GEOLOGY OF THE LOST CREEK COAL FIELD, MORGAN COUNTY, UTAH.

By FRANK R. CLARK.

INTRODUCTION.

The Lost Creek coal field lies in Morgan County, Utah, about 10 or 12 miles northeast of Devils Slide station, on the main line of the Union Pacific Railroad. (See fig. 44.) The field takes its name from Lost Creek, a tributary of Weber River, and comprises about 8 or 10 square miles in T. 5 N., R. 5 E., Salt Lake base and meridian. It lies between the Echo Canyon drainage basin on the east and the Ogden Canyon drainage basin on the west. The area examined includes parts of Tps. 4, 5, and 6 N., Rs. 4 and 5 E., but no coal of economic importance was found outside T. 5 N., R. 5 E., where it has been mined in a small way at several places to supply demands of ranchers. A considerable portion of the coal mined was hauled by team to the town of Croydon, 8 or 9 miles from the mines. The wagon road from the railroad to the mines is good for most of the distance except during the winter. The average grade of the road up Lost Creek is about 50 feet to the mile, but the grades of branch roads up the side canyons to the mines are from 200 to 300 feet to the mile.

The coal bed, which is lenticular and varies greatly in thickness even in small areas, is confined to one coal-bearing zone. It is subbituminous and contains much moisture and many impurities in the form of small lenses or partings of bone and shale.

The field was examined in 1914 for the purpose of verifying or disproving the many reports regarding the possibility of a commercial field in this area and to obtain data from which a proper classification and valuation of the land might be made. The mapping was done with the Gale telescopic alidade and plane table. Locations were made by the three-point intersection method from a system of triangulation expanded from a carefully measured base line. Secondary locations were made by stadia readings or short stadia traverses in deep canyons where points of the primary triangulation were invisible. These traverses were tied to Government land corners and to the primary system of triangulation.

The area outside the coal-bearing portion was mapped in a reconnaissance way. Approximate altitudes were carried into the coal field from the railroad at Devils Slide by stadia traverse and vertical angles.

The writer was assisted in the field by Gordon W. Clark. Ranchers in the area furnished information relating to the coal and its previous

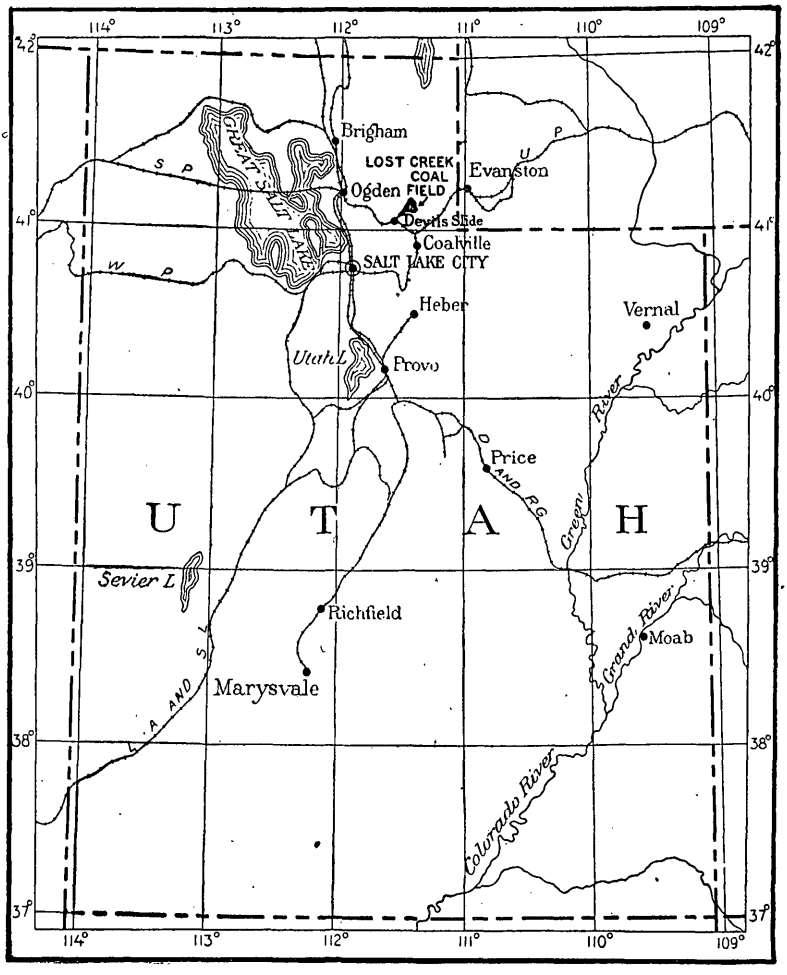


FIGURE 44.—Index map showing location of Lost Creek coal field, Utah.

development, and in this connection especial credit should be given to Mr. J. S. Turner for his hospitality and desire to aid the work in every way.

LAND SURVEYS.

The townships covered by this report were surveyed many years ago—Tps. 5 and 6 N., R. 5 E., Salt Lake base and meridian in 1891 and the remaining townships in 1899. Most of the corners found were well marked and check closely with the positions indicated by

the General Land Office plats, but several of the monuments appeared to have been moved from the positions in which they were originally set by the authorized surveyor. Those for the northwest corner of sec. 25, T. 5 N., R. 5 E., and the quarter corner between secs. 25 and 26 now appear to be about 100 feet north and 150 feet east of their true positions according to the Land Office plats, and that for the southwest corner of sec. 34, T. 5 N., R. 5 E., is about 200 feet north of its original position. All other corner monuments found appear to be in their original positions and to check with the official plats.

GEOLOGY.

STRATIGRAPHY.

The rocks exposed in this field comprise two formations which differ widely in character as well as in age; the older formation is of Jurassic age and the younger of Tertiary age (Wasatch formation). These formations are separated by a great unconformity representing a long interval of time during which the older rocks were minutely folded and the folds were later truncated by erosion.

JURASSIC ROCKS.

The rocks that are here assigned to the Jurassic consist of limestone, shale, and well-indurated sandstone. Some of the limestone beds are relatively pure, some contain many veinlets of quartz, and others are shaly and grade into calcareous shale. The shale, which in places is calcareous, is usually thin bedded and weathers silver-gray but is brown to slate-colored on freshly broken surfaces. In a casual search these beds yielded but few fossils—*Pentacrinus*, which is indicative of the Jurassic, being the only form identified.

TERTIARY ROCKS (WASATCH FORMATION).

The rocks overlying the Jurassic unconformably are correlated with the Wasatch formation of Echo Canyon, to the east, largely on the basis of their position and general character. No mapping has been done between the two areas, but there is little doubt that the correlation is justified. The Wasatch in the Lost Creek field may be divided for convenience of description into three parts—an upper and a lower conglomerate and intervening sandstone and shale. It is composed largely of coarse materials, the greater part being coarse conglomerate; a minor portion near the middle consists of conglomeratic sandstone, coarse sandstone, shale, and in places thin, lenticular, and valueless coal beds.

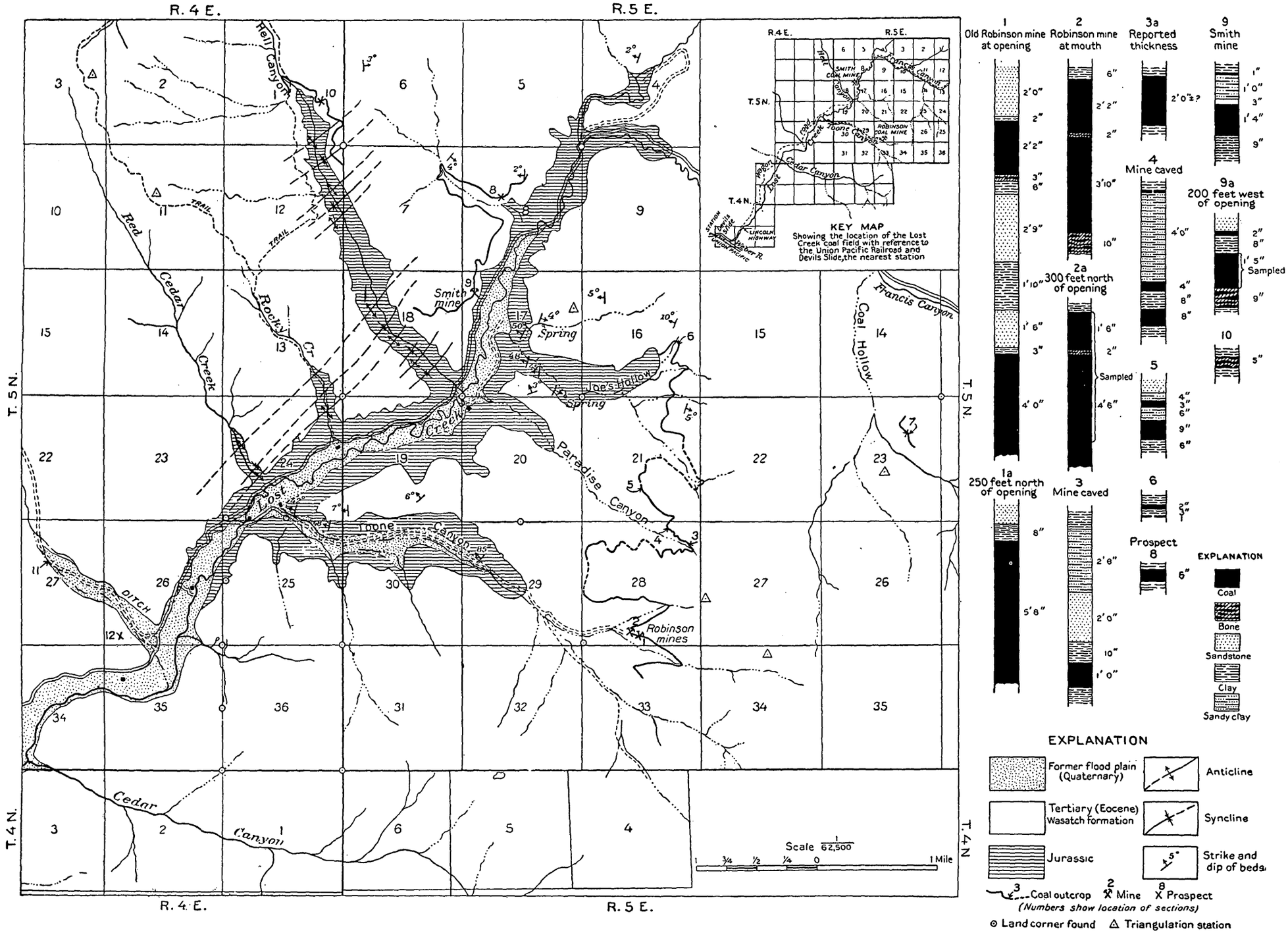
The Wasatch beds rest unconformably upon the upturned and eroded edges of rocks of Jurassic age. The thick, massive beds of

coarse conglomerate lie mainly in small areas east of Lost Creek, namely, in Coal Hollow, Joe's Hollow, Paradise Canyon, Toone Canyon, and the head of Cedar Canyon; a small outcrop occurs at Smith's mine, on the west side of Lost Creek. The Wasatch in surrounding areas is composed of thin beds of shale and of coarse sandstone which at many places is conglomeratic.

The maximum thickness of the Wasatch in this area is about 1,800 feet. At the head of Toone Canyon it is coarse conglomerate except for 300 or 400 feet of sandstone and shale near the middle. In Toone and Paradise canyons the lower conglomerate is from 700 to 900 feet thick and is composed largely of quartzitic pebbles and boulders which range from a fraction of an inch to 1½ feet in diameter. The lower conglomerate is usually gray to white, but locally it may be distinctly red. The upper surface of this conglomerate is exceedingly uneven and in many places varies as much as 12° from the bedding of the overlying sandstone, shale, and coal. The coal beds rest almost directly on this lower conglomerate and are overlain by the sandstone and shale member above mentioned. In most places where exposed the coal rests on the conglomerate or is separated from it by only a few feet of shale or sandstone.

Apparently the lower conglomerate was laid down in an erosional basin, for in Toone and Paradise canyons and Joe's Hollow this heavy conglomerate abuts squarely against the upturned, eroded edges of the Jurassic limestone, and the westward extension of the conglomerate is abruptly cut off by the limestone. It would seem from this that a fault may have cut the beds at this place, but no evidence of faulting was seen to the north or the south. The abrupt ending of this conglomerate suggests that either the Jurassic limestone in Toone and Paradise canyons, and especially in Joe's Hollow, extended above the general level of the surrounding country at the time the conglomerate was deposited, or during subsequent uplift the Jurassic limestone was faulted up against the lower conglomerate. Toward the east the contact between the Jurassic and Wasatch in secs. 17 and 16 rise about 1,000 feet in a mile. The base of the lower conglomerate in the southeast corner of sec. 16 is about 400 feet lower than the top of the Jurassic limestone.

Above the middle sandstone and shale member lies the upper conglomerate, which is distinctly red owing to the red sand matrix in which the pebbles are embedded. The pebbles and boulders are similar in character and size to those of the lower conglomerate and were laid down under similar conditions. The pebbles are usually well rounded though not greatly streamworn. They consist chiefly of quartzite with minor amounts of sandstone fragments (very irregular), limestone, and small masses of conglomerate of which the component pebbles are largely quartzite.



EXPLANATION

- Former flood plain (Quaternary)
- Tertiary (Eocene) Wasatch formation
- Jurassic
- Anticline
- Syncline
- Strike and dip of beds
- 3 Coal outcrop
- 2 Mine
- 8 Prospect

(Numbers show location of sections)

⊙ Land corner found △ Triangulation station

• House

GEOLOGIC MAP OF THE LOST CREEK COAL FIELD, MORGAN COUNTY, UTAH.

Interbedded with the upper conglomerate are small lenses of coarse sandstone which, being more resistant to weathering than the conglomerate, form benches and "caps" to the resulting fantastic erosional forms. The conglomerate wherever well exposed weathers into cylindrical columns 50 to 75 feet high. Examples of such weathering of the lower conglomerate are well shown in Coal Hollow and of the upper conglomerate in the head of Toone Canyon at what is locally called Chinatown, where an area of several acres is covered by great numbers of pillars of conglomerate, some of which in outline roughly resemble the figures of men wearing hats of different styles and others look like houses with palm or thatched roofs. Many nearly perfect cones remain which are 75 feet, more or less, in diameter at the base and 100 feet or more high, running to a point not more than 6 inches or a foot across at the top. Other cone-shaped masses may have caps of sandstone several feet across which are balanced on a long, narrow neck of conglomerate.

STRUCTURE.

The structure of the Jurassic formation is intricate and complicated. The rocks are highly folded and may be faulted, though exposures are too scanty to permit definite interpretation. These exposures (see map, Pl. XL) duplicate the same beds many times because of the close folds which were truncated by erosion before the deposition of the Wasatch.

The Wasatch beds were laid down on the truncated edges of the Jurassic rocks and are now generally flat lying. These beds in some places dip as much as 10°, but as a rule the dip is less than 5°. In the northern part of T. 5 N., R. 4 E., and in T. 5 N., R. 5 E., west of Lost Creek, the beds dip about 3° E. The dips recorded may not all represent true bedding, because in many places the upper surface of the lower conglomerate contains false bedding which varies as much as 13° from the true bedding.

COAL.

COAL BEDS.

Coal is believed to occur in the Lost Creek field in small areas in a thin stratigraphic zone, and in more than one bed, because an outcrop may be at the base of the zone in one locality and yet near by another may appear at the top of the zone, although only at locality 1, in sec. 28, T. 5 N., R. 5 E., at the mouth of the old Robinson mine (see graphic section), was more than one bed actually seen at the same place. The coal is generally associated with "bone" in the form of thin partings or as the floor of the bed.

Thirteen sections showing more or less coal were measured in the Lost Creek field. The location of each section and its graphic representation are shown on Plate XL. Four of the sections were measured at the Robinson mines within a few hundred feet of one another.

The lenticular character of the coal bed is made obvious by comparing the graphic sections with the localities on the map. The coal of economic value, so far as shown by these sections, is confined to two small areas in the vicinity of the local mines. The thickest coal bed known is at the Robinson mine, in the SE. ¼ SW. ¼ sec. 28, T. 5 N., R. 5 E., but south and west along the south side of Toone Canyon no coal was found. Dark shale, which from a distance might be mistaken for coal, crops out in the NE. ¼ NW. ¼ sec. 33.

North of the Robinson mine the coal is of no economic value. Small prospect mines were opened and at one time worked in a small way at localities 3 and 4. The greatest thickness reported in these mines by men who worked in them is about 2 feet (No. 3a, Pl. XL). Good exposures at locality 5 do not show coal of economic value, and it is believed that coal even 2 feet thick is limited to very small areas in secs. 21 and 28. North of locality 5 the coal becomes even thinner and of still less value.

Coal 3 inches thick associated with dark shale crops out at locality 6, and this exposure suggests that coal of economic value is not likely to be found in this vicinity.

A thick lens of coal was reported to crop out on the east side of Coal Hollow at locality 7 where the bed had been faced up, but on close examination it was found to be a 7-foot bed of dark shale containing several thin lenses of coal. It crops out at the same position relative to the massive red and gray conglomerate as the coal bed at the Robinson mines in Toone Canyon. No other indications of coal are present in Coal Hollow, and it seems unlikely that coal of economic value will ever be developed there.

Evidence of coal in Francis Canyon and on Lost Creek above that canyon is negative. A small area of coal of economic importance was found in the vicinity of the Smith mine in the NW. ¼ NW. ¼ sec. 17, and two sections were measured, one (No. 9) at the mouth and the other (No. 9a) 200 feet down the slope. (See Pl. XL.)

A thin bed of coal has been prospected at locality 8, in the NW. ¼ sec. 8, but only 6 inches of coal was found here. This bed is near the same stratigraphic position as the coal in the Smith mine, but exposures between are so meager that no positive correlation of the beds can be attempted.

The zone of coal-bearing rocks was traced westward from the Smith mine to the point where it crosses Hell Canyon, and though several thin beds of carbonaceous shale were found there are no indications of coal except at locality 10, where a 5-inch bed of impure

coal of no economic value crops out. It was reported by one inhabitant that many years ago a thick bed of coal was exposed in Hell Canyon and later reported by another man that the supposed coal was nothing more than a ledge of sandstone covered by a dark slimy moss over which the water trickled continuously. The writer examined the bed of the creek in Hell Canyon but found no evidence of coal.

Coal was observed at only one other locality near the mouth of Guilder Sleeve Canyon, where 3 inches of coal crops out near the bed of the stream at locality 11, in the SW. ¼ NE. ¼ sec. 26, T. 5 N., R. 4 E. A coal bed 13 inches thick was reported to crop out at locality 12, in the SW. ¼ SW. ¼ sec. 25 of the same township, but exposures at the time of the examination did not show coal to be present.

It is concluded from the facts above given that the coal in the Lost Creek field occurs in small areas and is generally too thin to be of economic value. It is probable that thin beds of coal may be found at many other localities in surrounding territory, but it is highly improbable that beds of widespread economic importance will be found in this region.

MINES AND PROSPECTS.

Coal has been mined in a small way at three localities—in Toone Canyon, in Paradise Canyon, and on Lost Creek. The greatest development is in the SE. ¼ SW. ¼ sec. 28, T. 5 N., R. 5 E., in a tributary of Toone Canyon where Heber Robinson has mined coal during the fall and winter for several years.

The Toone Canyon mine has supplied the demands of ranchers and of the people of Croydon, near the mouth of Lost Creek. An incline tram runs from the mine mouth to the tipple, at the side of a wagon road over which coal is hauled to the ranches. Mine cars are used on the tram, and the loaded car pulls the empty car up the hill. Mules or horses were used to pull the cars in and out of the mine. Considerable coal has been taken out, but little or no timber has been used and few if any pillars of coal were left to support the mine roof. As a result, large areas have caved and others have been rendered unsafe. Only small quantities of coal may be recovered from these entries with any degree of safety. The coal faces are only slightly weathered.

In Paradise Canyon the coal has been opened at two points, at localities 3 and 4, in the NE. ¼ NE. ¼ sec. 28, T. 5 N., R. 5 E. As Paradise Canyon is steep on the sides and cumbered with many large boulders, road making was difficult and expensive. Indeed, the road is no longer passable for wagons and at many places only remnants of it are left. Several lumber houses and a few mine cars and light-

weight rails remain as proof of the active operations in the past. It was not possible to procure data showing the extent of the mine development or how much, if any, coal was hauled away. As the prospect openings are now completely caved, no examination of the coal bed could be made, but it is probable that the mining did not extend much beyond the prospecting stage. It is locally reported that the thickness and quality of the coal did not warrant extensive development.

The Smith mine, on the west side of Lost Creek in the NW. ¼ NW. ¼ sec. 17, T. 5 N., R. 5 E., is a small slope mine owned by W. Lucas and H. C. Smith and operated by Mr. Smith. The coal was hauled up the slope to the mouth of the mine by a windlass and cable operated by horsepower. A sharp syncline in the coal bed is reported at a depth of several hundred feet, but the report could not be verified, because at the time of the examination the mine was filled with water within 200 feet of the mouth. The coal in the mine is thin and contains a high percentage of ash, which for a considerable time will probably make further development impracticable.

PHYSICAL CHARACTER AND CHEMICAL COMPOSITION.

The coal in the Lost Creek field is subbituminous and brown to black. It is banded, consisting of alternating dull and vitreous layers. The dull bands are composed of bony coal and earthy layers which are high in ash. The bright bands contain the best coal, but the whole bed at the Robinson mine presents a rather dull appearance, and the coal when struck with the pick or hammer gives a dull thud rather than the metallic ring produced by striking good coal of bituminous or higher rank. The coal at the Smith mine shows bedding planes, and beyond the zone of surface weathering the coal is bright but contains many local layers of bone and impure coal high in ash. The coal in the Smith mine is more compact and harder to pick than that in the Robinson mine. Other exposures of the coal are too meager to show the details of its character, but all the coal appears to be of the same rank and to be similar in appearance.

As shown by the analysis of somewhat weathered samples, the coal is high in moisture (about 18 per cent in coal as received), which renders it poor for stocking purposes, as it soon reduces to slack on exposure to the atmosphere. The air-drying loss of moisture, which in weathered samples is always low, is from 6 to 8 per cent, and 10 to 12 per cent of moisture remains in the air-dried coal.

The analyses (p. 320) give the composition of samples from the Robinson and Smith mines. Each sample was obtained by cutting a channel across the bed from roof to floor and excluding the portions indicated in the sections on page 319.

Sections of coal bed sampled in Robinson and Smith mines.

Robinson mine, 200 feet from opening.

Shale.	Ft.	in.
Coal (sampled)	1	8
Bone		2
Coal, dull and earthy (sampled)		5
Coal, bright (sampled)	1	2
Coal, dull (high in ash)		2
Coal, bright (sampled)	1	7
Coal	1	
Total coal	6	0

Smith mine, 200 feet from opening.

Sandstone.	Ft.	in.
Shale		1
Coal, impure		2
Shale and coal lenses interbedded		8
Coal (sampled)	1	5
Bone		9
Shale.		
Total coal	1	7

After the sample was cut, collected on a waterproof cloth, and broken small enough to pass through a half-inch mesh screen it was quartered down to about 4 pounds, sealed in an air-tight can, and mailed to the Bureau of Mines at Pittsburgh, Pa., where the analysis was made by standard methods. The analysis of each sample is given in four forms, marked A, B, C, and D. Analysis A represents the condition of the coal at the point in the mine from which the sample was cut. Analysis B shows the condition of the sample after drying at a temperature slightly above the normal until its weight remains constant. Analysis C gives the theoretical condition of the coal after all the moisture has been expelled. Analysis D represents the coal free from both moisture and ash. This is supposed to represent the true coal substance free from the principal impurities. Forms C and D are obtained from the others by recalculation. They should not be used for ordinary comparison, as they represent theoretical conditions that never exist.

In analytical work it is not possible to determine the proximate constituents of coal with the same degree of accuracy as the ultimate constituents. Therefore the air-drying loss, moisture, volatile matter, fixed carbon, and ash are given to one decimal place only, whereas the ash (in an ultimate analysis), sulphur, hydrogen, carbon, nitrogen, and oxygen are given to two decimal places. It should also be understood that the calorific determination to individual units is not reliable; therefore, in the column headed "Calories" the heat values are given to the nearest five units and in the column headed "British thermal units" they are given to the nearest tens (the value of the British thermal unit being about one-half that of the calorie).

Coal analyses.

[Made by the Bureau of Mines; A. C. Fieldner, chemist in charge.]

Coal from Lost Creek field, Utah.

Laboratory No.	Air-drying loss.	Form of analysis.	Proximate.				Ultimate.					Heating value.	
			Moisture.	Volatile matter.	Fixed carbon.	Ash.	Sulphur.	Hydrogen.	Carbon.	Nitrogen.	Oxygen.	Calories.	British thermal units.
19799	8.7	A	18.1	[a] 27.4	35.3	19.23	0.63	5.28	47.47	0.81	26.58	4,540	8,180
		B	10.3	30.0	38.7	21.05	.69	4.73	51.97	.89	20.67	4,970	8,950
		C		33.4	43.1	23.47	.77	3.99	57.93	.99	12.85	5,545	9,980
		D		43.7	56.3		1.01	5.21	75.70	1.29	16.79	7,245	13,040
19800	6.4	A	17.5	[a] 27.8	36.9	17.8	.46					4,755	8,560
		B	11.9	29.7	39.4	19.0	.49					5,085	9,150
		C		33.7	44.7	21.6	.56					5,770	10,390
		D		43.0	57.0		.71					7,360	13,250
			Typical coal from Coalville, Utah.										
	4.8	A	14.2	36.0	44.8	5.00	1.41	5.79	61.40	1.09	25.31	5,905	10,630
		B	9.9	37.8	47.1	5.25	1.48	5.52	64.50	1.14	22.11	6,205	11,170
		C		42.0	52.1	5.85	1.64	4.91	71.58	1.27	14.75	6,885	12,390
		D		44.6	55.4		1.74	5.21	76.03	1.35	15.67	7,310	13,160
			Typical coal from Almy, Uinta County, Wyo.										
	6.7	A	14.4	36.8	41.6	7.22	0.21	5.37	59.97	1.15	26.08	5,805	10,450
		B	8.3	39.5	44.5	7.74	.22	4.96	64.28	1.23	21.57	6,220	11,200
		C		43.0	48.6	8.44	.25	4.41	70.08	1.34	15.48	6,785	12,210
		D		47.0	53.0		.27	4.81	76.54	1.47	16.91	7,410	13,330

[a] Volatile matter determined by the modified official method.

19799. Subbituminous coal from drift mine of Heber Robinson, in sec. 28, T. 5 N., R. 5 E., in Toone Canyon, 12 miles northeast of Devils Slide station on Union Pacific Railroad. Roof is shale and floor is coal. Sample probably slightly weathered; cut 300 feet northeast of opening September 5, 1914, by F. R. Clark.

19800. Subbituminous coal from abandoned slope mine of W. Lucas and H. C. Smith, in sec. 17, T. 5 N., R. 5 E., on west side of Lost Creek, 12½ miles northeast of Devils Slide station on Union Pacific Railroad. Roof is shale and sandstone and floor is shale. Sample slightly weathered; cut from rib 200 feet west of opening September 5, 1914, by F. R. Clark.

COMPARISON OF SUBBITUMINOUS COALS OF THE REGION.

The above table of analyses includes samples of subbituminous coal from the Lost Creek field and from rocks presumably of the same age in near-by fields in Utah and Wyoming. The analyses indicate in a general way the chemical character of the coal in each field. That from Coalville, Utah, and Almy, Wyo., appears to be the best because the coal contains less moisture and ash and shows a greater heating value.

The moisture in the Lost Creek coal is considerably higher than in the Coalville and Almy coals; the ash is from three to four times greater and the heating value is considerably less than in the other coals; and the sulphur in the Lost Creek coal is less than in the Coalville coal but greater than in the coal from Almy, which is exceptionally free from sulphur.

The chemical constituents of a coal which most vitally affect its commercial value are moisture, ash, and sulphur, but the heating value is the all-important factor.

The rapidity with which a coal disintegrates and is reduced to slack depends largely on the percentage of moisture it contains. Therefore, a coal with a low percentage of moisture possesses stocking qualities superior to one with a high percentage. The Lost Creek coal, containing a high percentage of moisture, is not a good stocking coal and would soon disintegrate on exposure to the air. A high percentage of moisture is also objectionable, because the moisture replaces its weight of combustible matter, and a part of the heat generated by combustion is used in evaporating the moisture.

The percentage of ash in coal also materially affects its commercial value. The ash not only displaces its own weight of combustible matter, but during combustion a part of the heat generated is used in heating the ash. The high percentage of ash increases the cost of shipping and also of handling the coal in a power plant and decreases the efficiency of the furnace.

The ratio of the volatile matter to the fixed carbon indicates in a general way the type of furnace best adapted for burning a coal with maximum efficiency. A low-volatile coal may be burned in a

common type of furnace without throwing off much smoke (unburned carbon), but the smokeless burning of a coal high in volatile matter requires a specially constructed furnace.

A high percentage of sulphur is objectionable in coal used for the manufacture of coke and gas or for the generation of steam.

The relatively low heating value of the Lost Creek coal compared with the coals from Coalville and Almy is due chiefly to the fact that the impurities in the Lost Creek coal are three to four times as great as in the other coals.

FUTURE DEVELOPMENT.

Wyoming, Colorado, and Utah contain great quantities of bituminous coal which is likely to be the first to be developed on a large scale, and therefore even the best subbituminous coal in these States will not be developed except to supply local demands. The Lost Creek coal, being inferior in rank to subbituminous coal of near-by fields, is not likely to receive serious attention. Moreover, the coal in the Lost Creek field occurs in areas so small that probably it can not be developed as a shipping coal. Apparently its production in the future, as in the past, will depend upon local consumption.