New Mexico Geological Society

Downloaded from: https://nmgs.nmt.edu/publications/guidebooks/41



Coal geology and mining history in the Dawson area, southeastern Raton coal field, New Mexico

Gretchen K. Hoffman
1990, pp. 397-403. https://doi.org/10.56577/FFC-41.397

in:

Tectonic Development of the Southern Sangre de Cristo Mountains, New Mexico, Bauer, P. W.; Lucas, S. G.; Mawer, C. K.; McIntosh, W. C.; [eds.], New Mexico Geological Society 41st Annual Fall Field Conference Guidebook, 450 p. https://doi.org/10.56577/FFC-41

This is one of many related papers that were included in the 1990 NMGS Fall Field Conference Guidebook.

Annual NMGS Fall Field Conference Guidebooks

Every fall since 1950, the New Mexico Geological Society (NMGS) has held an annual Fall Field Conference that explores some region of New Mexico (or surrounding states). Always well attended, these conferences provide a guidebook to participants. Besides detailed road logs, the guidebooks contain many well written, edited, and peer-reviewed geoscience papers. These books have set the national standard for geologic guidebooks and are an essential geologic reference for anyone working in or around New Mexico.

Free Downloads

NMGS has decided to make peer-reviewed papers from our Fall Field Conference guidebooks available for free download. This is in keeping with our mission of promoting interest, research, and cooperation regarding geology in New Mexico. However, guidebook sales represent a significant proportion of our operating budget. Therefore, only *research papers* are available for download. *Road logs*, *mini-papers*, and other selected content are available only in print for recent guidebooks.

Copyright Information

Publications of the New Mexico Geological Society, printed and electronic, are protected by the copyright laws of the United States. No material from the NMGS website, or printed and electronic publications, may be reprinted or redistributed without NMGS permission. Contact us for permission to reprint portions of any of our publications.

One printed copy of any materials from the NMGS website or our print and electronic publications may be made for individual use without our permission. Teachers and students may make unlimited copies for educational use. Any other use of these materials requires explicit permission.

This page is intentionally left blank to maintain order of facing pages.

COAL GEOLOGY AND MINING HISTORY IN THE DAWSON AREA, SOUTHEASTERN RATON COAL FIELD, NEW MEXICO

GRETCHEN K. HOFFMAN
New Mexico Bureau of Mines and Mineral Resources, Socorro, New Mexico 87801

Abstract—The Raton coal field, located in northeastern New Mexico, is the second largest coal area in the state. This field is part of the highly dissected Raton Mesa region that provides good exposures of the Cretaceous-Tertiary coal-bearing sequences deposited during the final regression of the Western Interior seaway. Most of the Late Cretaceous coals were deposited in back barrier and interdistributary swamps, whereas the Tertiary coals currently being mined were deposited further inland in poorly drained floodplain swamps. Mining of the Cretaceous Vermejo Formation coals began in the late 1890's in or near several of the canyon mouths along the eastern edge of the Raton field. Dawson, in the southeastern part of the field, developed into a major coal-producing area in the early 1900's. During the life of the town, ten mines were developed by the Dawson Fuel Company and the Stag Canyon Fuel Company, predecessors of the Phelps Dodge Corporation, at Dawson in the Vermejo Formation Raton coal bed, locally called the Dawson coal bed. The coals from these mines are of high volatile A bituminous rank and have very good coking properties, which made them marketable to the copper smelters and railroads. The Dawson mines produced 33 million salable tons from 1899–1950, almost half the total for Colfax County during this period.

INTRODUCTION

The intent of this article is to assemble and present details of the coal geology and mining history in the southeastern part of the Raton field, specifically the Dawson area. Statistics are compiled primarily from reports of the United States mine inspector for the territory (1899–1912), New Mexico State mine inspector reports (1913–1950), unpublished Phelps Dodge annual reports on the Dawson mines and data furnished by Phelps Dodge (Ken Bennett, written commun., 1990). A summary of the geologic data, particularly those related to coal, was compiled from existing geologic reports (i.e., Lee, 1924; Wanek, 1963; Pillmore, 1976). General concepts relative to the depositional environment and the subsequent quality of the coals in the Dawson area are derived from the existing data.

The Raton field is the second largest coal area in New Mexico (Fig. 1). Coal was discovered in the Raton area as early as the 1820's. The first phase of coal mining began in the late 1880's and continued at Koehler until 1966. The present phase of coal mining in the Raton field began with the opening in 1966 of Kaiser Steel Corporation's large underground York Canyon mine. This was followed by the opening of their surface mining operation in 1977. These mines and most of the Raton field in New Mexico were purchased by Pittsburg and Midway Coal Company in February, 1989. Most of the early coal mines were located along the eastern edge of the Raton field where entries were easily made into the sides of the numerous canyons where the coals were exposed. Both the Vermejo and Raton Formations in the Raton field have economic coal beds that are high volatile B to A bituminous in rank, and many of these coals have good coking properties. Most of the early mines produced coal from the Raton coal bed in the Vermejo Formation. Coal is presently mined from the York Canyon and Left Fork coal beds in the upper Raton Formation.

Geography

The Raton coal field covers 2590 km^2 in northeastern New Mexico. The coal field is part of the Raton Mesa region, a highly dissected plateau with escarpments 152–305 m high on the eastern and southern margins. Northwest-trending canyons are cut through the plateau by the Vermejo and Canadian Rivers and their tributaries, and provide good exposure of the Cretaceous-Tertiary coal-bearing sequences (Fig. 1).

GEOLOGY

Structural setting

The Raton coal field is in the New Mexico portion of the Raton Basin, a broad (10,360 km^2) asymmetrical syncline extending from southeastern Colorado into northeastern New Mexico. The western edge of the basin has steep dips with vertical to overturned beds and faulting associated with the Sangre de Cristo Mountains. The east limb of the Raton Basin gently dips 1–5° northwest and generally lacks significant faulting (Wanek, 1963). The most prominent feature in the New Mexico portion of the basin is the Vermejo Park anticline which has more than 762 m of structural relief within 6.4 km. The relief associated with this anticline is thought to be the result of a buried intrusive, delineated from drilling records (Pillmore, 1976). Minor faulting and gentle dips are common in the coal-bearing areas of the Raton Basin (Pillmore, 1976).

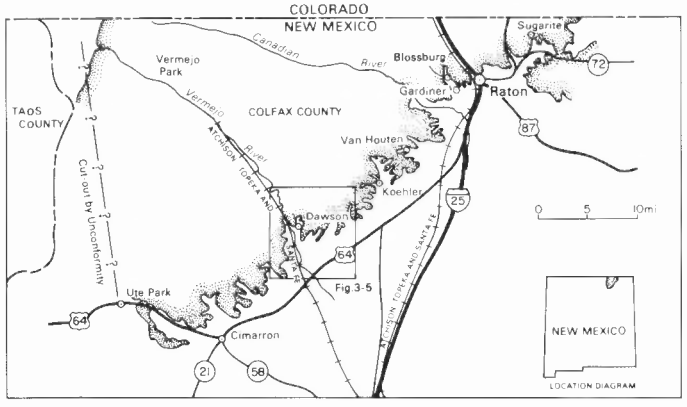


FIGURE 1. Raton Mesa region in New Mexico. Modified from Jurich and Adams (1984). Stipple pattern = extent of coal-bearing units.

Stratigraphy

The Vermejo and Raton Formations are the two coal-bearing sequences in the Raton coal field (Fig. 2). The Upper Cretaceous Vermejo Formation was named by Lee (1917) for the coal-bearing unit between the Trinidad Sandstone and the Raton Formation. The Trinidad Sandstone is a regressive unit consisting of offshore to nearshore marine sandstones. The Vermejo conformably overlies and in many places intertongues (Wanek, 1963) with the Trinidad Sandstone. This unit consists of thin- to medium-bedded, fine- to medium-grained sandstones interbedded with carbonaceous shales and coals (Wanek, 1963). The Vermejo Formation is thickest in the northwest (114 m) and thins to the southeast. Lee (1924) indicated that the Vermejo is absent near Van Houten and Koehler and pinches out 3.2 km northeast of Raton where it is truncated by an erosional unconformity at the base of the overlying

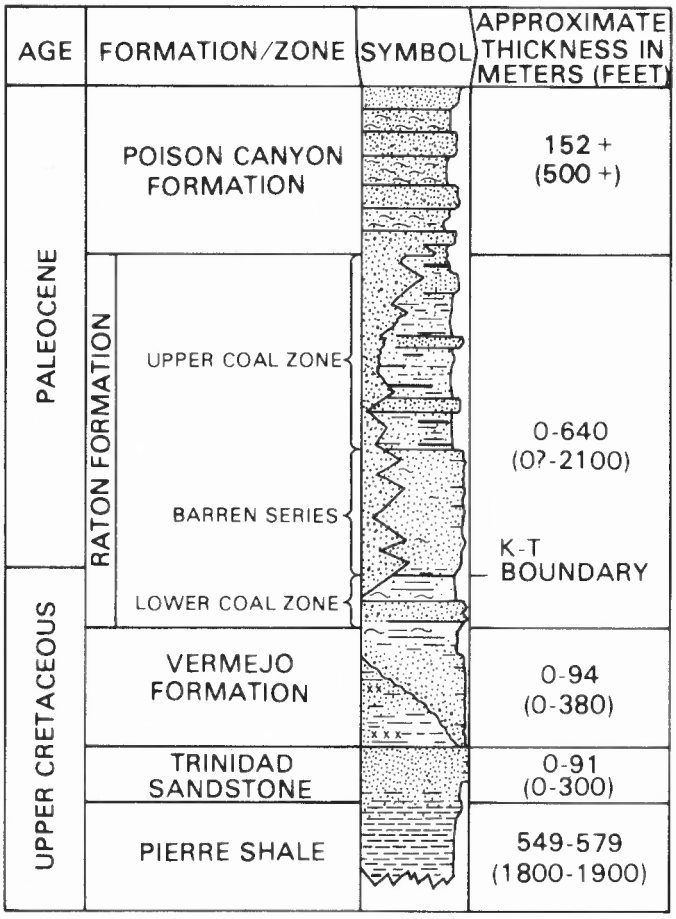


FIGURE 2. General stratigraphic column for Raton coal field. Modified from Pillmore and Flores (1987).

Raton Formation. In the Dawson area the Vermejo Formation contains a thick-bedded to massive coarse-grained sandstone 1.5–4.6 m above the base of the Vermejo. Lee (1924) named this sandstone the Rail Canyon Sandstone Member of the Vermejo Formation. This unit often disconformably overlies coals in the Dawson area and locally provides a good roof in the mines of the area. The Rail Canyon Sandstone Member has a maximum thickness of 11 m and is apparently restricted to the Dawson–Salt Peter Mountain area.

The Vermejo Formation is unconformably overlain by the Upper Cretaceous–lower Tertiary Raton Formation. The Raton Formation was named by Hayden (1869) and restricted by Lee (1917). This unit consists of three distinct lithofacies (Fig. 2). The basal part of the Raton Formation, referred to as the lower coal zone by Pillmore and Flores (1987), is a conglomeratic sandstone that is overlain by a zone of predominantly coarse- to fine-grained sandstones, with siltstones, mudstones and a few coals. The only economic coal bed in this lower zone is the Sugarite coal bed, which was mined in the early to mid-1900's in the Sugarite area (Fig. 1) northeast of the town of Raton. The basal unit of the lower coal zone of the Raton Formation is a conglomeratic to siliceous sandstone (0–15 m) in the eastern and central parts of the field. The lower coal zone ranges from 30 m in the eastern part of the field to 90 m in the central part west of Vermejo Park. The lower coal zone becomes part of, or intertongues with, the Cretaceous and Tertiary Poison Canyon Formation in the southern and western part of the Raton Basin (Wanek, 1963). Pillmore and Flores (1987) have located the Cretaceous-Tertiary boundary at or near the top of the lower coal zone at several sites in the coal field.

The barren series (Lee, 1924; Pillmore and Flores, 1987) overlies the lower coal zone of the Raton Formation. This unit coarsens upward, and is predominantly fine- to coarse-grained sandstones that locally are interbedded with siltstones, mudstones and a few carbonaceous shales and thin coals. The barren series is 55 m thick in the eastern part of the Raton field (Pillmore and Flores, 1987) and is 152–214 m thick in the southern part in the Cimarron-Dawson area (Wanek, 1963). A large tongue of arkosic conglomerate and silty shale splits the Raton Formation in the area from Ponil Creek to the north side of Van Bremmer Canyon (Wanek, 1963).

The upper coal-bearing zone of the Raton Formation consists of sandstones, siltstones, mudstones and coals. The majority of the 5 to 6 economic coal beds, described in detail by Pillmore (1976), are within this upper zone of the Raton Formation and occur in the central and eastern parts of the Raton field. This unit reaches a maximum thickness of about 305 m in the central part of the basin and, like the other units within the Raton Formation, intertongues with the Poison Canyon Formation to the south and west (Pillmore, 1976).

Coal geology

The coals in the Vermejo Formation developed in a different environmental setting than those in the Raton Formation. The fluvio-deltaic sequences of the Vermejo Formation were deposited landward of the barrier-bar and delta-front deposits of the Trinidad Sandstone as the Cretaceous shoreline retreated to the east-northeast (Flores and Tur, 1982). Pillmore (1976) noted in the New Mexico part of the Raton Basin the thick coal trends in the Vermejo Formation indicate a north to northeast trend for the late Cretaceous strandline. The Vermejo Formation coals formed in the back barrier coastal and interdistributary swamps of the delta plains (Pillmore and Flores, 1987). The Raton Formation deposits developed further landward on the upper alluvial plain (Flores, 1984). Some of the coals in the lower zone were developed in poorly drained peat swamps (e.g., the Sugarite bed), but the majority of the coals in this facies were formed in well-drained swamps that were not conducive to thick accumulations of peat. The upper zone coals in the Raton Formation were developed in poorly drained swamps that were conducive to the development of thicker peat deposits located on the floodplains of a meandering fluvial system (Pillmore and Flores, 1987). In the southern Raton coal field near Dawson the coals in the Vermejo Formation are of economic significance.

Both Lee (1924) and Wanek (1963) discussed three Vermejo Formation coal beds in the southern part of the Raton field. The lowest is the Cimarron coal bed (Wanek, 1963), which is exposed in the canyons along Ponil Creek near Cimarron. The few small mines and prospects that were developed in this seam operated sporadically from the 1920's through the 1940's (Nickelson, unpublished notes on reclamation evaluation for Office of Surface Mining, 1979), but no significant coal production came from the Ponil Creek area. The Dawson bed, stratigraphically higher than the Cimarron, was mined extensively at Dawson. This coal is 0.6–3.05 m thick in the Dawson area (Lee, 1924). The uppermost coal bed described by Wanek (1963) in the Vermejo Formation is the Raton bed. In general, the Raton bed is the name given to any coal bed mined in the Vermejo Formation during the early part of this century because it was considered to be the first minable seam above the base of the Vermejo Formation. The thickness of this bed is 0.6–3.8 m (Wanek, 1963). The Raton bed was the source of coal mined in the Koehler–Van Houten and Gardiner coal districts. Pillmore (1976) mentioned a Vermejo coal bed that occurs near the top of the Vermejo Formation. This coal bed is present only in areas where the formation is 76 m thick or greater. The Vermejo coal bed is 3 m thick in the Vermejo Park area and thickens to 4.6 m to the northwest (Pillmore, 1976). In the Salt Peter Canyon area, northeast of the Dawson district, the Vermejo coal bed is reported to be 0.9–1.2 m thick and approximately 76 m above the Dawson coal bed (Ken Bennett, written commun., 1989).

The Vermejo and Raton Formations' coals are bituminous of high volatile B to A rank. Rank is determined from the moisture, mineral-matter free Btu (MMFBtu) value (Ameican Society of Testing Materials, 1981). Table 1 is a comparison of the quality analyses of coals from both the Raton and Vermejo Formations. These coals have a low moisture and moderate ash content and are low sulfur coals of steam and

TABLE 1. Available quality analyses for Raton and Vermejo Formations, Raton field. Data from U.S. Bureau of Mines (1936) and Pillmore and Hatch (1976).

	Moisture	Ash	Fixed Carbon	Vol. Mat.	Sulfur	Btu	MMFBtu
Raton Formation							
Avg	2.62	12.44	49.40	36.30	0.64	12,754	14,765
Max	9.80	21.20	54.40	42.30	1.10	14,230	15,202
Min	1.30	5.20	42.10	31.90	0.40	11,290	13,189
# Samples	92	92	92	92	90	87	92
Vermejo Formation							
Avg	2.49	13.66	49.12	35.37	0.71	12,576	14,806
Max	5.40	26.30	54.40	38.70	1.20	13,320	15,444
Min	1.20	8.80	39.30	27.50	0.50	10,480	13,452
# Samples	68	68	68	68	68	61	68

coking quality. They are some of the highest-quality coals in New Mexico.

Thickness variations and coal quality of the Dawson bed

Figures 3 and 4 show the total clean coal thickness and ratio of bony (or shaly) coal to clean coal in the Dawson coal bed from measured sections and drill holes by Lee (1924) and Wanek (1963). The thickness of total clean coal is greatest from the east side of the No. 5 mine through the east side of the No. 6 mine (1.5–2.4 m) (Fig. 3). Total clean coal in the No.'s 9 and 10 mine area is also relatively thick, at 1.8 m. These areas form a northeast-southwest trend that has relatively small amounts of bony coal associated with thick clean coal (Fig. 4). The ratio of bony coal to clean coal is greatest ($\geq$0.5) west-northwest of this trend, on the west edge of No. 5 mine, and in the southern part of the No. 4 mine. The No. 7 and 8 mine areas have a moderately high ratio (0.38) of bony coal to clean coal. The No. 6 mine sections had some of the thickest coals with very few shaly coals. The data from the measured sections and drill holes indicate these coals were deposited in an elongated northeast-southwest-trending swamp, parallel to the regional trend of the retreating Late Cretaceous shoreline (Pillmore, 1976, p. 233). This orientation tends to indicate that these coals developed in a back-barrier swamp environment. There appears to have been a greater amount of sediment being brought into the swamp on the west-northwest side of the swamp, possibly from minor invasions of the sea bringing in sediments through washovers, or this condition could represent the invasion of tidal channels into the swamp. A general thinning of the coal to the southeast probably represents the edge of

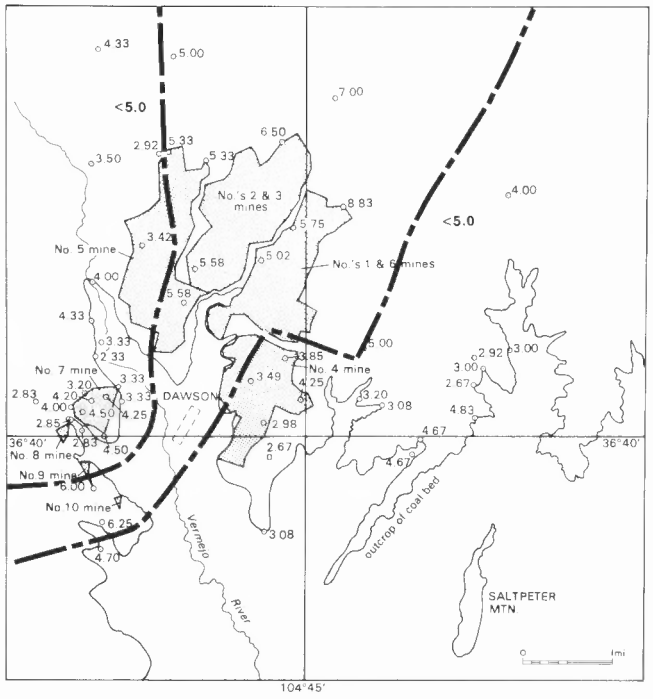


FIGURE 3. Dawson coal bed–total clean coal thickness. Modified from Lee (1924). Data from Lee (1924) and Wanek (1963). Thickness in ft.

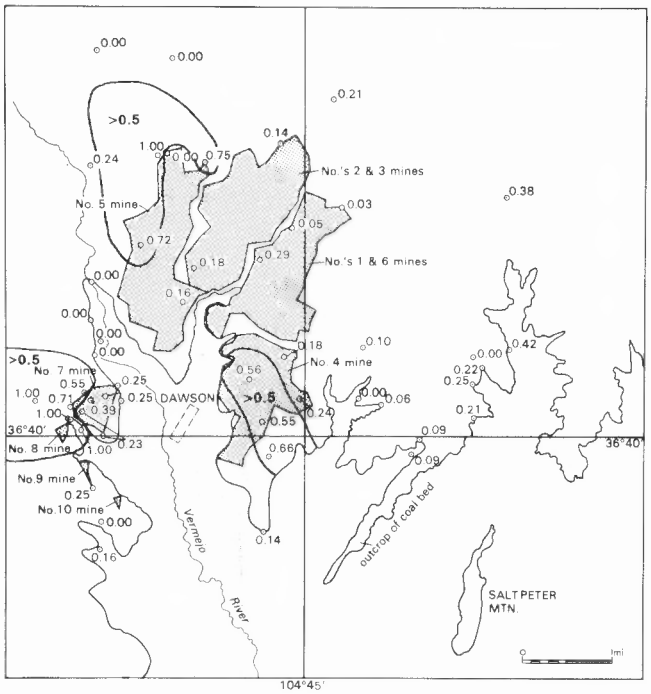


FIGURE 4. Dawson coal bed, ratio of bony coal to total clean coal. Modified from Lee (1924). Data from Lee (1924) and Wanek (1963).

the swamp environment on the landward side. The ratio of shaly coal to clean coal appears to have influenced the quality of the Dawson coals.

Table 2 is a summary of the analyses from the Dawson mines (U.S. Bureau of Mines, 1936; Lee, 1924). Coal analyses from Dawson No.'s 8 and 9 mines, with at least 4 samples, have higher than average ash content. The analyses from No.'s 1 and 4 mines also have higher than average ash content, but the few samples available make it difficult to draw any conclusions. The Dawson No.'s 5 and 6 analyses have the highest average MMFBtu values, which might be expected from the low shaly coal to clean coal ratio in these areas (Figs. 3, 4). All the coal analyses indicate the Dawson coals are high volatile A bituminous rank.

COAL MINING

Early mining of the Vermejo Formation coals

The Vermejo Formation coals were mined extensively in the early mining phase of the Raton coal field along its southeastern edge. The Vermejo Formation is exposed here in the canyon walls, cut by the Vermejo and Canadian Rivers and their tributaries. These areas were easily accessible by rail from the east. Early mining districts included the Gardiner-Blossburg district west of Raton, the Koehler–Van Houten, which included the mines near Willow and the Dawson district (Fig. 1). The Gardiner-Blossburg district had some of the earliest recorded coal mining (late 1880's) in the Raton field. The first commercial mines at Blossburg operated until 1902 (Reports of the United States Mine Inspector, 1902). Although the Blossburg district had several mines operating during the first period of mining, the first mines in this district were abandoned when it was discovered coal could be mined easier at Koehler, Van Houten and Dawson (Young, 1936).

Development of the Dawson district

Mining in the Dawson area is thought to have begun in the late 1890's with a small mine operated by John Barkley Dawson for domestic use. It is reported that the mine opened by J. B. Dawson was in a coal bed 2.7 m thick (Reports of the United States Mine Inspector, 1900). In 1900, the Dawson mine and 93.1 million m^2 of land in the

TABLE 2. Available quality analyses for Dawson mines. Data from U.S. Bureau of Mines (1936).

	Moisture	Ash	Fixed Carbon	Vol. Mat.	Sulfur	Btu	MMFBtu
Dawson #1 Mine							
Avg	2.70	26.30	39.30	31.70	0.70	10,480	14,668
Max	2.70	26.30	39.30	31.70	0.70	10,480	14,668
Min	2.70	26.30	39.30	31.70	0.70	10,480	14,668
# Samples	1	1	1	1	1	1	1
Avg Seam thk:	3.96						
Dawson #2 Mine							
Avg	2.64	14.18	47.22	35.95	0.70	12,475	14,849
Max	3.80	18.50	49.30	38.20	0.90	13,100	15,012
Min	2.20	10.80	44.40	32.30	0.60	11,890	14,689
# Samples	10	10	10	10	10	8	8
Avg Seam thk:	6.40						
Dawson #3 Mine							
Avg	2.30	12.20	48.20	37.30	0.80	12,920	14,910
Max	2.30	12.20	48.20	37.30	0.80	12,920	14,910
Min	2.30	12.20	48.20	37.30	0.80	12,920	14,910
# Samples	1	1	1	1	1	1	1
Avg Seam thk:	6.25						
Dawson #4 Mine							
Avg	2.10	15.60	48.50	33.80	0.70	12,160	14,650
Max	2.10	15.60	48.50	33.80	0.70	12,160	14,650
Min	2.10	15.60	48.50	33.80	0.70	12,160	14,650
# Samples	1	1	1	1	1	1	1
Avg Seam thk:	4.00						
Dawson #5 Mine							
Avg	2.37	14.20	47.30	36.13	0.69	12,567	14,865
Max	2.70	18.00	49.40	37.90	0.71	13,190	15,013
Min	2.10	10.61	45.70	33.60	0.67	11,790	14,662
# Samples	3	3	3	3	3	1	1
Avg Seam thk:	3.51						
Dawson #6 Mine							
Avg	2.01	13.96	46.74	37.29	0.69	12,596	14,856
Max	2.50	16.40	48.10	38.60	0.80	12,910	15,045
Min	1.40	12.10	45.70	35.40	0.60	11,950	14,548
# Samples	7	7	7	7	7	7	7
Avg Seam thk:	6.78						
Dawson #8 Mine							
Avg	2.67	18.35	45.88	33.10	0.75	11,755	14,689
Max	2.90	21.20	47.40	34.40	1.00	12,030	14,696
Min	2.40	16.60	44.20	31.90	0.50	11,290	14,670
# Samples	4	4	4	4	4	4	4
Avg Seam thk:	4.48						
Dawson #9 Mine							
Avg	2.67	15.86	46.67	34.78	0.67	12,105	14,665
Max	2.80	18.90	48.80	36.40	0.70	12,760	14,749
Min	2.60	12.20	44.90	33.00	0.58	11,540	14,526
# Samples	4	4	4	4	4	3	3
Avg Seam thk:	5.14						

Dawson area were purchased by the Dawson Fuel Company. The following year three mines were opened by Dawson Fuel, and the town of Dawson was born. A spur was built to Dawson by the El Paso and Northeastern Railroad, connecting with the Atchison, Topeka and Santa Fe Railroad at French Station, and the St. Louis and Rocky Mountain Railroad at Colfax. This spur eventually connected to the main Rock Island line at Tucumcari. Although the territorial mine inspector mentioned three coal beds in the Dawson district, only one was mined. At the Dawson No. 1 mine (Fig. 5) the coal was 3.35 m thick, and at the No.'s 2 and 3 the bed was 2.44 m thick with a 5 cm parting 0.6 m above the base. In 1901, a coal washing facility, sizing screens and 124 coke ovens were built 2.4 km south of the mines. A railroad tipple and power plant were also built at the Dawson mines. In May 1902, the first car load of Dawson coal was dumped over the tipple, and total production from May to June 1902 was 17,526 st.

In 1903, production increased to 243,579 st; 18,074 st of this total were converted to coke. Two additional mine openings were made and these became known as the No. 4 and No. 5 mines (Fig. 5) (Reports of the United States Mine Inspector, 1904). Production from the Dawson mines almost doubled in 1904 (443,398 st), and the coke production doubled as well.

Dawson mines under Phelps Dodge ownership

In 1905, the Dawson mines, including the rail line and 198 million m^2, were bought by Stag Canyon Fuel Company, a subsidiary of Phelps Dodge Corporation. Phelps Dodge acquired the Dawson properties to supply coke to their smelter operations in southeast Arizona. Several improvements were made by the new owners to the mines and to the community of Dawson. In 1905, a new tipple and power plant were constructed, and 446 underflue ovens were built to supplement the existing 124 coke ovens. Two boiler houses were erected to supply steam to a power house. A 32-bed hospital was erected in 1906, and

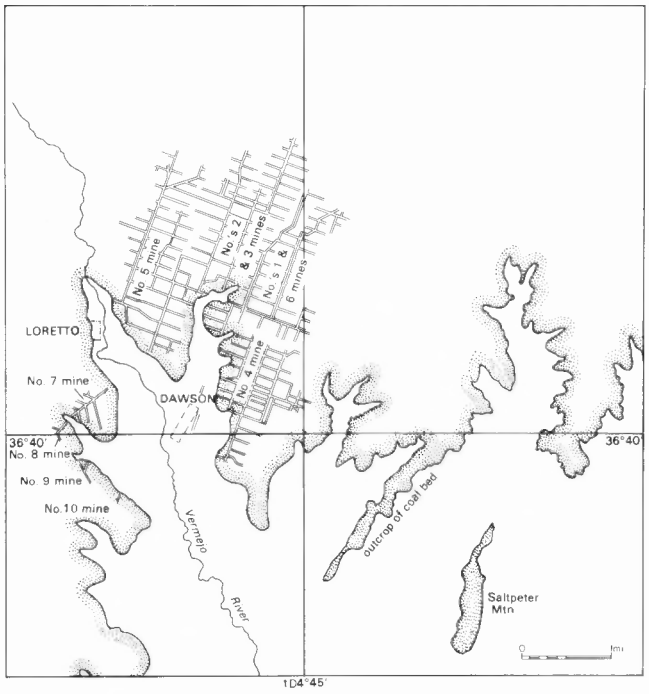


FIGURE 5. Dawson coal district mines in 1920. Modified from Lee (1924).

plans were made for a theater and community center. Total production from the mines for 1906 was 663,292 st, and two more mines (No.'s 5 and 6) were in the development stage.

Stag Canyon Fuel introduced electric shot firing in the Dawson No. 4 mine in 1906 to eliminate the danger of coal dust explosions. All the shots were fired simultaneously by electric current after everyone had left the mine. All underground workers had to check in and check out through a tag system to keep track of when the mine was clear for blasting. This was the first of many safety improvments that Stag Canyon Fuel implemented in the Dawson mines.

In 1907, production rose to 783,916 st, and a new coal washing plant, crusher and storage tanks were built. Production for 1908 was 846,473 st, but due to a recession in the West the amount of coal produced caught up with the demand. Only 450 of the 570 coke ovens operated in 1908. By this time electric shot firing had been installed in all of the Dawson mines. Coal dust continued to be mentioned as a problem in the Dawson mines by the U.S. mine inspector for the territory. The town of Dawson continued to grow, and Phelps Dodge completed the theater and amusement facility in Dawson at a cost of $40,000.

Demand rose, and total production reached 1,096,111 st in 1909. The Dawson No. 3 and 5 mines were connected to each other, and most of the main entries to the mines were over 1.6 km long. A 76-m shaft was sunk 1.6 km north of No. 2 to intersect the main air return course from No.'s 2 and 5 for better ventilation. In the early 1900's, the major markets for the coal and coke from the Dawson mines were the Phelps Dodge copper smelters in Arizona. Coke was also shipped to steel mills in Colorado and Pennsylvania. Phelps Dodge continued their emphasis on safety and built a rescue school to train the miners and other mine workers in first aid and rescue work. Sheridan (1909), who was the Territorial mine inspector at the time, indicated this building would also contain a technical library, and classes would be given on the latest mining methods to the supervisors. Manways, independent of haulage roads, were driven along principal entries to decrease the large number of accidents that occurred from men getting in the way of the hauling equipment. Pipelines were also installed in all the mines with a system of jets designed to wet down the coal dust in the working areas. To decrease the waste material, rewashing jigs were installed, and 38,910 st of marketable product was reclaimed from the jigs in 1909.

The population of Dawson at this time was approximately 4000 people, 1163 of which were adults employed at the mines, washery and coke ovens. Phelps Dodge built one school, and another was built by the county with a combined employment of 9 teachers and 2 janitors. School was in session for 10 months, uncommon in New Mexico at that time (U.S. Mine Inspectors Report, 1909).

Mining machines were installed in the No.'s 1 and 5 mines to increase production, and four more were ordered in 1910. By 1911, the rescue station was operational, and a second screening plant was built to meet the increase in yearly production which had reached 1.38 million st.

Production continued to increase at the Dawson mines throughout the early 1900's, and mine safety improvements continued to be emphasized by Phelps Dodge. Except for a fire in one of the mines that killed 3 miners in 1905, the safety record of the mines at Dawson was generally good. The Dawson mines were considered to be some of the safest mines in the U.S. until an explosion killed 263 workers on 22 October 1913 (New Mexico Mine Inspectors Report, 1913). The explosion, according to Phelps Dodge records, occurred in the No. 2 mine when coal dust ignited after an unsupervised shot was fired by a miner who had connected a shooting wire to the trolley wire. This act was strictly against company rules; all shots were to be fired after everyone had left the mines and by a trained individual, not by various miners. Only 29 men working underground survived the explosion. The Dawson No. 2 mine explosion was the fourth worst mine accident in U.S. mining history and it ranked highest in property damage (Price and Scholer, 1983).

Following this major disaster, Phelps Dodge decided to make several changes in their mining methods. The size of the mines was reduced (production limit of 750 st/day), and barriers were built in the No. 2 mine, essentially dividing the mine. A change-over from room and pillar to a form of longwall mining was introduced at this time (Phelps Dodge annual report, 1913). Tightly sealed pit cars were introduced first in the No. 5 mine to try to lower the amount of coal dust in the mine. The coal transported in these cars was thoroughly sprayed with water and then sent to the newly installed rotary dumps at the tipple. Moisture radiators were installed in all the mines to raise the mine temperature and increase the moisture to further reduce the amount of coal dust. To eliminate the possibility of unsupervised shots, the job of loading holes and connecting blasting wires became specialized and was no longer done by the miners. First aid and training became a requirement for certain employees in each of the mines.

In 1915, a depression in the copper industry took its toll on the coal industry, and production at the Dawson mines was reduced approximately 100,000 st from that of several previous years (see Table 3). Changes in the method of mining continued to be implemented, and additional tightly enclosed cars were ordered. Several dust barriers were installed in the mines. Demand for coal rose in 1916, and a scarcity of miners resulted in an increased need for mining machines. The area along the west side of the Vermejo River between the towns of Dawson and Loretto was explored for a new mine (Fig. 5), and the No. 7 mine was opened on coal that was 1.1–1.2 m thick. A new washery was built and more rotary dumps were installed to eliminate delays at the tipples. The total production in 1916 was 1,439,904 st (Phelps Dodge annual report, 1916), the highest yearly total for the Dawson mines.

A production drop to 1,406,079 st in 1917 was attributed to the continued labor shortage caused by World War I. New electric locomotives and mining machines helped offset this shortage of manpower. Development of the district continued with the opening of the No.'s 8, 9 and 10 mines on the west side of Vermejo Canyon (Fig. 5). Edison electric safety lamps were adopted and used in all the mines except in the No. 7, and sprinkler systems were extended to all the mines. A new boiler plant was built to meet the increased power needs of all the mine machinery. In 1917, the name was changed from Stag Canyon Fuel Company to Phelps Dodge Corporation, Stag Canyon Branch. All 10 mines that were developed by the company were open in 1918.

Demand for coal continued to decline, and in 1919 total employment at the Dawson mines was reduced from 1378 to 1005 men. Contracts for coke that had been made several years earlier were then well below market, and financially hurt the company. Most of these contracts ended in 1920, and there was a temporary recovery. By 1920, 42 mining machines and 38 electric locomotives were in use in the Dawson mines. Another explosion occurred in Mine No. 6 on 14 April 1920 when thirteen men were killed, and the mine was then closed for six weeks.

TABLE 3. Coal production for the Dawson mines. Data from U.S. Mine Inspector Reports (1899–1908); Phelps Dodge Corporation annual reports (1909–1932); and Ken C. Bennett, oral commun., 1990.

Years	Production (in st)	Events
1899–1905	1,358,886	J. B. Dawson and Dawson Fuel Co. ownership.
1906–1910	4,921,836	Stag Canon Fuel (Phelps Dodge) owners, six mines operating.
1911–1915	6,476,458	Rescue station operational. Explosion in 1913 due to coal dust. Depressed copper industry, 1915.
1916–1920	6,189,508	World War I, which led to increased mechanization. Explosion 1920 due to coal dust.
1921–1925	4,502,997	Soft coal and coke market, due to natural oil and gas competition. Explosion in 1923 due to coal dust. Use of rock dust to lower risk of explosions.
1926–1930	3,907,641	Coke ovens shutdown in 1926. Hard hats, goggles, and safety shoes became mandatory in 1928. No's. 3, 4, 5, 7, 8, and 9 mines closed.
1931–1935	1,273,749	From 1932, only the No. 6 mine was active.
1936–1940	1,215,440	
1941–1945	1,750,772	
1946–1950	1,452,242	Dawson No. 6 mine closed April 28, 1950.
Total	33,049,529	

The Phelps Dodge smelters closed down and the weather turned mild in 1921, both lowering the demand for coal, and Dawson's total production dropped to 724,510 st. This production level was the lowest since 1906 when Phelps Dodge first acquired the property. Lack of demand for coke closed the coking ovens from April of 1921 until June of 1922. Wages were also cut back to the 1917 scale. In 1922 the demand for coal from the Dawson mines bounced back briefly due to strikes in nearby unionized coal fields. Production exceeded 1 million st, although this was the last year that the Dawson mines would reach this level of production.

On 8 February 1923, the Phelps Dodge mines at Dawson experienced another disaster when an explosion occurred in the No. 1 mine, killing 120 men. Coal dust was ignited by an electric arc when a derailment of cars on an outgoing trip knocked down several timbers and the trolley feed wires contacted the iron pit cars.

Phelps Dodge reacted to this tragedy by introducing more safety measures. Battery-operated locomotives were introduced to eliminate the need for power lines in the haulage ways. Rock dust, referred to as "adobe" in the New Mexico mine inspectors report (1924), was applied to all mine entries, return air courses and cross entries. The rock dust, probably crushed limestone (C. Pillmore, written commun., 1990), was tested routinely to insure the amount of combustible coal dust in this material was not excessive. Ribs and roofs were plastered with a mixture of rock dust and water to further minimize coal dust (Fig 6). Working faces were kept wet, and coal was cut wet and kept damp by the miners using the sprinkling systems until it reached the tipple.

Production at the Dawson mines stayed at 700–900,000 st from 1923–1929. During this time the introduction of natural gas and fuel oil for power generation took its toll on the already-soft coal market. After 1926, no coke was produced from the coal at Dawson because of the conversion to oil at the copper smelters (Epler and Dillard, 1981). From this point on, most of the coal from the Dawson mines was used



FIGURE 6. Operator and helper loading coal into shuttle car and joy loader. White material is rock dust, which is applied to roof, rigs and floor to prevent coal dust explosions. Photo courtesy of Phelps Dodge Corporation.

by the railroads. In 1927, the No. 10 mine was closed followed by the No. 7 mine in 1928. Although there had been several cut backs in production, safety was still a high priority at the Dawson mines. In 1928 "hard boiled caps," goggles and safety shoes became requirements, and everyone working in the mines was required to take safety courses. The New Mexico Power Company began construction of a turbine and boiler plant for generation of electricity at Dawson in 1927 which supplied power the following year to the town and mines (Fig. 7). In 1929, most of the railroad contracts for coal were discontinued, and the No.'s 4, 5, 8 and 9 mines were closed. Coal continued to be supplied to the Southern Pacific Railroad.

The effects of the depression were felt in 1930, and coal production dropped to approximately one-half that of the previous year. The No. 3 mine was closed, and the remaining mines (No.'s 1, 2 and 6) were operated on a four-day work schedule. Production continued to decrease (248,236 st), and in 1933 only the No. 6 mine remained in operation. The Dawson No. 6 mine continued to operate until 28 April 1950 (Fig. 8). Phelps Dodge employed about 300 men from the mid-1930's until 1950 at Dawson (New Mexico Mine Inspectors reports, 1936–1950).

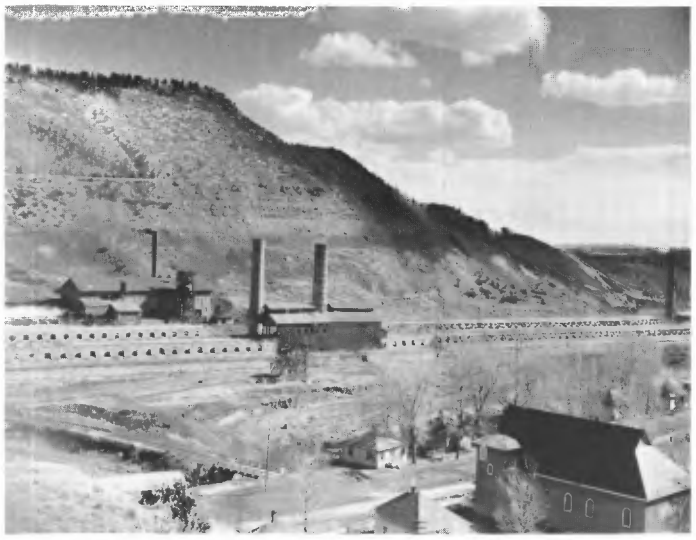


FIGURE 7. View of power house, town boiler plant, old coke ovens, and Catholic church at Dawson. View is looking east. Photo courtesy of Phelps Dodge Corporation.



FIGURE 8. Load trip of 35 mine cars emerging from portal of No. 6 mine. Photo courtesy of Phelps Dodge Corporation.

The mine was finally closed because of the high cost of labor, the depressed market caused by dieselization of the railroads and the fact that the working face was approximately 6.4 km from the tipple. Phelps Dodge was probably able to keep the Dawson No. 6 mine open through the 1930–1950 period because of the amount of mechanization that had been installed in the mine during better economic times. Total production from the Dawson district from 1899–1931 was 33 million st (New Mexico Mine Inspectors reports; Phelps Dodge annual reports; Ken Bennett, Phelps Dodge, oral commun., 1990). All the coal mined in this area was extracted by underground methods, and little or no retreat mining was done in the mines, leaving the coal pillars in place (Ken Bennett, oral commun., 1990). The total coal production for the Raton field in New Mexico during this period was 72.6 million st. During the latest phase of mining (1966–1988), production in this field has been 25.2 million st (Pillmore, 1976; New Mexico Energy and Mineral Department, Annual reports 1976–1989). When the Dawson No. 6 mine was closed, the property was converted to a cattle ranch. For tax purposes all equipment and structures were sold and moved or razed. Only 16 buildings remained, some of which were used by the cattle operation. Phelps Dodge is no longer in the cattle business, but it still owns the Dawson property which it leases to the CS cattle ranch for grazing (C. Pillmore, oral commun., 1990).

SUMMARY

Coal occurs in the Vermejo and Raton Formations of Late Cretaceous to early Tertiary age in the Raton field. The economic coals in the Vermejo Formation were developed in back-barrier estuarine swamps and possibly in some interdistributary swamps. In the Dawson district the thick coals seem to have been deposited parallel to the regional trend of the strand line, in a north-northeast direction in elongated back-barrier swamps. The thick coals in the Raton Formation formed further

inland in poorly drained floodplain swamps. The majority of all the coals in the Raton coal field are high volatile bituminous A rank.

The Vermejo Formation coals were extracted during the first phase of mining in the Raton coal field because of their accessibility along the eastern edge of the Raton Mesa. Dawson was built at the mouth of the Vermejo River where the Raton coal bed, locally called the Dawson coal bed, was easy to mine, and the mines were accessible by rail. The high quality and coking properties of the coal at Dawson made the mines competitive in several markets, particularly the smelters in the Southwest and the railroads. Phelps Dodge development and management of the mines at Dawson kept these mines in production for over 40 years. The fluctuations in the production at Dawson are a reflection of what occurred in the coal mining industry throughout New Mexico during the first mining phase from 1880–1960. Total production for Colfax County from 1896–1950 was 72.6 million st (U.S. Bureau of Mines Minerals Yearbooks, State Mine Inspectors reports). The Dawson district produced almost half of this total production. Coal production continued at Koehler, the neighboring mine to the north of Dawson, until 1966. This coal was shipped by Kaiser Coal Corporation to the steel mills at Fontana, California, until the York Canyon Mine was opened about 27 km north of Dawson, up the Vermejo River (C. Pillmore, written commun., 1990). The mine at York Canyon and the Cimarron mine, a few km north, owned by Pittsburg and Midway Coal Mining Co., are the only mines operating in the Raton coal field today.

ACKNOWLEDGMENTS

The writer is grateful for valuable reviews by Chuck Pillmore, Bob Eveleth and Ken Bennett. Special thanks to Chuck Pillmore for discussions of the geology and coal environments in the Raton Basin. Bob Eveleth was extremely helpful in clarifying some of the mining terms used in the mine inspector reports. Ken Bennett, with the Phelps Dodge Corporation, generously supplied the writer with little known facts, hard to find reference material and photos from the Dawson area, without which this paper would not have been as comprehensive an article.

REFERENCES

American Society of Testing and Materials, 1981, Annual book of ASTM standards; part 26, gaseous fuels; coal and coke; atmosphere analysis: Philadelphia, Pennsylvania, pp. 181–399.

Epler, W. and Dillard, G., 1981, Dawson: Fueled Arizona mines and smelters; *in* Phelps Dodge Centennial 1881–1981, supplement to Arizona Pay Dirt and New Mexico Pay Dirt, Summer 1981, pp. 116–121.

Flores, R. M., 1984, Comparative analysis of coal accumulation in Cretaceous alluvial deposits, southern United States Rocky Mountain basin; *in* Stott, D. F. and Glass, D., eds., The Mesozoic of middle North America: Canadian Society of Petroleum Geologists, Memoir 9, pp. 373–385.

Flores, R. M. and Tur, S. M., 1982, Characteristics of deltaic deposits in the Cretaceous Pierre Shale, Trinidad Sandstone, and Vermejo Formation, Raton Basin, Colorado: Mountain Geologist, v. 19, pp. 25–40.

Hayden, F. V., 1869, Preliminary field report (third annual) of the United States Geological Survey of Colorado and New Mexico: Washington, U.S. Government Printing Office, 155 pp.

Jurich, D. and Adams, M. A., 1984, Geologic overview, coal, and coalbed methane resources of Raton Mesa region, Colorado and New Mexico; *in* Rightmire, C. T., Eddy, G. E. and Kirr, J. N., eds, Coalbed methane resources of the United States: American Association of Petroleum Geologists, Studies in Geology 17, p. 164.

Lee, W. T., 1917, Geology of the Raton Mesa and other regions in Colorado and New Mexico; *in* Lee, W. T. and Knowlton, F. H., eds., Geology and paleontology of Raton Mesa and other regions in Colorado and New Mexico: U.S. Geological Survey, Professional Paper 101, pp. 9–221.

Lee, W. T., 1924, Coal resources of the Raton coal field, Colfax County, New Mexico: U.S. Geological Survey, Bulletin 752, 254 pp.

New Mexico State Mine Inspector, 1913–1950, Annual Reports: New Mexico Energy and Minerals Department, Albuquerque.

Pillmore, C. L., 1976, Commercial coal beds of the Raton coal field, Colfax County, New Mexico: New Mexico Geological Society, Guidebook 27, pp. 227–247.

Pillmore, C. L. and Hatch, J. R., 1976, Geochemical data on selected coal beds, Raton coal field, Colfax County, New Mexico: U.S. Geological Survey, Open-file Report 76-542, 25 pp.

Pillmore, C. L. and Flores, R. M., 1987, Stratigraphy and depositional environments of the Cretaceous-Tertiary boundary clay and associated rocks, Raton Basin, New Mexico and Colorado; *in* Fassett, J. E. and Rigby, J. K., eds., The Cretaceous-Tertiary boundary in the San Juan and Raton basins, New Mexico and Colorado: Geological Society of America, Special Paper 209, pp. 111–130.

Price, J. and Scholer, E. A., 1983, Disaster at Dawson; *in* Impact, Albuquerque Journal Magazine, pp. 8–10.

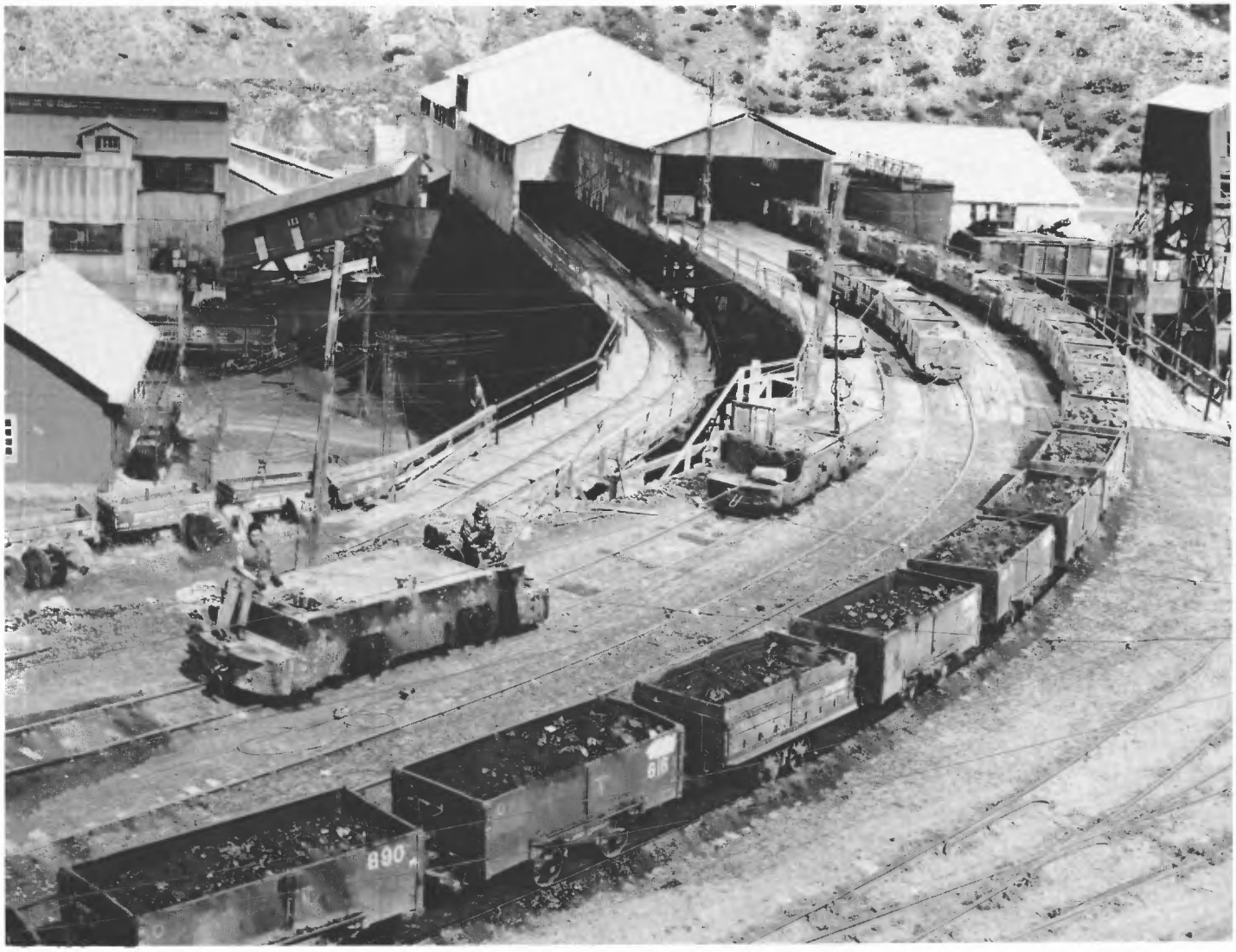
Reports of the United States Mine Inspector for the Territory of New Mexico to the Secretary of the Interior, 1899–1912, Annual reports.

Sheridan, J. E., 1909, Coal mines and plant of Stag Canon Fuel Co.: The Mining World, July 31, pp. 271–278.

U.S. Bureau of Mines, 1936, Analyses of New Mexico coals: U.S. Bureau of Mines, Technical Paper 569, 112 p.

Wanek, A. A., 1963, Geology and fuel resources of the southwestern part of the Raton coal field, Colfax County, New Mexico: U.S. Geological Survey, Coal Investigations Map C-45, 2 plates, scale 1:48,000.

Young, W. H., 1936, Production, distribution and use; *in* Analyses of New Mexico coals: U.S. Bureau of Mines, Technical Paper 569, p. 16.



A long coal trip has just emerged from one of the Dawson mines and is in the process of unloading at the tipple. Dawson, once New Mexico's premier coal producer, is now a ghost town. Photo courtesy of Phelps Dodge Co., circa 1920.