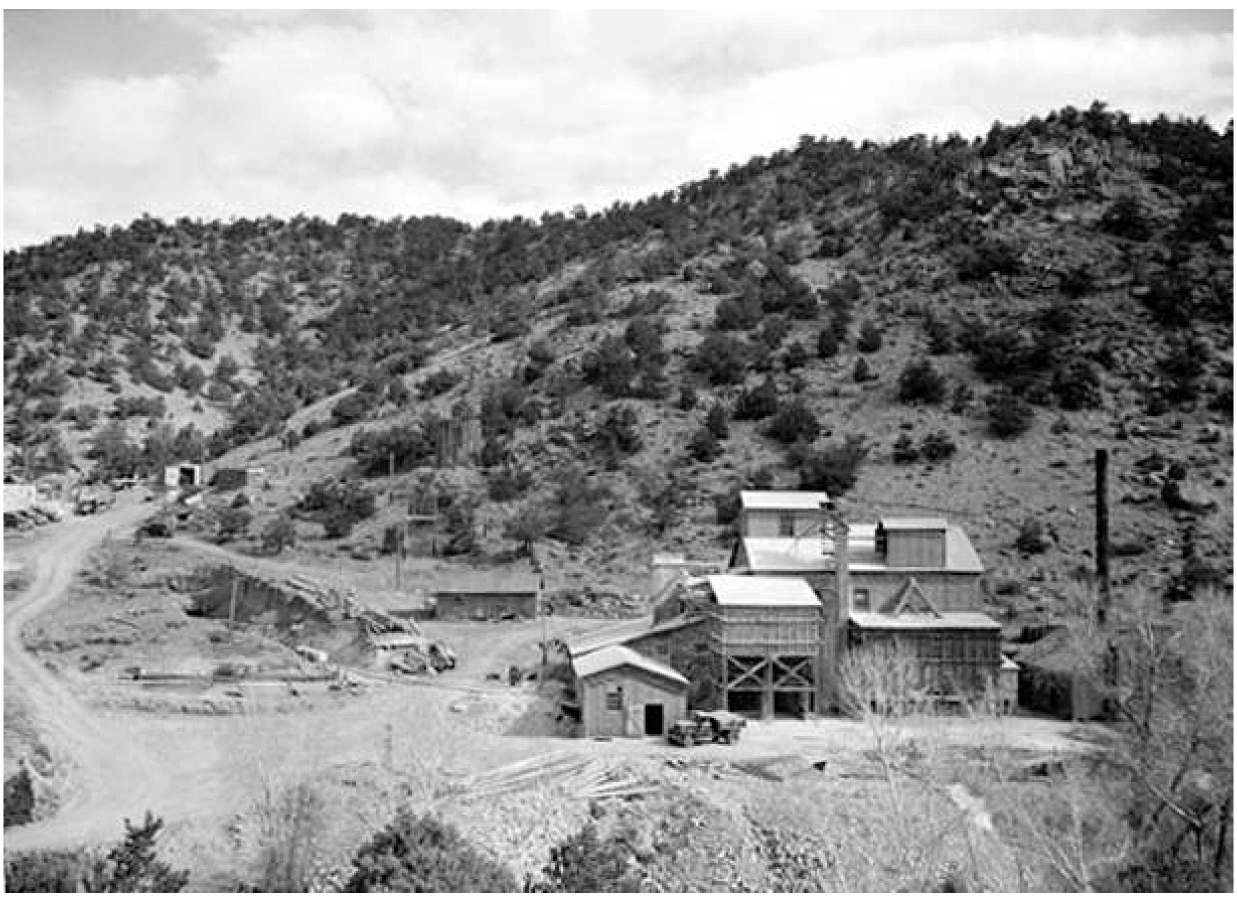
At first, miners extracted the fluorspar ore using the traditional underground methods of adits, drifts, stopes, raises, and ore carts. Usually the ore was hand sorted and shipped to Colorado Fuel and Iron Company near Pueblo, Colorado. However, with the deposits both near the surface and massive, American Fluorspar Corporation and

Colorado Fluorspar Mines both began mining by "shrinkage stopes through draw holes," the same procedure used in the great Climax molybdenum mine north of Leadville. And like the Climax operation, the two fluorspar companies finally resorted to open-pit mining.[12]

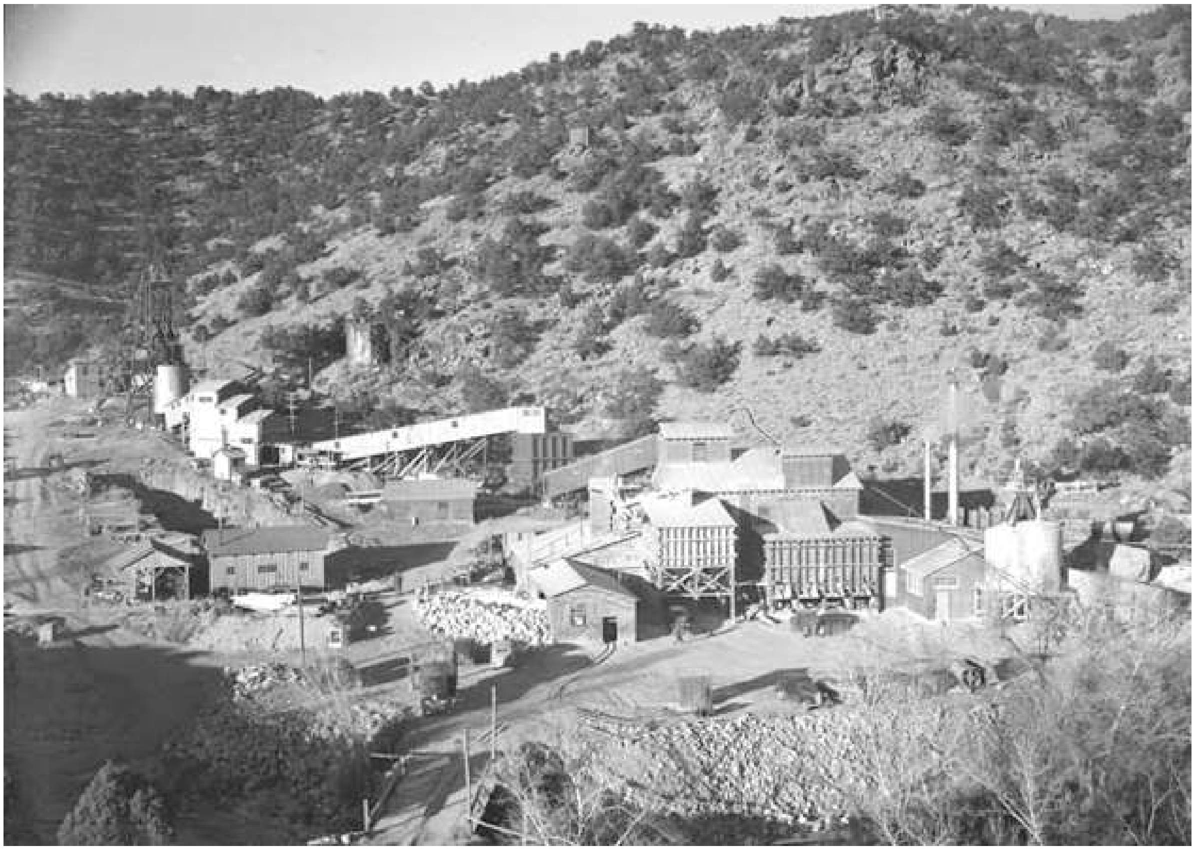
During the "shrinkage stopes" phase of mining, miners drove drifts in the footwall with crosscuts at right angles that had enough track to accommodate a mechanical loader and an ore car. On the 100-foot level, an electric locomotive collected the loaded thirty-cubic-foot side-dump ore cars and hauled them to an ore pass, where they dumped into a large ore pocket covered by an eight-inch grizzly. From there the ore was hoisted to the crude ore bin in thirty-cubic-foot skip cars. Twenty-cubic-foot end-dump cars, bottom-lined with wood, hauled waste rock to the dump.

Colorado Fluorspar Mines, Inc.

In 1938, the Colorado Fluorspar Corporation took over the operation of the major mine on the single Eastern vein, which strikes 30 to 50°NW and dips about 85°SW.[13] They constructed a forty-five-ton flotation mill with Denver "Sub-A" flotation machines. This mill operated continuously until the end of 1944. In January 1945, Colorado Fluorspar Mines, Inc., acquired the property. At the time, reserves in the vein at the Colorado Mine were estimated at 17,700 tons of measured fluorspar ore—about 90 percent of the district's production—83,900 tons of indicated ore, and 110,000 tons of inferred ore to a depth



The Colorado Fluorspar Mill in Salida in 1940. Photograph by Ben Zellers. (Courtesy of the Western History Collection, Denver Public Library, #6217.)



The Colorado Fluorspar Mill, Salida, c. 1947, by Ben Zellers. Note the changes since 1940. (Courtesy of the Western History Collection, Denver Public Library, #6251.)

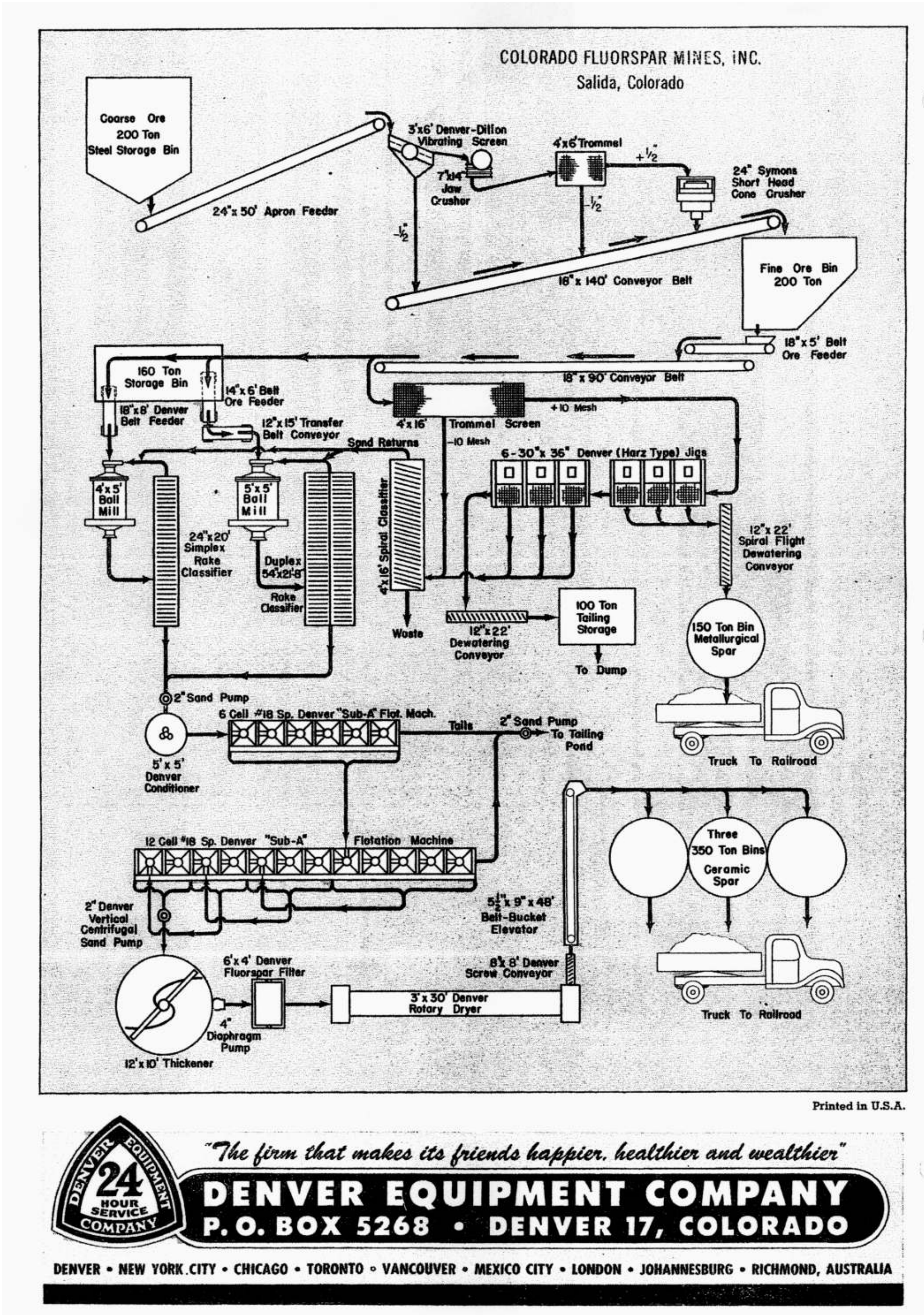
of about 225 feet with an estimated grade of 70 to 75 percent calcium fluoride.

Subsequently Colorado Fluorspar, also supplied by Denver Equipment Company, enlarged their mill to a 160-ton plant, added a two-stage crushing section, a second ball mill and classifier together with more Denver "Sub-A" flotation machines, a Denver drum filter, and a Denver dryer. Colorado Fluorspar also added Denver Harz-type jigs, increasing the mill's capacity yet another one hundred tons per day in addition to the flotation circuit.

Other improvements in 1945 included a new mine shaft, head frame, hoist, and three battery-powered locomotives. A sawmill on site provided timber framing and any lumber needed in the mine and mill. The assay and analytical lab sported a thousand-gram laboratory flotation cell, a sample splitter, a testing sieve shaker, a mini-crusher, a disc pulverizer, and a laboratory bottle-type agitator.[14]

Water for mining and milling operation came from the Arkansas River. A 600-gallon-per-minute electric centrifugal pump lifted water one hundred feet vertically and a thousand horizontally to a 3,000-gallon supply tank. From there a 400-gallon-per-minute centrifugal pump delivered water to the jig plant while a second 200-gallon-per-minute centrifugal pump took water to another 13,500-gallon supply tank, providing approximately a 150-foot head of water pressure for the operation. "Rocky Mountain spring water," coming from melting snow in the nearby mountains, supplied the flotation machines and required no softeners or purifying agents.[15]

Water for the boiler came from a local spring. A small triplex pump raised water about three hundred feet vertically to the boiler head tank. This



Flow Diagram of the Colorado Fluorspar Mill.
(From Lintner, "Colorado Fluorspar Mines," p. 8.)

spring water contained a negligible amount of dissolved mineral salts, so no detergents were added prior to its use. The boiler head tank connected to the yard and plant fire protection systems, a lesson probably learned from the fiery destruction of the Kramer Mill just to the north in 1945.

The Rural Electrification Authority provided the electrical power needed to run the Colorado mill at 22,000 volts, as the REA did for all of the mines and mills in the Brown's Canyon District. An on-site substation reduced the power to three-phase, 60-cycle, 440-volt current for the integral horsepower motors and large motors of the mine. For the smaller motors and electrical lighting, the current was further reduced to single phase, 110 volts.[16]

The flow diagram for the Colorado Fluorspar Mill, drawn by Robert Lintner, fluid engineer for Denver Equipment Company, illustrates the operation. A fifty-foot apron feeder took the ore from the coarse ore bin and fed it to a four-foot by six-foot, single-deck, Denver-Dillon vibrating screen equipped with half-inch-opening screen cloth. To prevent damage to the screen cloth, steel bars, spaced about six inches apart, were welded above the screen to collect oversized material then returned to a nine- by fourteen-inch jaw crusher.

A worker sorted waste from the feeder by hand, then hauled it in a truck to the dump. A twenty-four-inch Symons cone crusher reduced all oversize material coming off the vibrating screen to a half inch. The screen undersize fell directly onto a 140-foot-long conveyor belt which, combined with the material from the cone crusher and the trommel screen, emptied into a wooden "fine" ore bin.[17]

From there another conveyor belt took the ore to the jig plant or to the flotation plant or both, depending on whether the customer required ceramic- or metallurgical-grade spar. The jig plant housed two three-compartment, thirty- by thirty-six-inch Denver Harz-type jigs. The first jig produced twenty to twenty-five tons of metallurgical-grade fluorspar, which then passed to a spiral dewatering conveyor that loaded the concentrates into a 150-ton-capacity concentrate storage bin. Wastes from the jigs were dewatered, conveyed to a 100-ton storage bin, and then trucked to the dump.[18]

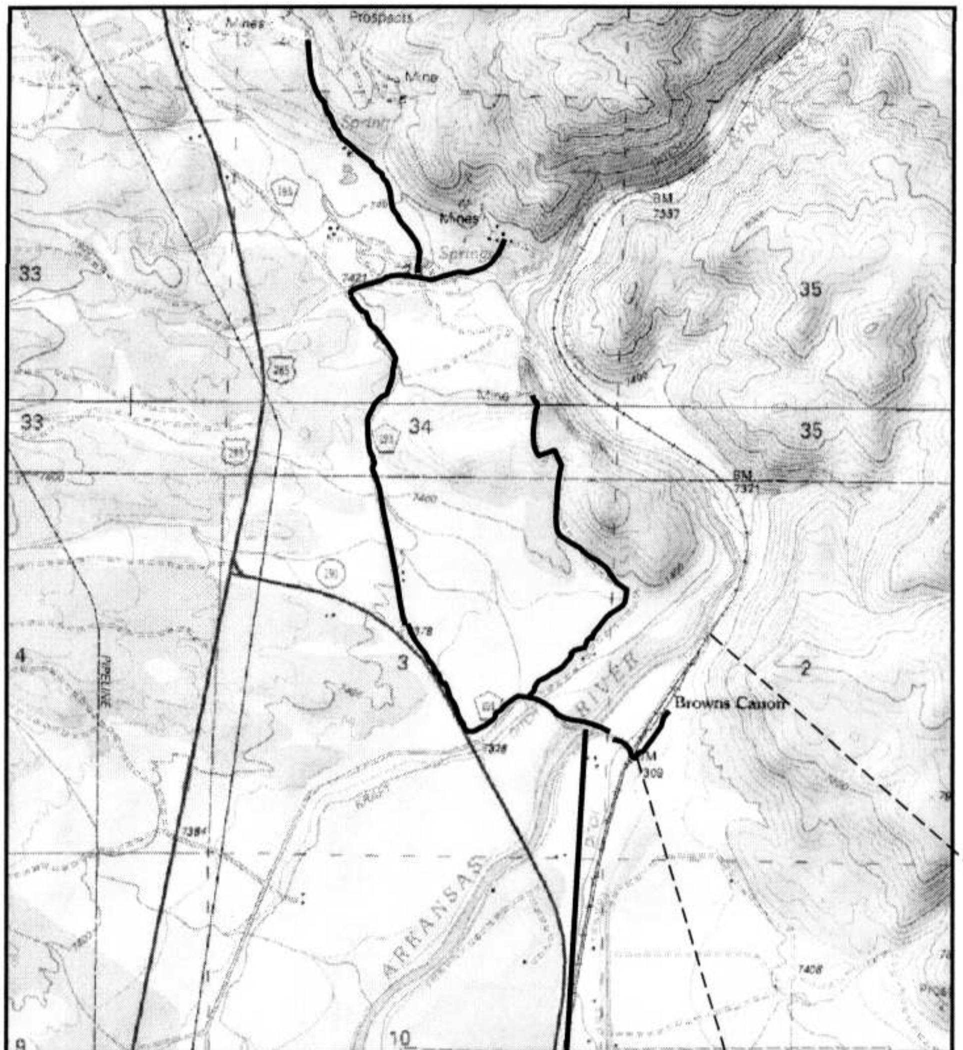
Concentrate produced in the second jig was dewatered in a sixteen-foot spiral classifier and then sent to a storage bin; from there a ninety-foot conveyor belt carried it to the flotation plant. All undersize material was conveyed to a five-by-five-foot ball mill. The slurry was pumped to a Denver conditioner, which prepped the flotation feed for approximately four minutes. The pulp, kept at 90°F, overflowed and was fed into a series of Denver "Sub-A" flotation machines that cleaned and re-cleaned the concentrate to produce ceramic grade calcium fluoride. The pH was controlled by adding soda ash in hot water. One pound of secret formula surfactant, "S-142," was added to every half ton of feed; it created froth bubbles that selectively attached the fluorite and floated it to the surface of the solution. The S-142 also suppressed silicate minerals, especially silicon dioxide.[19] The entire flotation process required about half an hour.[20] The product from this mill was very low in iron, calcium carbonate, and sulphides, thus the fluorspar concentrates could be used in the glass industry.

Concentrates from the flotation machine were then thickened from a feed of 10 percent solids to 65 percent solids and pumped to a Denver rotary drum filter, which reduced the moisture content to 10 to 12 percent. The filtered concentrate fell onto an oil-fired Denver rotary dryer, running at 300°F, that reduced the moisture to .5 percent. From the dryer, the concentrates fell into a bucket elevator that discharged into three steel storage bins.

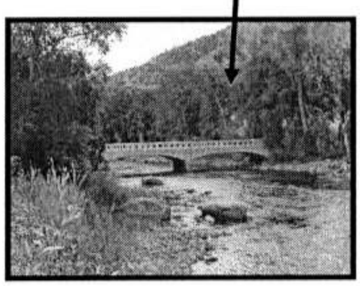
The finished product from the storage bins was loaded into paper-lined, canvas-topped trucks and drivers hauled the powdered fluorspar to the D&RGW Railroad's siding on the east side of the Arkansas River, two miles southeast of the mill. The trucks crossed the "Old Stone Bridge" to the

Workman tending a rotary filter at the Kramer Mill in 1942, by Ben Zellers. (Courtesy of the Western History Collection, Denver Public Library #6212.)

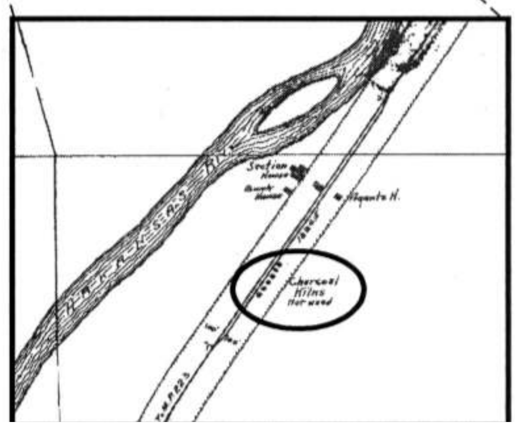
An American Fluorspar Company truck at a loading chute in 1940, by Ben Zellers. (Courtesy of the Western History Collection, Denver Public Library, #5507.)



Truck routes from the mines to the railroad siding at Kraft, labeled "Browns Canyon."



The Old Stone Bridge built across the Arkansas River at Brown's Canyon in 1908. (Courtesy of bridgehunter.com.)



Brown's Canyon siding in 1899, before construction of the road bridge across the Arkansas River. (Courtesy of William Reich.)

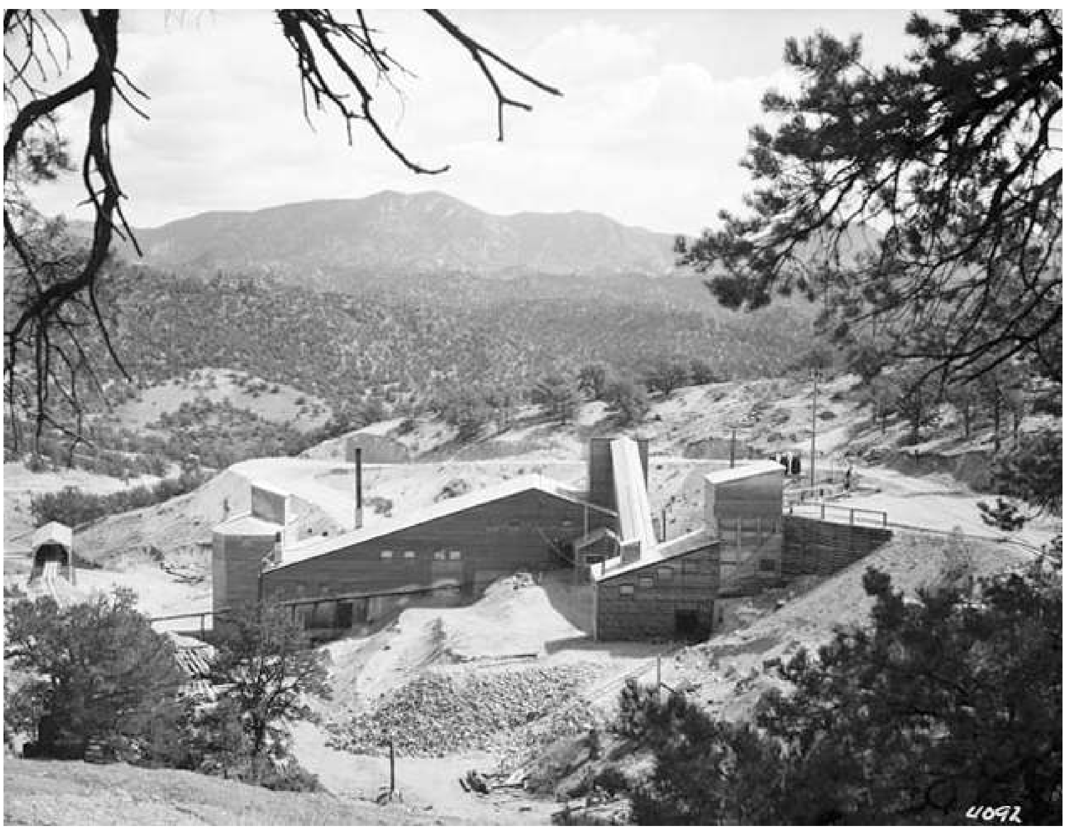
siding at Kraft (Brown's Canyon), built originally to serve charcoal kilns located there in the late 1890s .[21] From Kraft the bulk fluorspar moved by rail directly to the Pueblo steel mill. For customers further away, such as glass manufacturers, Colorado Fluorspar sacked and shipped concentrates in one hundred-pound paper bags. Monthly the mill produced about 850 tons of high-grade fluorspar, with an average concentrate of 90 percent calcium fluoride, at a profit of six dollars per ton.

Other Mines and Mills

East of the Arkansas River near Colorado's great Calumet iron mine, Magnus and Sons' open pit worked a fluorspar vein. The company processed the fluorspar at the Western Feldspar mill at the intersection of CR 175 with the railroad crossing at the Knickerbocker Ranch northwest of Salida. M&S sold its product to Pittsburgh Paint and Glass and to a beer bottling manufacturer in Texas for use as a hardening and tempering agent.[22]

North of the Colorado and American mines and mills, the Fluorspar Syndicate's mine, located just south of County Road 194 , was reported as a "past producer" in 1937.

Southeast of the Fluorspar Syndicate's mine, between 1937 and 1940 the Lionelle brothers consistently worked their Lloyd and Delay adit and Puzzle Mines, which yielded a total of four hundred tons of metallurgical grade fluorspar. Their adit was 135 feet long and exposed about four feet of fluorspar along an east-trending vein in the gneissic quartz monzonite. At the Lionelle, the overlying almost unconsolidated Brown's



The Kramer Mill, looking east, photographed by Ben Zellers in 1942. A flotation mill built at the mine in 1942 supplied fluorspar of ceramic and acid grades until destroyed by fire in July 1944. (Courtesy of the Colorado Historical Society, X6210.)

Canyon Formation was mineralized with fluorite, barite, and brownish-yellow iron oxide in veinlets and blebs less than .05 mm in diameter. Some of the fluorite formed pale purple cubes with their edges truncated by dodecahedrons. In 1947 this area was called the Lionelle Occurrence. The fluorite was microcrystalline, sometimes banded. Interestingly, it fluoresced blue under long-wave ultraviolet light. Breccia zones nearly twenty feet thick were sporadically mineralized with fluorspar.

North of County Road 194 at the White King deposit, the fluorspar occurred on the contact between the rhyolitic tuff and banded gneiss and quartz monzonite. Other minerals included pyrite, goethite, hematite, manganite, opal, pyrolusite, quartz, calcite, barite, kaolinite, montmorillonite, and psilomelane. The Blue Stone deposit was a vein south of and parallel to the White King with the same list of associated minerals.

The combined output of the White King, Blue Stone, and Puzzle deposits amounted to about seventeen hundred tons of fluorspar, either as a hand-picked metallurgical-grade product or as ceramic-grade flotation concentrates mostly taken from the White King between 1929 and 1934, and 1943 and 1944.

For a time, Commercial Minerals, Inc. owned the Blue Stone deposit, a source of about six hundred tons of fluorspar in 1943 and 1944. The company's mine, a shallow shaft with an adit and several cuts, followed an irregular vein trending northeast and northwest in the monzonite. The mineralized zones were sometimes more than five feet thick, with 25 to 40 percent calcium fluoride. Eventually, Allied Chemical Corporation acquired these mines from American Fluorspar. By 1969, several caved workings, consisting mainly of a 220-foot adit and a shallow shaft, occurred along steep northeast-trending mineralized faults in the gneissic quartz monzonite.

The ore bodies, of chiefly white, pale green, or pink and sugary fluorite, six inches to five feet thick, were a network of veins averaging about 30 percent calcium fluoride with fine-grained quartz as gangue. The mineralized faults also cut through the overlying Brown's Canyon Formation several hundred feet southwest of the adit, demonstrating that the mineralization had occurred after the deposition of the Miocene Brown's Canyon Formation.

Kramer Mine and Mill

During World War II, the Kramer Mine and Mill, previously called the Last Chance Mine, operated about a mile northeast of the Colorado Fluorspar Mine. At the Kramer Mine, a fault strikes 60°NW and dips 60°NE in Precambrian coarse-grained gneissic granite. The fault locally consists of a sheeted zone of granite containing veinlets of intimately intergrown fluorite and chalcedony. The wall rock and breccia of granite were partly replaced by fluorite and silica.

The fluorite at the Kramer was commonly a white, pink, or brown dense variety, but in places it was green and more coarsely crystalline. One band of red fluorite assayed almost 60 percent calcium fluoride, 25 percent iron oxide, 10 percent silica, 4 percent calcium carbonate, and almost 2 percent water. Lenses rich in fluorite ranged in thickness from a few inches to about three feet. The sheeted zone, up to twenty-five feet thick, was mined in an open cut. The accessory mineral list at the Kramer included pyrite, goethite, hematite, manganite, opal, pyrolusite, quartz, calcite, barite, montmorillonite, chalcedony, and psilomelane.

Over a thousand tons of metallurgical-grade concentrates came from the Last Chance before 1942. In 1942, Kramer Mines, Inc., leased the property from Universal Mines, Inc., formerly the Salida Fluorspar Corporation. Kramer produced about ten thousand tons of flotation concentrates between 1942 and 1944. The workings eventually extended under the county road in claims originally owned by Commercial Minerals (formerly Universal Mines, Inc., and Mansheim-Salida Fluorspar Co.), which Kramer Mines had also

The ruins of the Kramer Mill in 2009, by Beth Simmons. (Courtesy of the author.)

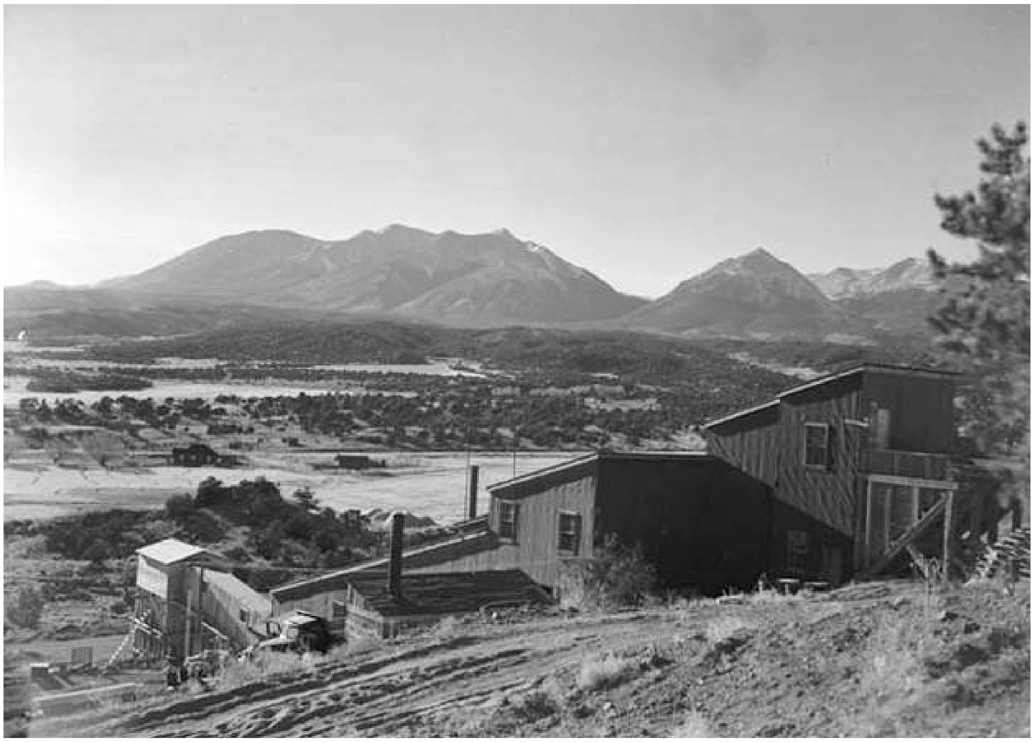
leased. In 1943, miners drifted the 90-foot level of the Last Chance eastward from the winze and exposed a fifty-foot deposit that ran six feet thick. They excavated a stope 90 feet long and extended the drift more than 150 feet further west along mineralization two to three feet thick.

A fault that strikes about N65°W and dips about 60°NE cut a gneissic quartz monzonite and a few small lenses of older metamorphic rocks and localized the fluorspar. The fault included a sheeted zone that contained many veins of fluorspar. Fluorite and silica partly replaced the wall rock and fault breccia; in places the fluorspar veins were as much as six inches thick and extended into the hanging wall. Two main ore bodies occurred along the fault. The company developed the eastern ore body by open pits, Adit No. 1, No. 2, the Lower Adit and the 90-foot level. Miners worked the western ore body from open pits and the Lower Adit. The maximum thickness of the ore bodies, about twenty-five feet, was mined in a large open pit west of the county road. Ore mined at the Kramer averaged about 30 percent calcium fluoride.

The Kramer mill, a modern combination jig and flotation facility similar to the Colorado Fluorspar mill, was completed in October of 1942. It produced ceramic-grade and a small quantity of acid-grade concentrate that averaged 93 to 94 percent calcium fluoride. The mill burned in July 1944. All that remains are the concrete foundations, which incorporate large pieces of the local snowflake obsidian from the nearby exposure of the Wall Mountain Tuff vitrophere. Later, Mr. Kramer, the company's owner, opened a fluorite operation in the St. Peter's Dome District on the southeast side of Pikes Peak.[23]

United States Fluorspar and Manganese Mines and Mill

United States Fluorspar and Manganese, Inc.,



The U.S. Fluorspar Corp. Mill in the 1940s, by Ben Zellers. (Courtesy of the Western History Collection, Denver Public Library, #6253.)

acquired deposits at the north end of the district, about a mile northwest of the Colorado Fluorspar Mines, from the Chaffee County Fluorspar Corporation in September 1945. These included the Chimney Hill deposit on the Morgan Ranch, first worked about 1936. Several adits and winzes at Chimney Hill showed that fluorspar occurred in four bodies in silicified Tertiary rhyolite as lenses twenty to thirty feet long and seven to eight feet wide and also as a network of small veinlets.

At the nearby Manganese Hill deposit, also on the Morgan Ranch, two inclined shafts exposed an ore body averaging four or five feet in width and cut across Precambrian granite. The Bancroft Incline, the Hilltop Mine (1939), and the Curly Lee shaft higher on the hill also worked this deposit. Some of these deposits were eventually worked by open pit.[24]

In these mines, open cuts, adits, and a shaft with three levels exposed two fluorspar bodies that averaged about 30 percent calcium fluoride in the fault zone. The southeast shoot was about 450 feet long and averaged 6 to 8 feet in width on the upper levels; below, the fluorspar pinched to narrow stringers in the granite. The northwest shoot was about 400 feet long and in a sheeted section had a maximum width of about 25 feet. On the lower level the fluorspar pinched to small veins. In some spots, the Brown's Canyon Formation formed the wall rock. The veins consisted of several types of fluorite: soft, fibrous, fine-layered greenish to purplish; and dense, brown, partly earthy and partly hard and granular.

The brown fluorite, formed later than the others, contained manganese-oxide minerals as small pockets and coatings. It formed the main body of fluorspar exposed in the lowest incline. The veins in this deposit were rich; hand-picked ore shipped as metallurgical grade contained at least 85 percent calcium fluoride. In 1953, diamond core drilling revealed that more than a million tons of fluorite-bearing material lay underneath the Tertiary deposits on these hillsides, but by the end of that year the Chimney Hill mine's shaft was flooded to ten feet below the main adit.

Today's Brown's Canyon District

As school buses filled with tourists eager to raft the river rattle by toting trailers stacked high with rubber rafts, it is hard to imagine the hustle and bustle of this district during the forty-year heyday of Brown's Canyon's fabulous fluorite fling, a portion of Chaffee County's past that few historians report. For years, trucks hauled raw ore day and night from the mines to the mills, concentrates between the fluorspar mills, and milled fluorspar south to the railroad spur.

But because of foreign competition, all of Brown's Canyon's fluorspar mines were out of business by 1960 and the modern equipment in the mills was scrapped. The men and women employed in the fluorspar industry, numbering at least a hundred, found employment elsewhere. Most probably turned to ranching in the Arkansas Valley; others might have worked in the Climax Mine at Fremont Pass or in the mines and mills at Leadville. The railroad quit running in 1997, and the Arkansas Headwaters Recreational Area emerged as the government agency that oversees pubic land use in the valley, probably ending any potential for future fluorite mining in the Brown's Canyon District.[25]

Expensive mountain homes now grace many of the piñon-covered fluorspar mine claims and mill sites. Despite a pure water report from the 1950s, the region's ground water contains fluorine. This is a geohazard residents seem to overlook as they bulldoze old mine dumps, close off mine tunnels, backfill open pits, and cautiously patrol potential cave-ins on their beloved pieces of the past with spectacular panoramas of the Collegiate Range to the west, the Sawatch Mountains to the south, and the Mosquito Range to the northeast.

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Beth Simmons earned her Ph.D. in Colorado history documenting the Mosch family, a mining family that own the Phoenix Gold Mine, now a tour operation in Idaho Springs. She authored A Quick History of Idaho Springs*, and, with Katherine Honda,* The Legacy of Arthur Lakes*, a biography of the professor from Golden who found the first large dinosaur bones along the hogback north of Morrison, Colorado, then became a great Western mining expert. Simmons teaches geology and Colorado history at colleges in the Denver area and has been a member of the Mining History Association for five years, giving presentations about Arthur Lakes at the MHA meetings in Leadville and Creede.*

Notes:

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2. Eckel, *Minerals of Colorado*, 212.
3. Doak C. Cox, "General Features of Colorado Fluorspar Deposits," *Proceedings of the Colorado Scientific Society* 14, no. 6 (1945): 267.
4. Ralph E. Van Alstine. "Geology and Mineral Deposits of the Poncha Springs NE Quadrangle, Chaffee County, Colorado, with a Section on Fluorspar Mines and Prospects." U.S. Geological Survey, *Professional Paper 626*, 1969. Mineralogical and mine data and information for this article also derived from: S. M. Del Rio, *Mineral Resources of Colorado, First Sequel* (Denver: State of Colorado Mineral Resources Board, 1960) 87-8, 440; Ralph E. Van Alstine, "Fluorspar Investigations," Summaries of Mining Districts and Mineral Deposits in: John W. Vanderwilt, *Mineral Resources of Colorado* (Denver: State of Colorado Mineral Resources Board, 1947), 457-65; Ralph E. Van Alstine, "Continental Rifts and Lineaments Associated with Major Fluorspar Districts," *Economic Geology* 71 (1976): 977-87; and Alan R. Wallace, "Distribution and Occurrence of Fluorine, Fluorite, and Fluorspar in Central Colorado," Paper, GSA Rocky Mountain Section 60th annual meeting, 2008, 32-3.
5. Eckel, *Minerals of Colorado*, 172, 210, 213.
6. R. O. Old, *Colorado: United States, America, Its Mineral and Other Resources* (London: British and Colorado Mining Bureau, 1872), 17.
7. Cox, "General Features of Colorado Fluorspar Deposits," 265.
8. Cox, "General Features of Colorado Fluorspar Deposits," 268, 270, 271.
9. Van Alstine, "Geology and Mineral Deposits," 30.
10. Cox, "General Features of Colorado Fluorspar Deposits," 276-7, 284.
11. Sites differ between the online resource, the Minedat.org mineral database and mineralogy reference (Mineral Data, "Fluorite," www.mindat.org), and the description in Van Alstine, "Geology and Mineral Deposits," Figure 12.
12. Robert E. Lintner, "Colorado Fluorspar Mines, Incorporated, Salida, Colorado," in series "For Your Engineering Notebook," *Bulletin No. M4-B47*, Denver: Denver Equipment Co. (DECO), n.d. (post 1945), 1, 2.
13. Lintner, "Colorado Fluorspar Mines," 1.
14. Lintner, "Colorado Fluorspar Mines," 2, 7.
15. Lintner, "Colorado Fluorspar Mines,"2, 4.
16. Lintner, "Colorado Fluorspar Mines," 1.
17. Lintner, "Colorado Fluorspar Mines," 2.
18. Lintner, "Colorado Fluorspar Mines," 3.
19. Alex Paul, retired Kramer Mines' mining engineer, personal communication, 7 Aug. 2009.
20. Lintner, "Colorado Fluorspar Mines," 4.
21. William Reich, author, personal communication, 22 Sep. 2009. See also: William Reich, *Black Smoke and White Iron: A History of Colorado Kilns, Ovens, Furnaces, and Rails* (Colorado Rail Annual 29; Golden: Colorado Railroad Museum, 2009).
22. Eleanor Fry, *Salida: The Early Years* (Salida, CO: Arkansas Valley Publishing Co, 2001), 187-9.
23. Dr. Thomas A. Steven, retired USGS geologist, personal communication, 7 Aug. 2009.
24. At the age of ninety-one, Dr. Steven, still actively pursuing geology in Colorado, led a field trip to the Brown's Canyon District in 2009. Steven had mapped the shafts of the Manganese Mine on one of his first assignments with the USGS in Colorado in 1945. He later extensively mapped Colorado's San Juan Mountains.
25. Eleanor Fry, *Salida,* 187-189.