CHAPTER V

HISTORIC & CULTURAL

Prepared for

TRAIL MOUNTAIN MINE

BY

ENGINEERING DEPARTMENT

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HISTORICAL AND CULTURAL RESOURCES

5.1 Scope

This chapter reviews the existence and potential for historical, archeological, and paleontological resources in the area of Trail Mountain mine. Also discussed is the potential effect the mining activities will have on the cultural resources.

5.3 Historic Resources

5.3.1 Historical Inventory

No historical resources are known to exist within the Tract 2 mine permit area. See also Trail Mountain Coal Company approved Mine Plan ACT/015/009 Volume 1, Chapter 5, Page 5-3 and Appendix 1 and Appendix 2.

5.3.2 History of Mining

Mining activities existed near the site of the proposed Trail Mountain Tract 2 mine permit area since 1898 (Doelling 1972). The first large scale operation near the site was the Johnson mine opened in 1909, a series of three mines the Johnson property operated from 1909 through 1948. The amount of coal produced during that period and the extent of the workings is unknown.

In 1946 three additional operations started in the Cottonwood Canyon. Two prospects operated for a short time, 1946 to 1958 (Doelling 1972). Activity at the Trail Mountain Mine, which is contiguous to the Tract 2 property, started in 1946 and lasted until 1967.

The mine then shut down for ten years and reopened once again in 1977. The Trail Mine has been in operation from 1977 until the present.

5.3.3. Effects of Mining on Historical Resources

There are no sites listed or eligible for listing in the National Register of Historic Places located within the Tract 2 mine permit area. (Jim Dikeman Utah State Historical Society). Therefore, no effect will occur due to the mining in the Tract 2 mine permit area. The Tract 2 mine permit area will be accessed from underground and there will be no surface disturbance. The only potential for surface disturbance will be the possibility of subsidence. Based on our subsidence monitoring plan, and based on our historic records, we do not expect to have any appreciable subsidence. We have had no subsidence, and our prediction is that we will have very minor subsidence in the Tract 2 mine permit area. For additional information on geotechnical and subsidence related data, see Chapter 12 of the Trail Mountain Coal Tract 2 mine permit. Trail Mountain Coal Company commits to, on an annual basis, to review all subsidence monitoring data received from the United States Forest Service and make that data available to the Division of Oil, Gas and Mining, and to the Office of Surface Mining and other appropriate regulatory agencies.

A cultural and historical survey was conducted in the lease area, July 1979 by the Archeological Environmental Research Corporation (AERC). (See Appendix 1) No historic or archeological sites were found on the lease. Five archeological sites are four isolated artifacts were identified in the lower section of Cottonwood Canyon. These site locations are mapped in figure 5-1 in the Trail Mountain Mine and Reclamation Plan ACT/015/009 Volume 1, Chapter 5, Page 5-4.

5.4 Archeological Resources

See Trail Mountain Coal Company Approved Mine Plan ACT/015/009 Volume 1, Chapter 5, Page 5-5. See also 5.3.3

5.4.2 Effects of Mining on Archeological Resources

There is no anticipated effect of mining on Archeological Resources. See Trail Mountain Coal Company Approved Mine Plan ACT/015/009 Volume 1, Chapter 5, Page 5-6. See also 5.3.3

5.5 Paleontology Resources

5.5.1 Paleontologic Inventory

Fossils are found on the Trail Mountain Tract 2 mine permit area in nearly all of the geological units. No paleontological surveys have been conducted on the lease. The Blackhawk formation contains numerous plant fossils. Some of these fossils are extremely rare. Crocodile, fish, and turtle remains along with dinosaur tracks and bones have been found in the Blackhawk Formation.

5.5.2 Effects on Mining on Paleontology Resources

No significant effects on the paleontology resources are expected by the mining activities in the Tract 2 mine permit area, except on subsidence which cannot be quantified. With the implementation of a subsidence and hydrologic monitoring program by Trail Mountain Coal Company, the extent and effects of subsidence can and will be studied.

5.6 Public Parks

6.6.1 Inventory of Public Facilities

No public facilities are located within the Tract 2 mine permit area.

5.6.2 Effect of Mining on Public Facilities

No effect on public facilities is expected from mining operations within the Tract 2 mine permit area. (See also 5.3.3).

5.7 Bibliography

U. S. Forest Service 1982
Environmental Assessment for Trail Mountain Coal Company
Tract 2 Coal Lease No. U-49332

APPENDIX 1

CULTURAL AND HISTORICAL SURVEY

ARCHEOLOGICAL - ENVIRONMENTAL
RESEARCH CORPORATION

588 West 800 South Bountiful, Utah 84010
Tel: (801) 292-7061 or 292-9668

July 7, 1983

Subject: Cultural Resource Evaluations of Three Proposed Exploratory Drilling Locations in the Trail Mountain Locality of Emery County, Utah

Project: Natomas Coal Company, Locations TM-83-2, TM-83-3, and TM-83-4

Project No.: NCC-83-1

Permit: U. S. Forest Service Special Use Permit

To: Mr. Thomas Johnson, Natomas Coal Company, 5970 South Syracuse Street, Suite 124, Englewood, Colorado 80111

Mr. John Niebergall, District Ranger, U.S. Forest Service, Manti-LaSal National Forest, Ferron, Utah 84523

FOREST SERVICE
MANTI-LASAL NATIONAL FOREST
FERRON, UTAH
RECEIVED
JUL 15 1983

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GENERAL INFORMATION:

On July 6, 1983, F. R. Hauck of AERC conducted cultural resource evaluations of three proposed coal exploratory drilling locations and their access routes for Natomas Coal Company. These locations, TM-83-2, 3 and 4, are situated on Trail Mountain in Emery County, Utah.

Location TM-83-2 is situated in the SW¼ of Section 28, Township 17 South, Range 6 East. TM-83-3 is placed in the SE¼ of Section 23 with its access coming northward through Section 26. The third location is situated in the SE¼ of Section 27. Both TM-83-4 in Section 27 and TM-83-2 have access routes which are contained within the same sections where the wells will be drilled.

All evaluated surfaces are on lands administered by the Ferron District Office of the Manti-LaSal National Forest.

METHODOLOGY:

The three proposed well locations were examined by walking a series of concentric 10 to 15 meter wide transects around the staked well centers. The surfaces evaluated covered about a 50 meter radius around each center stake. Access roads were examined by walking a 10 to 12 meter wide transect along the flagged routes.

The National Register of Historic Places has been consulted and no registered properties will be affected by the proposed operations.

RESULTS:

No cultural resource sites were identified during the survey.

CONCLUSION AND RECOMMENDATIONS:

AERC recommends that a cultural resource clearance be granted to Natomas Coal Company based upon adherence to the following stipulations:

1. All traffic, personnel movement, and construction be confined to the examined locations;

2. all personnel refrain from collecting any artifacts and from disturbing any cultural resources in the area; and

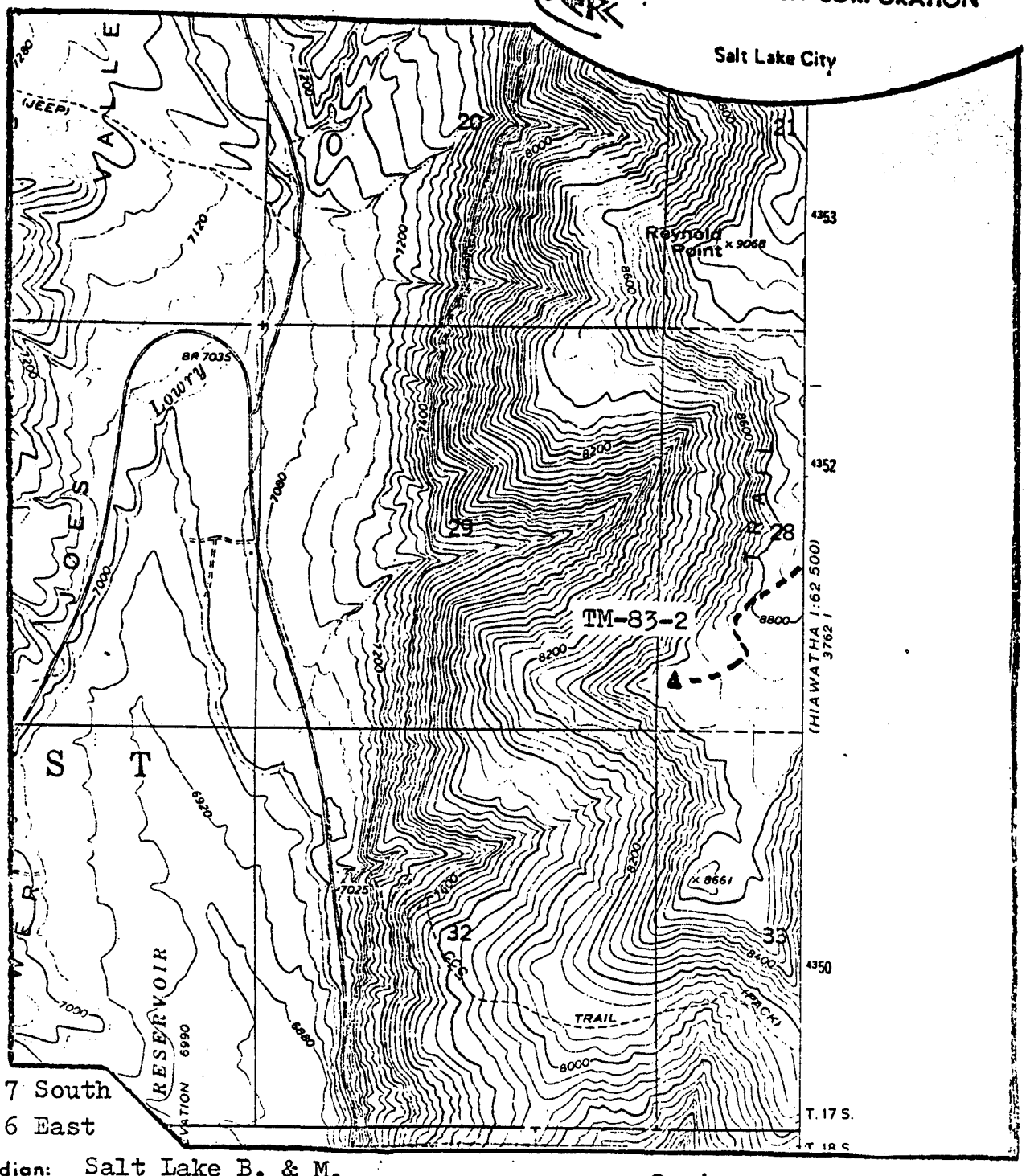
3. a qualified archeologist should be consulted should cultural materials from subsurface deposits be exposed during development of the access roads and well locations, or if the need arises to relocate or extend operations outside the evaluated zones.

F. R. Hauck

F. R. Hauck, Ph.D.

ARCHEOLOGICAL-ENVIRONMENTAL RESEARCH CORPORATION

Salt Lake City



T. 17 South

R. 6 East

Meridian: Salt Lake B. & M.

Quad: Mahogany Point, Utah 7.5 minute-USGS

Project: NCC-83-1

Series: Central Utah

Date: 7-7-83

Cultural Resource Survey on Trail Mountain in Emery County, Utah

Legend:

Well Location ▲

Access Route

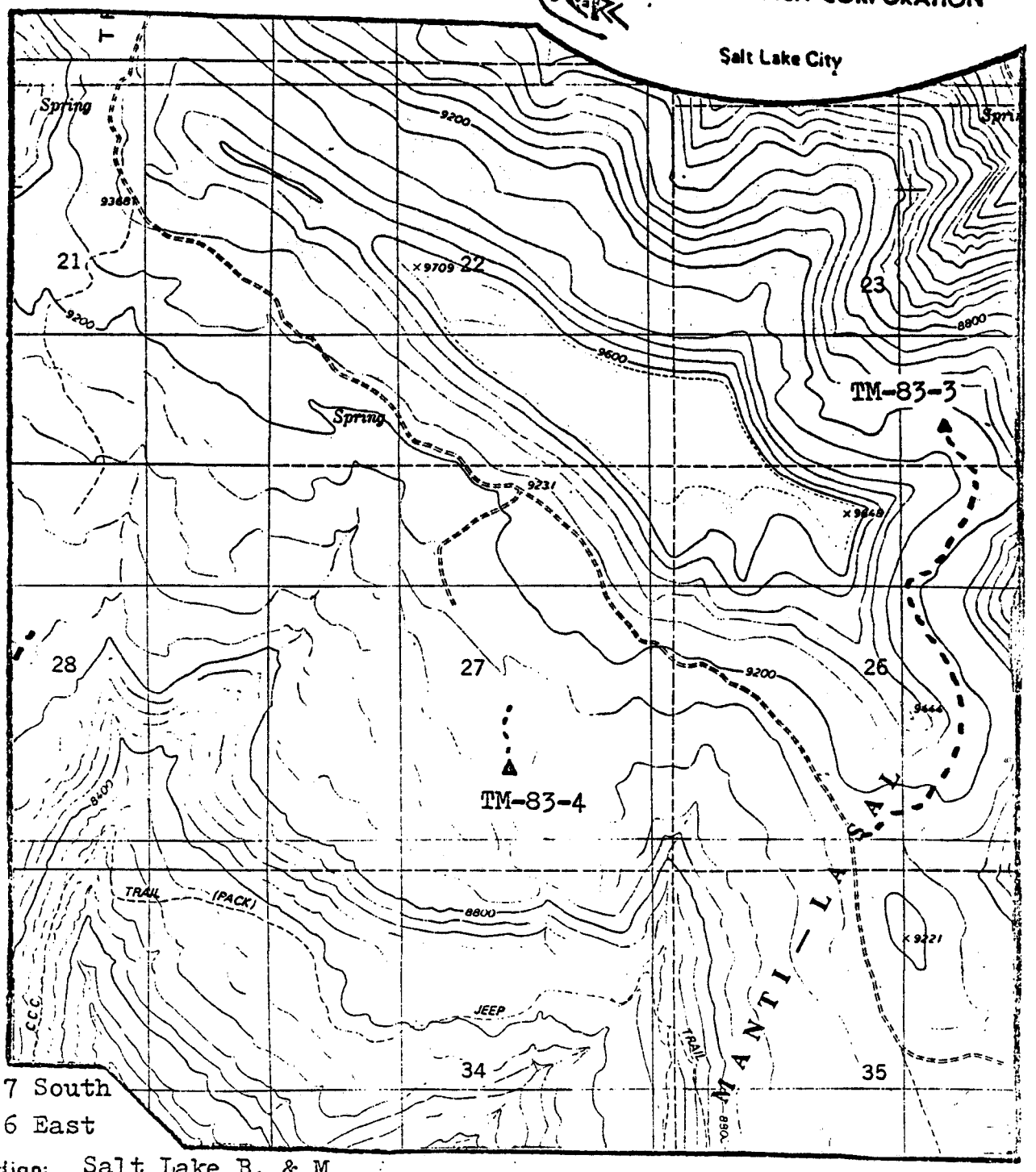
0 .5 1 Mi.

.5 0 .5 1 Km.

Scale

RESEARCH CORPORATION

Salt Lake City



T. 17 South

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Cultural Resource Survey on Trail Mountain in Emery County, Utah

Quad: Mahogany Point, Utah 7.5 minute-USGS

Legend:

Well Location ▲

Access Route

0 .5 1 Mi.

.5 0 .5 1 Km.

Scale

APPENDIX 2

DIVISION OF STATE HISTORY

RECEIVED
APR 17 1986
DIVISION OF
OIL, GAS & MINING

NORMAN H. BANGERTER
GOVERNOR

STATE OF UTAH
DEPARTMENT OF COMMUNITY AND
ECONOMIC DEVELOPMENT

Division of
State History
(UTAH STATE HISTORICAL SOCIETY)

MELVIN T. SMITH, DIRECTOR
300 RIO GRANDE
SALT LAKE CITY, UTAH 84101-1182
TELEPHONE 801 / 533-5755

April 8, 1986

John J. Whitehead
Permit Supervisor/
Reclamation Hydrologist
Division of Oil, Gas & Mining
355 West North Temple
3 Triad Center, Suite 350
Salt Lake City, Utah 84180-1203

RE: Tract 2 Lease Addition, Diamond Shamrock's Trail Mountain Coal Company, Trail Mountain Mine, ACT/015/009, #3, Emery County, Utah

In Reply Please Refer to Case No. G828

Dear Mr. Whitehead:

The staff of the Utah Preservation's Office has reviewed the copy of Diamond Shamrock's Trail Mountain Coal Company's plans for adding new lease acreage to the Trail Mountain Mine. From our review of this report, it appears that no surface disturbances are planned for this project, and that the D&RG survey indicated that no cutural or historic sites were located in the project area. We have no additional comments on this project at this time.

Since no formal consultation request concerning eligibility, effect or mitigation as outlined by 36 CFR 800 was indicated by you, this letter represents a response for information concerning location of cultural resources. If you have any questions or concerns, please contact me at 533-7039.

Sincerely,

Charles M. Shepherd
Architectural Conservator
Office of the State Historic
Preservation Officer

CMS:jrc:G828/2785V

Board of State History: Thomas G. Alexander, Chairman • Leonard J. Arrington, Vice Chairman • Douglas D. Alder
Phillip A. Bullen • J. Eldon Dorman • Hugh C. Garner • Dan E. Jones • Dean L. May • William D. Owens • Amy Allen Price

CHAPTER VI

GEOLOGY

Prepared for

TRAIL MOUNTAIN COAL COMPANY

Orangeville, Utah

BY

JBR CONSULTANTS GROUP

Salt Lake City, Utah

January, 1986

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APPENDIX 1 Coal Drilling at Trail Mountains North Horn Mountain and John's Peak Areas, Wasatch Plateau, Utah

By:

F. D. Davis and H. H. Doelling, UGMS Bulletin 112 Nov. 1977

6.1 Scope

This chapter is intended to present the regional geologic framework in the Wasatch Plateau Coal Field and the general geology of the Trail Mountain area where Trail Mountain Coal Company's Tract 2 permit application area is located. The geologic descriptions will focus of the strata from the surface down to the first aquifer beneath the coal seam to be mined.

6.2 Methodology

The principal geologic work in the area has been done by Speiker (1931), Doelling (1972), and Davis and Doelling (1977). These workers have described the general geology and Davis and Doelling (1977) have also provided some more detailed information based on drill hole data in the general area of Trail Mountain. These sources, combined with data from the Trail Mountain Mine in the ACT/015/009 permit area, which is adjacent to the Tract 2 permit application area on the east, represent the principal data sources used in the preparation of this chapter.

6.3 Regional Geologic Framework

The Tract 2 application area is located 11 miles northwest of Orangeville in Cottonwood Canyon near the center of the Wasatch Plateau coal field. It is found on the Mahogany Point 7 1/2 minute quadrangle. Tract 2 lies at the south end of Trail Mountain and shares a common boundary with the current Trail Mountain Mine permit area, ACT/015/009, located to the east. The location of the application area is shown on Figure 6-1, the Location Map.

Trail Mountain, like most of the Wasatch Plateau coal field, is underlain by gently dipping, predominantly clastic sedimentary rocks of Tertiary and Cretaceous age. The

generally westerly regional dip results from the location of this part of the coal field off the west flank of the San Rafael Swell.

The principal stratigraphic units in the region are the Mancos Shale and the Mesa Verde Group of Cretaceous age, and the Wasatch Group of both Tertiary and Cretaceous ages. These units and the formations which make them up are described in the Generalized Stratigraphic Section, Figure 6-2. The relationships between the principal stratigraphic units and lithofacies are shown in Figure 6-3. The Mesa Verde Group is made up of four formations including the Blackhawk Formation which contains the major coal seams in the Wasatch Plateau coal field. The Hiawatha seam is the only currently minable coal seam in the Trail Mountain area. The Hiawatha seam occurs at the base of the Blackhawk Formation at the contact with the underlying Star Point Formation.

6.4 Geology of the Project Vicinity

Three major stratigraphic units, the Mancos Shale, the Mesa Verde Group and the Wasatch Group, are exposed in the Trail Mountain mine area. The principal structural feature in the area is the Straight Creek Syncline. The general geology of the Trail Mountain area is depicted on the Geologic Map, Figure 6-4.

6.4.1 Stratigraphy

The Mancos Shale crops out in Cottonwood Canyon beginning approximately one mile south of the Trail Mountain Mine portal. The upper-most member of the Mancos Shale, the Masuk Shale Member, is the only sub-unit of the Mancos exposed in the project area. It " . . . consists of light gray to blue gray sandy marine shale . . . " (Davis and Doelling, 1977).

The Mancos Shale is overlain by the Mesa Verde Group. The sandstones of the Mesa Verde Group form the cliffs that dominate the walls of Cottonwood Canyon. The lower-

most formation of the Mesa Verde Group is the Star Point Sandstone which is 250 to 350 feet thick in the vicinity of the Trail Mountain Mine.

The Star Point is made up of yellow-gray, thick-bedded and massive, cliff-forming sandstones which are separated by tongues of the underlying Masuk Shale Member of the Mancos Shale. The stratigraphic and lithofacies relationships between the Mancos and the Star Point are shown generally on Figure 6-3. The three principal sandstone tongues were each deposited in delta-front environments.

The Blackhawk Formation overlies the Star Point Sandstone. It has a thickness range of from 625 feet to 800 feet in the project area. The Blackhawk is comprised of interbedded fine and medium grained sandstones, siltstones, carbonaceous shales, and coal beds. The lithologies in the lower Blackhawk were deposited in lagoonal and shallow marine environments. The upper Blackhawk sandstones were deposited in a fluvial environment. The Hiawatha coal seam occurs at the base of the Blackhawk and is the seam that is mined at the Trail Mountain Mine.

The Castlegate Sandstone, a coarse-grained and commonly conglomeratic cliff-former, overlies the Blackhawk Formation. With the exception of occasional thin, sandy shale beds the Castlegate is made up entirely of fluvial sandstone. It ranges in thickness from 250 to 350 feet in the vicinity of Trail Mountain.

Overlying the Castlegate Sandstone is the Price River Formation which is comprised of medium to coarse-grained fluvial sandstones with occasional interbeds of conglomerate and shale. The Price River ranges from 400 to 800 feet in thickness in the vicinity of Trail Mountain. It forms the very steep, ledged slopes that occur above the cliffs of the Castlegate Sandstone.

The Wasatch Group caps Trail Mountain and overlies the Price River Formation. The lower Wasatch Group is defined as the North Horn Formation and is of Cretaceous and Tertiary ages. The North Horn is predominantly shale with interbeds of sandstone, conglomerate, and freshwater limestone. It forms gentle to moderately steep slopes.

The Tertiary Flagstaff Limestone overlies the North Horn Formation and is preserved only on the top of Trail Mountain (see Figure 6-4, Geologic Map). It is perhaps 100 to 200 feet thick, although its original thickness probably ranged from 500 to 1500 feet (Davis and Doelling, 1977). The Flagstaff, a local cliff-former, consists of dense, thin-bedded lacustrine limestone with interbeds of sandstone, shale, and volcanic ash.

6.4.2 Structure

The strata in the Trail Mountain area dip 3 to 4 degrees to the southwest. The structure and stratigraphy of the Trail Mountain area in the vicinity of the Trail Mountain Mine are depicted on Cross Section A-A', Figure 6-5. The line of section is shown on the Geologic Map, Figure 6-4. This east-west section shows that the apparent dip of the local strata in the plane of the section is 2.3 degrees.

Immediately to the north of the project area is the Straight Canyon Syncline which, as Figure 6-4 shows, has a northeast striking axis and plunges to the southwest. Despite the syncline's proximity to the project area, it appears likely to influence the local dips in only that part of the Tract 2 area that is located in the central and northern parts of Sections 25 and 26, T. 17 S., R. 6 E. (Davis and Doelling, 1977). Here one might anticipate dips of from 3 to 4 degrees to the west or northwest. Davis and Doelling (1977) also report that local dips of up to 10 degrees occur on the limbs of the gentle folds in the Trail Mountain - North Horn Mountain area. The structure contour map of the top of the Hiawatha coal bed prepared by these authors suggests that maximum dips of 7 degrees might be found near the north edge of the property. However the drill hole control used in preparing the map is insufficient to permit use of calculated attitudes for actual dip determinations in small areas. Therefore, while it is possible that steeper than normal dips may be encountered in this part of the mine, the available data do not permit reliable estimates of their magnitude. The literature reports no known faults in the vicinity of the Tract 2 area and no faults have been encountered in the Trail

Mountain mine. Therefore no faulting is anticipated in the Tract 2 area. The Joes Valley Fault, located approximately three and one half miles west of the Tract 2 area, is the only known fault in the Trail Mountain area. The Joes Valley Fault is a normal fault that is the eastern bounding fault of a major, 70-mile-long, 2-mile-wild graben. The displacement on this normal fault has been calculated to be 2300 feet in Section 20, T. 17 S., R. 6 E. due west of the Tract 2 area (Davis and Doelling, 1977). The beds in the Tract 2 area are not anticipated to have been disturbed by the extensional tectonism which resulted in the Joes Valley Fault.

6.4.3 Overburden Thickness

The overburden thickness in the Tract 2 area is depicted on the Overburden Thickness Map, Figure 6-6. Overburden thickness ranges from 400 feet in the northeastern part of Tract 2 to more than 2200 feet in the western part of the area. Average overburden thickness is 1800 to 2200 feet. Overburden in Tract 2 is comprised of the following stratigraphic units: The Blackhawk Formation, the Castlegate Sandstone, the Price River Formation, and the North Horn Formation. No overburden will be removed during developing or mining of the Tract 2 area.

6.5 Geology of Coal Bed and Adjacent Units

6.5.1 Exploration and Drilling

Trail Mountain Coal Company has done no exploration; drilling in either the ACT/015/009 permit area or the Tract 2 application area. Drill hole data obtained by a Utah Geological and Mineral Survey coal drilling program carried out in 1975 is presented in Davis and Doelling (1977). All of the holes drilled during this program were drilled outside of the ACT/015/009 permit area and the Tract 2 area in Straight Canyon and Cottonwood Canyons. The United States Geological Survey drilled five wells on the south end of Trail Mountain during a 1981-1983 hydrologic investigation

program (Lines, 1985 - see Appendix 7-□). None of these wells were drilled in the Tract 2 area or in the ACT/015/009 Permit area. The closest well was drilled approximately three quarters of a mile west of Tract 2 in the southeast corner of Section 34, T. 17 S., R. 6 E. No lithologic or coal thickness data for this or any other drill hole was presented in Lines' (1985) report. The United States Geological Survey reports (K. Waddell, personal communication, 1985) that no lithologic descriptions for the Section 34 drill hole are available in the Survey's files. A review of the files of the Utah Geological and Mineral Survey indicated that while there is publicly available data available for many drill holes in the Mahogany Point 7 1/2' Quadrangle, none of these holes are located such that they are of benefit to coal exploration or mine planning in the Tract 2 area.

6.5.2 Stratigraphy

The Star Point Sandstone commonly forms the floor in the Trail Mountain Mine. The Hiawatha coal seam directly overlies the Star Point Sandstone in most parts of the Trail Mountain mine in ACT/015/009, although a one to two foot zone of shale occasionally occurs between the Hiawatha seam and the Star Point. The lithologies that comprise the immediate roof are variable and include shale, siltsone, dirty coal and fine-grained sandstone. This variable zone is commonly up to six feet in thickness, although nearby outcrop data from Utah Geological and Mineral Survey files indicate that the zone may exceed 16 feet in thickness. This variable zone is commonly overlain by a thick layer of competent sandstone. The local generalized stratigraphic section is presented in Figure 6-7.

6.5.3 Structure

As previously stated, there are no known faults in the existing Trail Mountain Permit Area. ACT/015/009, or in the proposed Tract 2 permit area. Available published geological data, discussed above, and the experience of the Trail Mountain Coal

Company, strongly suggest that no currently unrecognized faults will be encountered underground in the Tract 2 area.

6.5.4 Coal Reserves

Coal reserves in Tract 2 are estimated to be 4.75 million tons of recoverable coal. Total in-place coal reserves are estimated at 9.5 million tons. Reserves were calculated by exploration from coal thickness data available at outcrop in the surrounding area and from underground measurements in the Trail Mountain Mine adjacent to Tract 2 on the east. Because no coal thickness data are available for Tract 2, an isopach map for the Hiawatha seam has not been prepared. Various coal thickness values based on proximate available data were assumed in calculating the coal reserves at Tract 2; however, the average thickness used for all of Tract 2 was 8.75 feet. Tract 2 is 621.17 acres in area and this area was used in calculating reserves. Coal density of 80 pounds (.04 tons) per cubic foot or 1750 tons per acre foot was used in making the calculations. In the small area that is adjacent to outcrop in the canyon immediately north of the Trail Mountain Mine portal, the limit of estimated natural burning and a mining limit of 200 feet from outcrop in the drainage were taken into account in making reserve calculations.

6.5.6 Coal Quality

Because no drilling has been done in the Tract 2 area, coal quality data for the Hiawatha seam in the area is not available. Coal quality data from the Hiawatha seam in the ACT/015/009 permit area has been use to estimate the coal quality in Tract 2. This data is presented below in Table 6.1.

Table 6.1

Mean Coal Quality Data from Seven (7)
Proximate Samples Taken from the
ACT /015/009 Permit Area.**

Moisture %	Ash %	Volatile Matter %	Fixed Carbon %	Sulfur %	BTU/lb.
4.69	8.38	39.64	47.28	0.57	12,517

See figure 6-8 for sample locations

**Ch 6 Rev. 1-11-87

The sulfur content of the Hiawatha seam in the ACT/015/009 Permit Area of the Trail Mountain mine, based on a single sample taken in March, 1983 is shown below in Table 6.2.

Table 6.2

Pyrite Content of the Hiawatha Coal Seam
ACT/015/009 Permit Area, Trail Mountain Mine.

Sulfur Forms	Weight %	
	As Received	Dry Basis
Pyritic Sulfur	0.10	0.11
Sulfate Sulfur	0.00	0.00
Organic Sulfur	0.41	0.43
Total Sulfur	0.51	0.54

As the above table shows, approximately 80 percent of the sulfur present occurs as organic sulfur. The remaining sulfur occurs as pyrite or pyrite/marcasite and represents 0.11 percent by weight of the coal in this sample.

6.5.7 Roof and Floor Analysis

Again, since no exploratory work has been done in the Tract 2 area, roof and floor data from the Trail Mountain Mine in ACT/015/009 has been used to estimate the pyrite content, acid generating potential and alkalinity of the rocks immediately above and below the Hiawatha coal bed and the clay content of the stratum beneath the seam. The results of this are shown in Table 6-3.**

**Ch 6 Rev. 1-11-87

ANALYTICAL REPORT

APRIL 20, 1983

ATOMAS COAL COMPANY

Job No.: 6303-S83027
Chemist: LLZ
Location: Casper, WY

Client I.D.	Interval	Sample Number	% Pyritic Sulfur	Acid Base* Potential	Neutralization* Potential	meq H+/100 gr.	% Clay Fraction
ample No. TNM 1 W,40 Down	0.0-2.7 Ft.	1	0.18	+81.6	+87.5	11.9	2.0
ample No. TNM 1 W, 40 Up	2.0-4.0 Ft.	2	0.33	+90.2	+106.5	32.5	

* ± Tons $CaCO_3$ Equivalent/1000 Tons Material

TABLE 6-3

These opinions or interpretations are based on observations and material supplied by the [illegible] to whom, and for whose exclusive and confidential use, this report is made. The interpretations or opinions expressed represent the best judgment of Core Laboratories, Inc. (all errors and omissions excepted) [illegible] Core Laboratories, Inc. and its officers and employees, assume no responsibility and make no warranty or [illegible]

6.6 References

Doelling, H. H. 1972. Central Utah Coal Fields. Utah Geological and Mineral Survey, Monograph No. 3. Salt Lake City, Utah.

Davis, F. D. and Doelling, H. H. 1977. Coal Drilling at Trail Mountain, North Horn Mountain, and Johns Peak Areas, Wasatch Plateau, Utah. Utah Geological and Mineral Survey, Bulletin 112. Salt Lake City, Utah.

Lines, G. C. 1985. The Groundwater System and Possible Effects of Underground Coal Mining in the Trail Mountain Area, Central Utah. U. S. Geological Survey Water Supply Paper 2259. Washington, D. C.

Speiker, E. M. 1931. The Wasatch Plateau Coal Field. U. S. Geological Survey Bulletin 118. Washington, D. C.**

Coal Drilling at Trail Mountain, North Horn Mountain, and Johns Peak Areas, Wasatch Plateau, Utah

by F. D. Davis and H. H. Doelling

UTAH GEOLOGICAL AND MINERAL SURVEY
a division of the
UTAH DEPARTMENT OF NATURAL RESOURCES

BULLETIN 112 PRICE $4.50 NOVEMBER 1977

Coal Drilling at Trail Mountain, North Horn Mountain, and Johns Peak Areas, Wasatch Plateau, Utah

by F. D. Davis and H. H. Doelling

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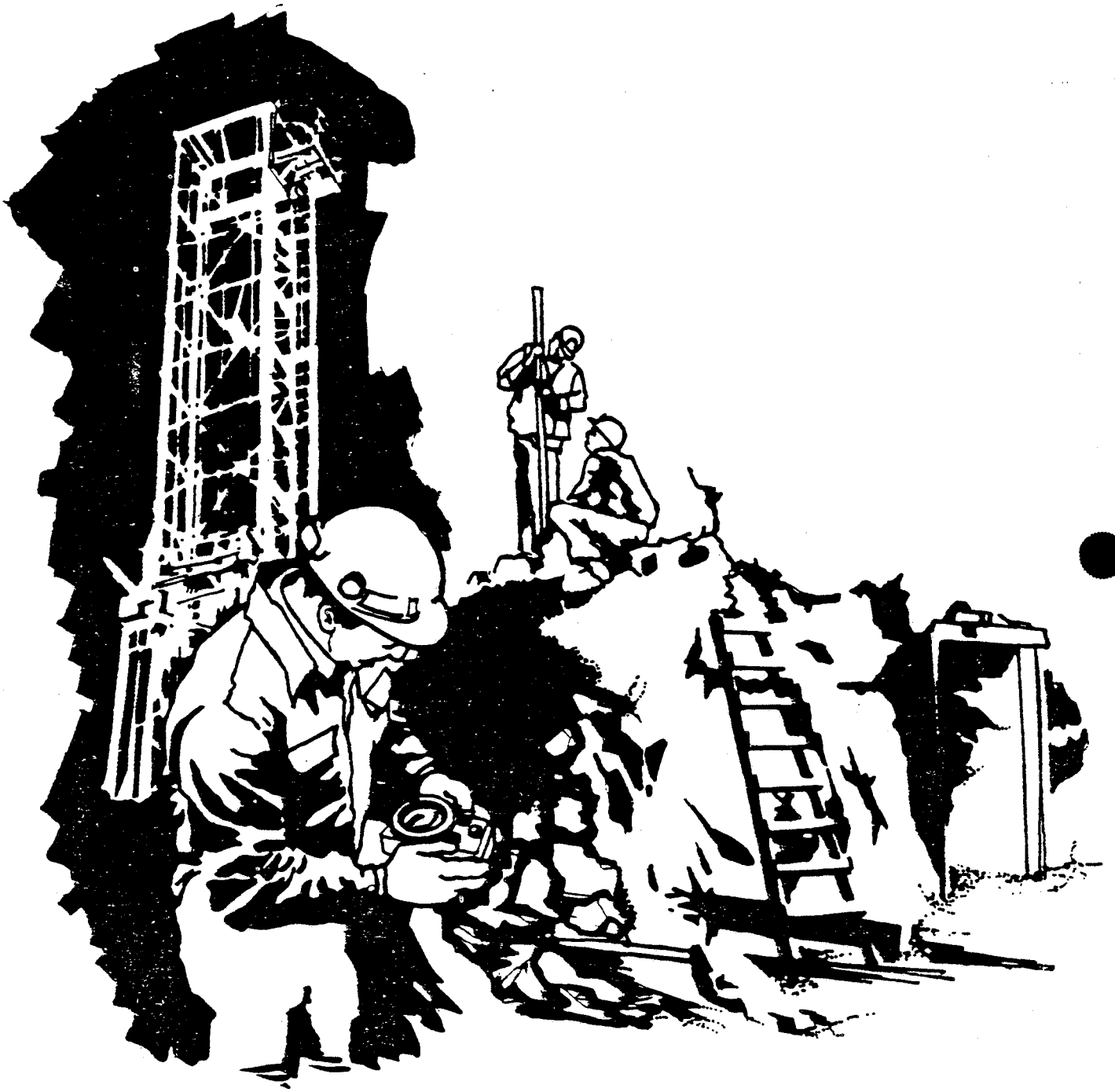
UTAH DEPARTMENT OF NATURAL RESOURCES

BULLETIN 112 PRICE $4.50 NOVEMBER 1977



COAL DRILLING AT TRAIL MOUNTAIN, NORTH HORN MOUNTAIN, AND JOHNS PEAK AREAS, WASATCH PLATEAU, UTAH

by F. D. Davis[1] *and H. H. Doelling*[2]

ABSTRACT

The drilling of seven core holes by the Utah Geological and Mineral Survey was done under contract with the United States Geological Survey. An eighth hole was planned but was abandoned because of environmental considerations. The total footage drilled was 4,590.4 feet and included 1,935.4 feet of coring. The depth of the holes ranged from 276.4 feet to 1,158.3 feet. Drilling was mostly in the Blackhawk Formation, a coal-bearing unit of the Mesaverde Group of Late Cretaceous age; and in each hole the upper few feet of the underlying Star Point Sandstone were intersected. All but one hole intersected at least one coal bed 4 feet or thicker, the thickest being 9.3 feet. Three areas were investigated, Trail Mountain, North Horn Mountain, and Johns Peak. At Trail Mountain the Hiawatha bed ranges in thickness from 4.5 to 9.3 feet and averages a little over 7 feet. Only in one hole was more than one minable seam found. One hole was drilled in western North Horn Mountain, but no thick coal bed was intersected. The important coal bed penetrated in the Johns Peak area is thought to be the upper Ivie and is 4 to 6 feet thick.

INTRODUCTION

Location and Geography

The Wasatch Plateau coal field is in central Utah in parts of Carbon, Emery, Sanpete, Sevier, and Utah Counties (figure 1). The width of the field ranges from 7 to 20 miles and its length is 90 miles for an area of about 1,100 square miles. Three drilling areas within the plateau were chosen around Trail Mountain, on North Horn Mountain, and near Johns Peak. The first two are in the center of the plateau in the vicinity of the towns of Castle Dale and Orangeville. The third is in the southern part of the field.

The Wasatch Plateau is composed of gently undulating to flat-lying strata. The terrain is very rugged, and only from the higher surfaces can one appreciate the true plateau nature. It is deeply dissected by canyons such as Huntington, Straight, Cottonwood, Ferron, Muddy Creek, and Ivie Creek. Local relief is commonly 2,000 to 3,000 feet. Some eminent elevations are Bald Mountain, 10,425 feet; Trail Mountain, 10,055 feet; East Mountain, 10,706 feet; The Cap on North Horn Mountain (figure 2), 9,610 feet; and Johns Peak, south of Ivie Creek, 9,540 feet. Castle Valley, below and to the east of the plateau, ranges in elevation from 5,700 to 6,300 feet.

The chief drainages of the plateau flow southeasterly into the Colorado River. The master streams are perennial, whereas most tributaries are not. The average runoff is greatest in June with the snowmelt; however, great fluctuations are common due to thundershowers and both late and early snowfalls. The normal annual precipitation on top of the plateau is 30 inches. Lower elevations receive less, and at the base an average of 12 inches is recorded.

Plan and Objectives

The primary objective of the drilling project was to collect new quantitative, qualitative, correlative, and stratigraphic data in areas in which little was known about coal. The demand for such information was from federal and state agencies, private industry, and the public in response to a national energy crisis and the need for national self-sufficiency in energy. Surface mapping alone is not adequate for a proper evaluation of the coal character in the Wasatch Plateau field. Where the beds crop out, the true character is difficult to evaluate, because the coal is normally thinned by oxidation and weathering. In most localities the coal is covered by a mantle of soil.

As originally planned the drilling project was to consist of eight drill holes with the northernmost six in the central part of the coal field and two in the southernmost part. Drilling was to be exploratory, and not designed for the development of minable areas. The program's purpose was (1) to determine the existence of minable coal and (2) to delineate, if possible, inferred or indicated reserves. To determine measured reserves, drill holes should not be placed more than one-half mile apart in the Wasatch Plateau coal field. The six drill sites in the central part of the field were spaced from 3.1 to 6.7 miles apart in a roughly north-south zigzag pattern. Sites for drill holes 7 and 8 were 1.6 miles apart in a north-south direction in the southernmost part of the coal field. These plans were followed, with one exception. Some terrain modifica-

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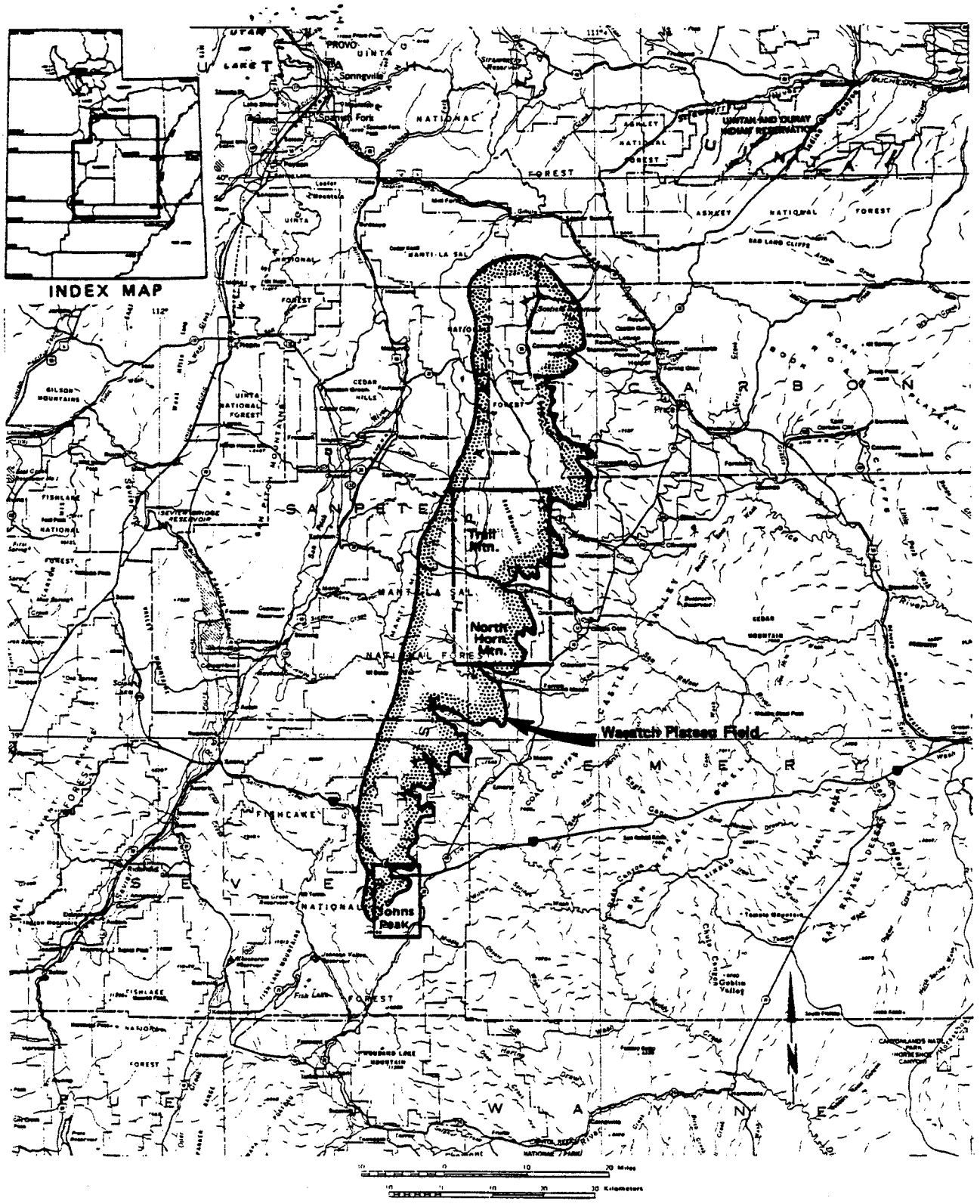

Figure 1. Location map of Wasatch Plateau and adjacent areas in central Utah.

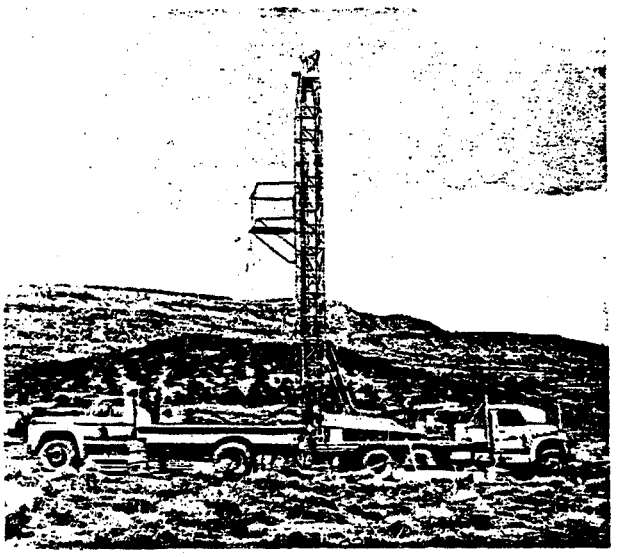

Figure 2. Drilling equipment at the site of drill hole 6. The view is to the north with "The Cap" on North Horn Mountain in the background.

tion would have been necessary to set up the drilling equipment at the site for drill hole 1 in the SE¼NE¼ sec. 27, T. 15 S., R. 6 E.[3] Environmental objections caused this proposal to be rejected by the U. S. Forest Service. No satisfactory alternative could be found in the vicinity, so the site was abandoned.

The coal beds in the lower half of the Blackhawk Formation were the known objectives. The hole locations were topographically and geologically selected for minimum depth to the coal beds while providing a fairly wide geographic spacing. All drill sites were on U. S. Forest Service lands. Prospecting permits were obtained from the Manti-La Sal National Forest and the Fishlake National Forest.

Boyles Brothers Drilling Company of Salt Lake City, Utah, received the drilling contract and commenced drilling on July 7, 1975. The drilling rig was a Winter-Weiss Portadrill capable of drilling with air or water. Drilling with air was done whenever possible. Core rods and cores were of NC size, and a wireline core barrel was used.

Because of field conditions and requests by the U. S. Forest Service, the holes were drilled in the following sequence: 5, 6, 4, 3, 2, 7, and 8. The descriptions of the drill holes, however, are presented in numerical order in Appendix I. The upper parts of each hole were rotary drilled, and at least 150 feet or more of the coal and coal-bearing strata at the bottoms of the holes were cored. The core recovery was excellent and electric logging was not used. The wide spacing and core-hole data indicate that electric logging would have assisted little in interpreting the results.

[3] All legal descriptions of locations in this report are from the Salt Lake Base and Meridian (SLBM).

GEOLOGY

The Wasatch Plateau comprises Tertiary and Cretaceous strata, predominantly limestone, sandstone, and shale that differ in resistance to erosion; the limestones and sandstones form cliffs, and the shales form slopes. The consolidated rocks of the coal field and, more specifically, the areas of this report, range in age from Late Cretaceous to Paleocene. Plate 1 is a geologic map of the Trail Mountain-North Horn Mountain area and plate 2 is a geologic map of the Johns Peak area. Brief descriptions of the units are listed in table 1. Unconsolidated Quaternary deposits of various types are also present.

Stratigraphy

Masuk Shale

The Masuk Shale is the uppermost member of the Mancos Shale. It consists of light gray to blue gray sandy marine shale of Santonian age. The Masuk ranges in thickness from 300 to 1,300 feet and forms the slope at the base of the Wasatch Plateau beneath the Star Point Sandstone. It is well exposed in the lower reaches of Huntington, Cottonwood, Rock, and Ferron Canyons. The member thins to the south and west.

Star Point Sandstone

As the lowermost of three formations composing the Mesaverde Group of the Wasatch Plateau, the Star Point consists of several tan, massive, cliff-forming sandstones separated by one or several shale tongues of the underlying Masuk Shale. The formation, Campanian in age, ranges from 200 feet thick in the eastern part of the coal field to 1,000 feet or more in the western part. The Star Point is the lowest cliff in the escarpment on the east side of the Wasatch Plateau (figure 3). Spieker (1931, p. 23) measured the following section in the central part of the field:

Section of Star Point Sandstone on east side of Grimes Wash, south of Anderson mine

Hiawatha coal bed (base of coal-bearing Blackhawk formation)

	Feet
1. Sandstone, white, massive	*24*
2. Sandstone, buff, medium grained, massive at top, considerably split by bedding planes in lower half	*108*
3. Sandstone, buff to gray, medium grained, platy and somewhat friable	*36*
4. Shale, sandy, dark gray, marine (tongue of Mancos shale)	*60*
5. Sandstone, platy, friable (like No. 3)	*24*

Table 1. Generalized section of rocks exposed in the central and southern Wasatch Plateau coal field.

System	Group	Formation		Thickness (feet)	Description
Tertiary	Wasatch	Flagstaff Limestone		100-1,000	Light gray to cream limestone; thin and even bedded; dense; fossiliferous; ledge- and cliff-forming.
		North Horn Formation		900-2,000	Mostly red-, brown-, and salmon-colored shales; varying thicknesses of sandstone, freshwater limestone and conglomerate; slope-forming.
Cretaceous	Mesaverde	Price River Fm.	Upper Price River Member	400-800	Mostly tan and gray; medium- to coarse-grained sandstone; some gray shale and conglomeratic sandstone; ledge- and slope-forming.
			Castlegate Sandstone Member	150-500	Light gray, yellowish brown, and white, medium- to coarse-grained sandstone and conglomeratic sandstone; cliff-forming.
		Disconformity			
		Blackhawk Formation		400-1,100	Light to medium gray sandstones; gray to black shales; gray siltstones; important coal beds in lower half; sandstones weather tan, brown, yellowish brown; ledge- and slope-forming.
		Star Point Sandstone		200-1,000	Tan, light gray, and white massive sandstones separated by one or more shale tongues; cliff-forming.
	Mancos Shale	Masuk Shale		300-1,300	Light gray to blue gray sandy marine shale; thins to west and south; slope-forming.

6. Concealed (probably shale with thin beds of sandstone) 66
7. Sandstone (like No. 3) 42
8. Sandstone, buff, massive 140
Mancos shale (main body)

500

We have seen outcrops of unit No. 1 that have spalled off, thereby revealing tan, unweathered sandstone. The weathered surface of this upper sandstone, however, is white at most places. The contact is sharp between this white sandstone cliff and the overlying slope-forming beds of the Blackhawk Formation.

Section of Star Point Sandstone measured below the Axel Anderson mine in the NW¼NW¼ sec. 8, T. 19 S., R. 7 E., by H. Doelling and L. Green, July 1975.

Blackhawk Formation

Star Point Sandstone	Thickness, in feet
Sandstone, white, light gray on fresh surface, medium-grained, friable	13

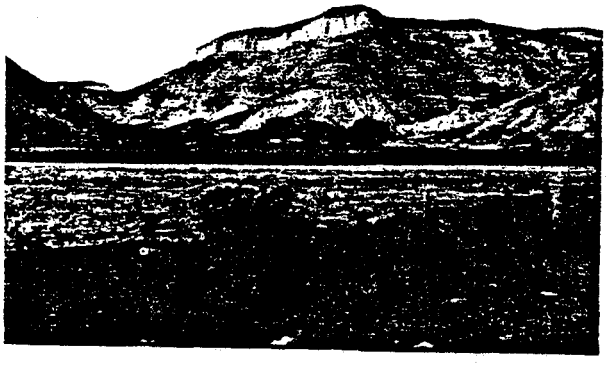

Figure 3. A view looking northwest at the confluence of Straight Canyon (to the left) and Cottonwood Canyon. The Star Point Sandstone forms the lowest cliff in the escarpment at the center of the photo.

Sandstone, brownish tan, medium-grained, cliff-forming; contains pockets of clay galls 34
Sandstone, shaly, medium-grained, friable, platy 3
Sandstone, fine- to medium-grained, cliff-forming 13
Sandstone, shaly, fine-grained, platy-weathering; partings of dark gray shale and siltstone containing carbonaceous material 13
Sandstone, fine- to medium-grained, cliff-forming 12
Sandstone, fine-grained, medium- to thin-bedded; shaly partings 7
Sandstone, medium gray, fine-grained; interbedded with sandy siltstone 18
Sandstone, shaly, fine-grained, thin-bedded; partings of lavender to gray siltstone 16
Sandstone, fine-grained, medium- to thick-bedded, cliff-forming 7
Sandstone, fine-grained, platy-weathering, thin-bedded; some siltstone with partings of vegetative material 10
Sandstone, light gray, fine-grained 8
Sandstone, shaly, fine-grained, thin-bedded; contains carbonaceous debris 27
Covered slope 36
Sandstone, shaly; fine- to medium-grained, weathers platy 19
Sandstone, medium-grained, cliff-forming 10

Total Star Point 246

Masuk Shale

Blackhawk Formation

The Blackhawk Formation, the middle member of the Mesaverde Group, contains the minable coal beds of the Wasatch Plateau. All the thick and important coal beds are in the lower half of the formation. The Blackhawk is Campanian in age, and the type section is near the Blackhawk mine at Hiawatha (sec. 3, T. 16 S., R. 8 E.).

The unit consists of light to medium gray sandstone, light gray to black shale, light to medium gray siltstone, and coal. The sandstones are mostly fine grained and weather to shades of tan, yellow brown, yellow gray, and occasionally white. They form ledges and cliffs (figure 4). The shales and siltstones underlie covered slopes. Many of the siltstones and darker shales are carbonaceous, containing leaf imprints of sequoias, ferns, and willows.

Seven drill holes penetrated the coal-bearing strata, and all bottomed in the top of the Star Point Sandstone. Drill hole 6 penetrated through the Blackhawk Formation, which was 895 feet thick. At the northernmost site (drill hole 2) the Blackhawk was 1,039 feet thick, and at the southernmost site (drill hole 8) it was 525 feet thick. Composite thicknesses of the Blackhawk in the Trail Mountain area show it to vary from 746 to 1,039 feet. There are not enough

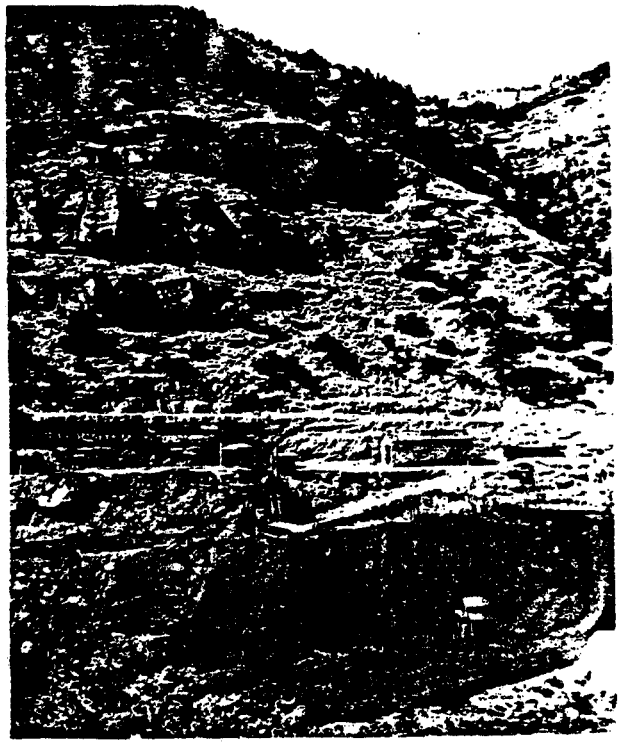

Figure 4. A view of a typical exposure of the Blackhawk Formation at the Trail Mountain mine in Cottonwood Canyon. The Hiawatha coal bed is exposed in a cut at the bottom, and the Castlegate Sandstone forms the cliff at the top.

data to provide isopachous information, and the thicknesses appear erratic. Not enough data were obtained to relate the thickness of the overlying Castlegate Sandstone to the Blackhawk thickness, i. e., to see if the thickening of one unit relates to the thinning of the other.

The drill cores showed numerous and rapid vertical lithologic changes. It appears that the sediments of the Blackhawk Formation were deposited in littoral marine, floodplain (fluvial), deltaic, and coastal lagoonal-paludal environments.

Price River Formation

Castlegate Sandstone Member. The Price River Formation is the uppermost member of the Mesaverde Group, and the Castlegate Sandstone is the lowermost unit of the Price River. The Castlegate is Campanian in age, and the type section is in Price River Canyon about 2 miles above the old town of Castlegate.

Along the eastern front of the plateau and within the canyons, the unit forms the uppermost cliff of the escarpment (figure 5). Ranging in thickness from 150 to 500 feet, it consists of fluvial sandstones, conglomerates, and a few thin beds of gray sandy shale. The sandstones, chiefly medium to coarse grained and

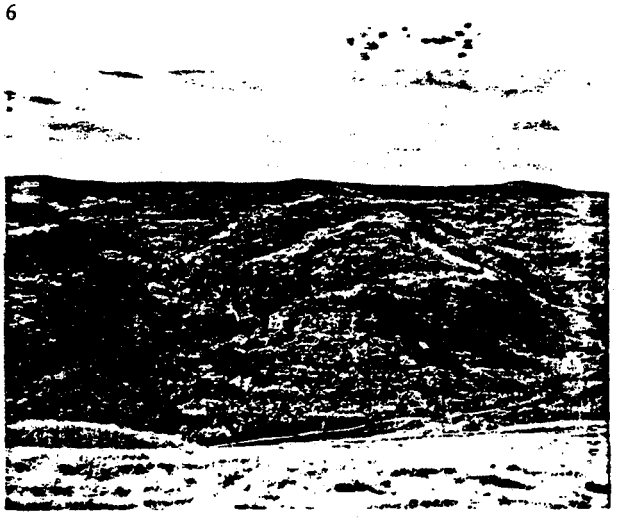

Figure 5. A view of the west side of upper Cottonwood Canyon. The prominent outcrops in the center of the photo are the Castlegate Sandstone, which is underlain by the Blackhawk Formation. The receding slope above the Castlegate is the upper Price River Member, and on the skyline is the North Horn Formation.

massive, weather to shades of light gray, tan, white, and yellow brown. The cliff, however, generally has a light gray hue. The conglomerates, light gray in most places, contain pebbles of white quartzite and gray limestone in a coarse sandy matrix.

Section measured on the west side of Trail Mountain in upper Joes Valley (NE¼ sec. 20, T. 17 S., R. 6 E.) appears to represent the typical unit as follows:

Upper Price River Member

Castlegate Sandstone Member	Thickness, in feet
Sandstone, tan, medium-grained, cliff-forming; massive beds, calcareous	39.7
Sandstone, yellow brown, medium- to coarse-grained, cross-bedded, calcareous, cliff-forming; contorted bedding	42.1
Conglomerate: interbedded with coarse-grained, cross-bedded sandstone; cliff-forming	19.7
Sandstone, tan, medium- to coarse-grained, cross-bedded, cliff-forming; weathers light gray	8.3
Sandstone, tan, coarse-grained, calcareous, cliff-forming; massive beds; weathers light gray	63.1
Total Castlegate Sandstone	172.9

Blackhawk Formation

In the upper part of drill hole 6 the Castlegate was 227 feet thick (from 18 to 245 feet) and contained considerable yellow, white, and even orange, medium- to coarse-grained sandstone.

Upper Price River Member. The upper Price River Member forms a steep receding slope above the Castlegate Sandstone cliff. The strata are predominantly fluvial sandstones, but there are a few thin interbedded pebble conglomerates and gray shales. The sandstones are gray, grayish tan, tan, and brown; most are medium to coarse grained, but some are fine grained.

In the area investigated, the member appears to range from 400 to 800 feet in thickness. A section measured on the west side of Trail Mountain in the NE¼ sec. 20 and the NW¼ sec. 21, T. 17 S., R. 6 E., was 673 feet thick. The type section is in Price Canyon between Castlegate and Crandall Canyon where it is 488 feet thick (Spieker, 1931, p. 40). The unit is Late Campanian and Maestrichtian in age.

North Horn Formation

Spieker (1931, p. 45) originally divided the Wasatch Formation into three members: (1) the lower member, (2) the Flagstaff Limestone Member and, (3) the upper member. His lower member is now the North Horn Formation. On the older geologic maps of the Wasatch and Fish Lake Plateaus, the areas mapped under the symbol Tw (Wasatch) are mostly North Horn.

The North Horn generally forms slopes and, in places, produces a hummocky terrain. Mostly it consists of shales, but it has subordinate amounts of sandstone and thin beds of white and light gray freshwater limestone. Spieker (1931, p. 46) described the shales as being of various colors such as red, green, purple, gray, and chocolate brown. Distant views of the formation show it distinctly pink or salmon colored. Late Cretaceous fossils have been found in the lower part of the unit, and Tertiary fossils have been identified from the upper part.

Over the Wasatch Plateau the North Horn varies in thickness from 900 to 2,000 feet. A section measured on Trail Mountain in the N½ sec. 21 and the NW¼ sec. 22, T. 17 S., R. 6 E., was 979 feet thick. This section is mostly covered, and only the sandstones crop out as low ledges. They are gray, light gray, and tan and fine grained; one bed is greenish brown, and all are thin bedded. The upper contact with the more resistant Flagstaff Limestone is commonly a pronounced break in slope.

Flagstaff Limestone

The Flagstaff was the original middle member of the Wasatch Formation, but it now has formational status. The unit forms a white cliff around the highest summits and ridges of the plateau and consists of white and light gray, thin-bedded lacustrine limestone with some thin beds of gray shale and dense white volcanic ash. The Flagstaff is Paleocene in age.

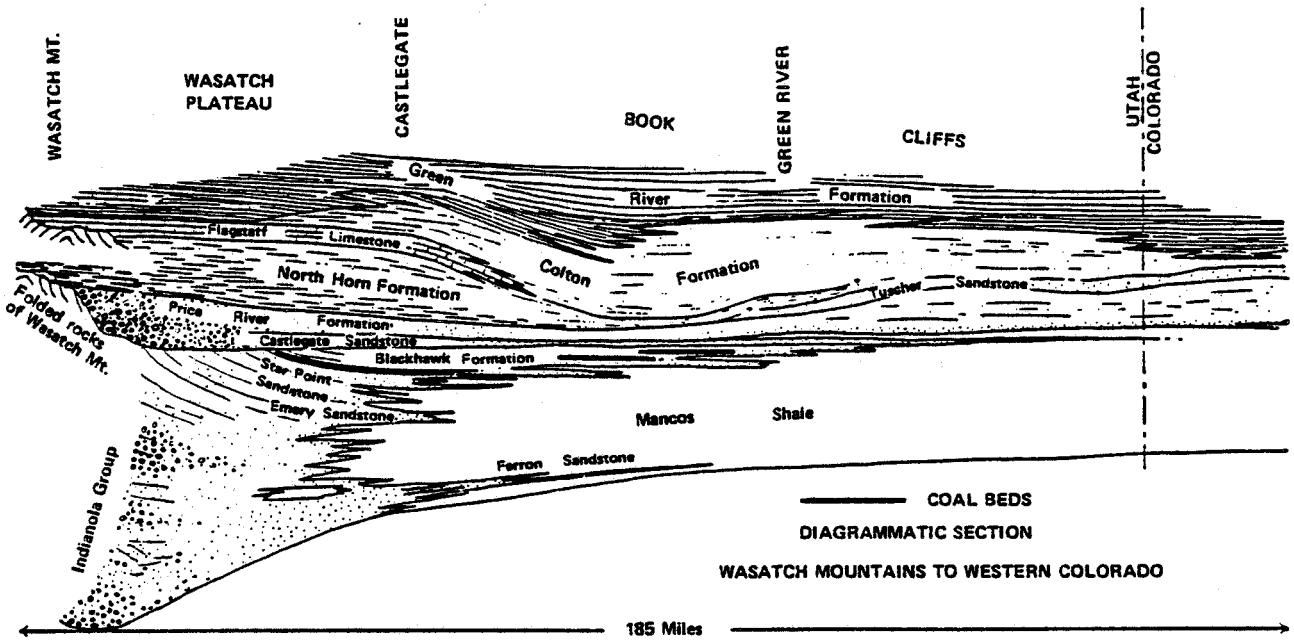

Figure 6. Stratigraphic relationships in central and eastern Utah (modified from Spieker, 1949).

The original thickness of the unit probably varied between 500 and 1,500 feet, but in the central and southern parts of the plateau, only erosional remnants are left. On top of Trail Mountain in the NW¼ sec. 22, T. 17 S., R. 6 E., the following section was measured:

Flagstaff Limestone	Thickness, in feet
Limestone, dense, light gray, thin-bedded, fossiliferous	25.2
Covered slope	79.4
Total Flagstaff Limestone	104.6

North Horn Formation

The stratigraphic relationships of the units just described are shown diagrammatically in figure 6. For stratigraphic work relating to coal, the two key horizons in the field are the top of the Star Point and the top of the Castlegate.

Quaternary Deposits

Unconsolidated Quaternary deposits consist of alluvium (stream channel and valley fill deposits), regolith, glacial drift, moraines (figure 7), and colluvium (including talus) on slopes and at the base of slopes and cliffs. These deposits consist of mixed proportions of clay, silt, sand, and gravel with boulders.

Some examples of alluvial thicknesses are: (1) drill hole 3 in Cottonwood Canyon, 120 feet; (2) drill hole 4 in Cottonwood Canyon, 60 feet; (3) drill hole 5 in Straight Canyon, 5 feet; and (4) drill hole 7 in Horse Fork, 38 feet.

The regolith thickness south of The Cap on North Horn Mountain is 18 feet at drill hole 6. The thickness of the glacial drift in drill hole 8 was 45 feet.

Structure

Tectonically, the Wasatch Plateau is in a transition zone between the relatively stable Colorado Plateau on the east side and the relatively complex and unstable Basin and Range province on the west side. On the west side the strata of the plateau dip into a

Figure 7. A view to the north of upper Cottonwood Canyon. The topography has been modified by Pleistocene glaciation.

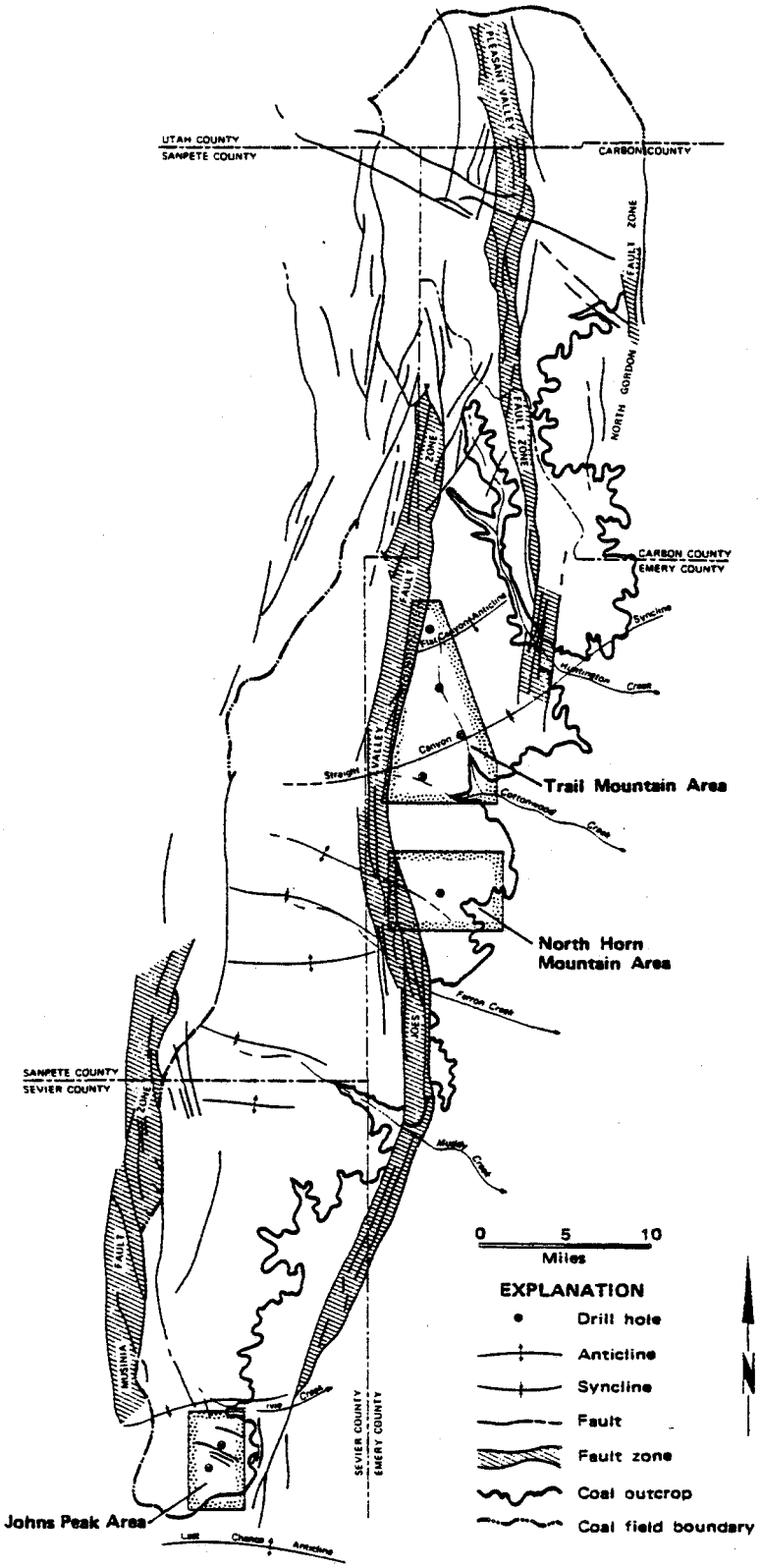

Figure 8. Principal structural features of the Wasatch Plateau coal field.

complexly faulted monocline, whereas on the east side, gentle dips prevail and faults are less numerous.

Faults

Many north-trending vertical or nearly vertical faults displace strata in the coal field. Most of the major faults are in four zones: North Gordon, Pleasant Valley, Joes Valley, and Musinia (figure 8). A fifth zone, called Water Hollow, lies westernmost in the Wasatch Plateau. The principal coal-bearing areas of the plateau, however, all lie east of the Musinia zone.

The North Gordon fault zone is in the northeastern part of the coal field. Most of the faults strike from north to N. 70° W., but a few are diverse and cross-cutting within the zone. The east and west boundary faults do not have the greatest displacement. The fault zone is about 18 miles long in a north-south direction and averages about 4 miles in width. The largest displacement of strata is about 800 feet (Spieker, 1931, p. 54). The North Gordon fault zone does not affect any of the three areas drilled for this project.

The Pleasant Valley fault zone is a north-trending graben with an average width of about 4 miles. The bounding faults have the greatest displacements, up to 1,500 feet, but many splinter faults within the zone have much less. This fault zone extends from the north end of Pleasant Valley southward across Huntington Creek and dies out in the cliffs just north of Cottonwood Creek between Grimes Wash and Danish Bench. Four coal mines—the Co-op, the Deer Creek, and the Beehive and Deseret—have been hampered somewhat by minor faults within this fault zone. The zone lies to the east of the Trail Mountain drilling area.

The Joes Valley fault zone is also a north-south trending graben with the bounding faults having the greatest displacements. The graben is at least 70 miles long and about 2 miles wide. It begins just north of Cleveland Reservoir near upper Huntington Canyon and can easily be traced southward through Scad Valley, Joes Valley, North Dragon, across Ferron Canyon, and south to Ivie Creek and farther. Many minor and subsidiary faults occur within the zone and form numerous fault blocks and wedges. Two prominent horsts in upper Joes Valley are Bald Ridge and Middle Mountain. Along the Joes Valley fault (the east boundary fault of the graben) in sec. 20, T. 17 S., R. 6 E., the Flagstaff Limestone abuts against upper Blackhawk strata; a measured section has proved that the stratigraphic displacement in this vicinity is 2,300 feet. Farther south the graben again cuts adjacent to the Wasatch Plateau as the Paradise fault zone. In the central Wasatch Plateau it marks the west boundary of Trail Mountain and North Horn Mountain. To the south it lies east of the Johns Peak area.

The Musinia fault zone forms the west edge of the Wasatch Plateau coal field in its southern parts. Areas bearing coal that lie to the west are generally assigned to the Salina Canyon coal field. Along Interstate Highway 70 in Salina Canyon the zone is a graben bounded by two major faults; the interior of the graben is faulted as well. The zone trends north-south, and the bounding faults have displacements that locally exceed 2,000 feet.

Many other faults exist locally, most trending north-south. These generally have minor to moderate displacements. In key localities there are east-west trending faults with moderate displacements. One such set cuts the strata in the south area of drilling. Most of these faults have displacements of less than 100 feet. The faults will form effective barriers to mining.

Folds

Most of the strata in the coal field have been gently warped into broad anticlines and synclines that trend northeast or roughly perpendicular to the principal fault zones. The synclines in several places roughly parallel the principal canyons, such as at Ferron Creek and Muddy Creek. In the northern part of the Trail Mountain drilling area is the Flat Canyon anticline. The dip gently lowers the strata southward into the Straight Canyon syncline (plate 3). The axes of both structures trend N. 35° to 40° E., and the syncline plunges to the southwest. The synclinal axis crosses Cottonwood Canyon near drill hole 4 and the dam at Joes Valley reservoir. The strata then gently rise onto a broad anticline probably centered along South Horn Mountain. To the south, Ivie Creek and Tommy Hollow form the approximate east-west axis of a syncline of broad amplitude. From there to the south edge of the field, in the Johns Peak area, the strata rise steadily onto the Last Chance anticline. The dips of strata on the limbs of all of these folds are at most places less than 10 degrees and average 3 or 4 degrees.

Unconformities

The upper Cretaceous formations in the Wasatch Plateau reveal a remarkable succession of mixed and intertonguing marine and continental sediments. Up to the end of the deposition of the Blackhawk strata, these sediments are mainly fine grained, thus indicating relatively long intervals of quiet and uniform conditions. The erosion and flood of the coarse clastics of the Castlegate Sandstone produced an erosional disconformity at the top of the Blackhawk Formation. These coarse continental sediments indicate crustal disturbance to the west and probably the first phase of the

Table 2. Locations, depths, and elevations of drill holes.

Drill hole number	Name	Area	Location	Elevation of collar (feet)	Total depth (feet)
1	Scad Valley	East Mountain	SE¼NE¼ sec. 27, T. 15 S., R. 6 E.	[1]	[1]
2	Little Joes Valley	Trail Mountain	SE¼SW¼ sec. 22, T. 16 S., R. 6 E.	8,750	889.4
3	Dairy Canyon	Trail Mountain	SE¼SE¼ sec. 3, T. 17 S., R. 6 E.	8,350	632.5
4	Roans Canyon	Trail Mountain	SW¼SE¼ sec. 24, T. 17 S., R. 6 E.	7,470	369.6
5	Straight Canyon	Trail Mountain	SW¼NW¼ sec. 3, T. 18 S., R. 6 E.	6,750	460.0
6	Rock Canyon	North Horn Mountain	SE¼SE¼ sec. 3, T. 19 S., R. 6 E.	8,050	1,158.3
7	Horse Fork	Johns Peak	NW¼NE¼ sec. 15, T. 24 S., R. 4 E.	7,965	276.4[2]
8	Johns Peak	Johns Peak	NE¼SE¼ sec. 21, T. 24 S., R. 4 E.	8,570	495.1

[1] Not drilled.
[2] Deepest of three adjacent holes.

Laramide orogeny. The mode of deposition of the Price River Formation produced many intraformational disconformities and local unconformities.

DESCRIPTIONS OF DRILLING

The seven drill holes are listed above with their locations, total depths, and approximate collar elevations (table 2). The elevations were not surveyed but were taken from the most up-to-date topographic maps available. In addition to its number, the well was given a name.

Drill Hole 1, Scad Valley

This hole was not drilled because of environmental objections raised by local officials of the U. S. Forest Service. All holes were chosen near existing roads in places where the least amount of site damage would occur. The proposed site of drill hole 1 was along a dugway rising to the top of East Mountain opposite Horse Canyon. Suitable places to drill were abundant along the lower parts of the dugway road, but it was feared that the east Joes Valley fault was too close or that the locations were west of the fault. At the only sure place the dugway was too narrow for vehicles to be turned around or pits to be dug. After considering all reasonable possibilities, we abandoned the site for drill hole 1 on September 4, 1975.

Drill Hole 2, Little Joes Valley

Drill hole 2 was in Little Joes Valley just east of upper Joes Valley in the SE¼SW¼ sec. 22, T. 16 S., R. 6 E. The elevation of the collar was 8,750 feet. Drilling commenced on August 26, 1975. Coring started at a depth of 600 feet on September 3, 1975. For lithologies and depths the reader should see the drill log in Appendix 1. Coring was stopped at a depth of 889.4 feet on September 18, 1975.

Twenty-one coal seams were drilled or cored in this hole. They ranged in thickness from 0.1 foot to 4.6 feet. The following intervals were submitted for testing: (1) 640.9-644.9 feet (sample WP-2-1), (2) 728.9-732.5 feet (sample WP-2-2), (3) 766.75-769.65 feet (sample WP-2-3), (4) 774.0-777.7 feet (sample WP-2-4), (5) 870.8-874.1 feet (sample WP-2-5), and (6) 874.1-875.4 feet (sample WP-2-6). Core recovery was 100 percent.

Four coal beds are considered minable, using a minimum thickness of 3.5 feet:

Interval (feet)	Thickness (feet)	
(1) 640.9-644.9	4.0	
separation:		84.0
(2) 728.9-732.5	3.6	
separation:		41.6
(3) 774.05-777.7	3.65	
separation:		93.1
(4) 870.8-875.4	4.6	

Coal bed (1) (the Castlegate "A" bed) has 0.5 foot of gray siltstone with coaly partings overlying it. A 4.2-foot bed of fine-grained sandstone overlies the siltstone. Above the sandstone is 0.3 foot of siltstone, 0.2 foot of shale, and 0.2 foot of coal. A 14.9-foot bed of fine- to medium-grained sandstone overlies this sequence. Underneath coal bed (1) is 0.4 foot of dark brown to black shale followed by 0.1 foot of sandstone, 0.2 foot of shale, 0.4 foot of bone coal, 1.5 feet of siltstone, and a 26.0-foot bed of sandstone.

Coal bed (2) (the upper Bear Canyon bed) is overlain by 0.2 foot of bone coal followed by 0.2 foot of black coaly shale. Overlying the shale is 26.8 feet of fine- to coarse-grained sandstone that should be adequate for a mine roof. Underlying coal bed (2) is 0.1 foot of bone coal, 3.1 feet of siltstone, and a 30.3-foot bed of sandstone.

Figure 9. Geologists examine and measure coal cores from the lower part of the Blackhawk Formation.

Coal bed (3) (the Bear Canyon bed) is overlain by 0.1 foot of bone coal followed by 0.15 foot of siltstone, 1.6 feet of sandstone, 0.9 foot of siltstone, 0.4 foot of shale, 0.9 foot of siltstone, 0.35 foot of bone coal, 2.9 feet of coal, 0.5 foot of sandstone, 0.2 foot of shale, and 30.3 feet of fine- to coarse-grained sandstone. Underneath coal bed (3) is 18 feet of gray, calcareous, dense siltstone that should make a good mine floor.

Coal bed (4) (the Hiawatha bed) is overlain by 0.1 foot of bone coal followed by 0.3 foot of black shale, 4.1 feet of siltstone, 0.6 foot of black shale, and a 9.4-foot bed of siltstone. Underneath the Hiawatha seam is 8.5 feet of gray siltstone that should make a good floor.

At the site for drill hole 2 the Blackhawk Formation was 1,039 feet thick of which 155 feet was above the site (plate 4). The lower 250 feet of the unit contains 76 percent of the coal in the formation, the greatest number of beds, and the thickest beds. The lithologies and their percentages for this interval are listed in table 3.

Table 3. Lithologies and percentages in the lower part of the Blackhawk Formation.

Drill hole number	Sandstone (feet)	Siltstone (feet)	Shale (feet)	Coal (feet)	Totals
2	122.2 48.9%	89.95 36.0%	13.6 5.4%	24.25 9.7%	250.0 100.0%
3	181.4 72.6%	39.1 15.6%	13.2 5.3%	16.3 6.5%	250.0 100.0%
4	151.7 60.7%	54.6 21.8%	19.8 7.9%	23.9 9.6%	250.0 100.0%
5	122.7 49.1%	37.5 15.0%	79.2 31.7%	10.6 4.2%	250.0 100.0%
6	97.0 38.8%	107.0 42.8%	30.8 12.3%	15.2 6.1%	250.0 100.0%
7	91.8 50.5%	42.2 23.2%	34.7 19.1%	13.2 7.2%	181.9[1] 100.0%
8	75.7 30.3%	126.8 50.7%	35.9 14.4%	11.6 4.6%	250.0 100.0%

[1] Only this amount was drilled or cored in drill hole 7.

Drill Hole 3, Dairy Canyon

Drill hole 3, Dairy Canyon, was in Cottonwood Canyon just south of Dairy Canyon in the SE¼SE¼ sec. 3, T. 17 S., R. 6 E. The elevation of the collar was 8,350 feet. Drilling commenced on August 12, 1975. Coring began at a depth of 300 feet on August 22, 1975. The cores were carefully examined and logged (figure 9). Coring ended at a depth of 632.5 feet on August 24, 1975. For lithologies and depths the reader should see the drill log in Appendix I.

Twelve coal beds were drilled through or cored in this hole. The coal core from 502.3 to 503.9 feet (sample WP-3-1) was submitted for testing. The 9.3 foot Hiawatha coal core was split into three parts and submitted for analysis: (1) 614.1-616.0 feet (sample WP-3-2), (2) 617.0-620.0 feet (sample WP-3-3), and (3) 620.0-623.8 feet (sample WP-3-4). The core recovery was 100 percent.

The black, lustrous, slightly resinous Hiawatha coal bed, 9.3 feet thick, is the only coal considered minable in this drill hole. If the coal is mined, the roof would consist of thin-bedded shales and siltstones. The mine floor would be excellent, consisting of the medium-grained massive Star Point Sandstone immediately underlying the Hiawatha bed.

At drill hole 3 the Blackhawk Formation was 911.9 feet thick of which 288.4 feet was above the drill site. The lower 250 feet of the unit contains seven coal beds, the thickest coal beds, and 77 percent of the coal in the formation. The various lithologies and their percentages were tabulated for this interval (table 3).

Drill Hole 4, Roans Canyon

Drill hole 4 was in Cottonwood Canyon at the mouth of Roans Canyon in the SW¼SE¼ sec. 24, T. 17 S., R. 6 E. The elevation of the collar was 7,470 feet (figure 10). The drilling commenced on August 5,

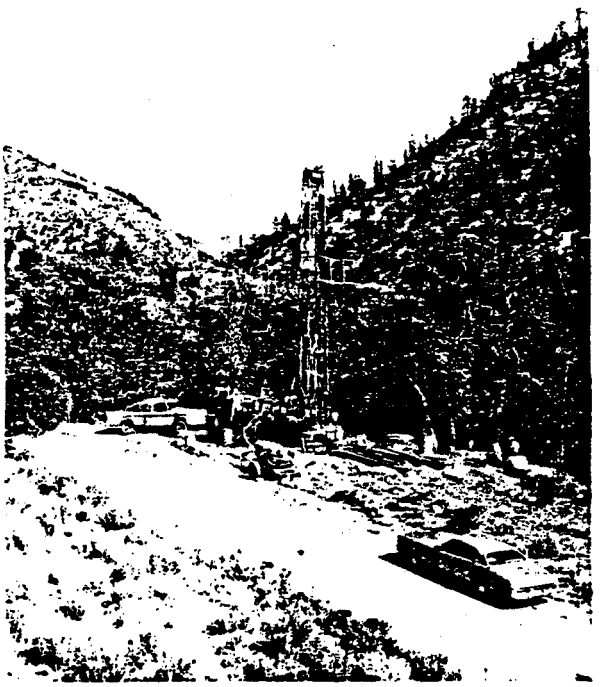

Figure 10. Drill site 4 in Cottonwood Canyon. The view is to the north with the Blackhawk Formation forming the canyon walls.

1975. Coring began at a depth of 158.8 feet on August 7, 1975. Coring ended at a depth of 369.6 feet on August 9, 1975.

Eleven coal beds were cored in this hole. The coal cores from the following intervals were submitted for analysis: (1) 173.6-175.1 feet (sample WP-4-1), (2)267.6-268.9 feet (sample WP-4-2), (3) 270.4-273.3 feet (sample WP-4-3), and (4) 346.6-348.6 feet (sample WP-4-4). The Hiawatha coal core was broken into three samples for analysis: WP-4-5, WP-4-6, and WP-4-7, respectively representing the 352.7-356.1, 357.1-359.4, and 359.4-361.5 foot intervals. The core recovery was 100 percent.

The Hiawatha bed, 8.9 feet thick, is the only coal considered minable. If it is mined, the roof would consist of 1.4 feet of gray, carbonaceous, fissile shale overlain by 2.0 feet of gray, fine-grained sandstone. This sandstone may be fairly competent as a mine roof. Overlying it is 0.4 foot of gray, carbonaceous, fissile shale and a 2.3-foot coal bed.

Underlying the Hiawatha coal is a 3.6-foot siltstone bed that is underlain by the medium-grained, massive Star Point Sandstone.

At drill hole 4 the Blackhawk Formation was 747.3 feet thick of which 382.1 feet was above the drill site. The lower 250 feet of the unit contains 100 percent of the logged coal. The lithologies and their percentages for this interval are tabulated in table 3.

Drill Hole 5, Straight Canyon

Drill hole 5 was in Straight Canyon in the SW¼NW¼ sec. 3, T. 18 S., R. 6 E. The elevation of the collar was 6,750 feet. Drilling commenced on July 7, 1975. Coring began at a depth of 260.0 feet on July 10, 1975. Coring was stopped at a depth of 460.0 feet on July 12, 1975.

Six coal beds were drilled or cored in this hole. Cores from two coal beds were submitted for analysis: (1) 333.65-335.2 feet (sample WP-5-1), (2) 443.6-445.9 feet (sample WP-5-2), (3) 445.9-447.8 (sample WP-5-3), and (4) 448.8-450.9 feet (sample WP-5-4). Numbers (2), (3), and (4) were from the Hiawatha coal bed. The core recovery was 100 percent.

The only coal considered minable in this hole is the Hiawatha bed, 7.5 feet thick. If mined, it would have an excellent roof—20.5 feet of fine-grained sandstone that should be a competent anchor rock. The mine floor would be a 1.3-foot thick siltstone underlain by 1.5 feet of shale. Underneath this shale would be the massive Star Point Sandstone.

At drill hole 5 the Blackhawk Formation was 882.7 feet thick of which 428.8 feet was above the drill site. The lower 250 feet of the unit contains 80.9 percent of the logged coal as well as the thickest beds. The lithologies and their percentages for this interval are tabulated in table 3.

Drill Hole 6, Rock Canyon

Drill hole 6 was at the head of Rock Canyon in the SE¼SE¼ sec. 3, T. 19 S., R. 6 E. The elevation of the collar was 8,050 feet. The hole was spudded on top of the Castlegate Sandstone. Drilling started on July 14, 1975. From 235 to 245 feet a light gray medium-grained sandstone was the basal unit of the Castlegate. The uppermost bed of the Blackhawk Formation, from 245 to 247 feet, was a gray, fine-grained sandstone.

Coring began at a depth of 800 feet on July 23, 1975 and stopped at a depth of 1,158.3 feet on July 29, 1975. The top of the Star Point Sandstone was penetrated at a depth of 1,140 feet.

Fourteen coal beds were drilled or cored in this hole. Coal cores from the following intervals were submitted for testing: (1) 843.4-844.7 feet (sample WP-6-2), (2) 922.3-924.7 feet (sample WP-6-1), and (3) 970.3-973.8 feet (sample WP-6-3). The core recovery was 100 percent.

The only minable coal, and it is marginal, is the 970.3- to 973.8-foot interval (3.5 feet thick) which is correlated with the Bear Canyon bed. If mined, the roof would be a 3.4-foot sandstone overlain by 0.7 foot of black shale and 5.4 foot of sandstone. Underlying the coal would be 1.5 feet of sandstone, 1.2 feet of siltstone, 0.7 foot of coal, 0.4 foot of shale, and 1.9 feet of siltstone.

The Blackhawk Formation was 895 feet thick in this hole (the 245- to 1,140-foot depth interval). The lower 250 feet of the formation contains 10 of the 14 coal beds as well as the thickest one (plate 5). The Hiawatha(?) coal seam at the base of the unit is only 0.6 foot thick. The Star Point Sandstone could not be positively identified. The 895-foot Blackhawk thickness compares favorably with a 895-foot Blackhawk measurement made at the outcrop near the old Anderson mine in Rock Canyon. The lithologies and percentages of strata in the lower 250 feet are listed in table 3.

Drill Hole 7, Horse Fork

Drill hole 7 was drilled in Horse Fork, a tributary to Clear Creek, in the NW¼NE¼ sec. 15, T. 24 S., R. 4 E. The elevation of the collar was 7,965 feet.

A measured section of the Blackhawk Formation in Clear Creek Canyon showed that the unit was about 606 feet thick. Miscalculations due to faulting and a greater than anticipated dip resulted in drilling through the coal beds. The interval from 230 to 276.4 feet was cored and ascertained to be the Star Point Sandstone. We decided to move the rig a few feet and drill another hole (7A) in which the coring was to begin at a depth of 140 feet. Consequently, a 3.5-foot coal bed was cored from 167.8 to 171.3 feet. The Star Point Sandstone was penetrated at a depth of 219.9 feet. However, the cuttings from 65 to 85 feet indicated that we had drilled through another fairly thick coal bed. We again moved the rig a few feet and drilled another hole (7B), coring from 65 to 85 feet. Consequently a 4.25 foot coal bed was cored from 78.55 to 82.8 feet. A composite drill log, which is given in Appendix I, was made for the three holes.

Drilling commenced on drill hole 7 on September 22, 1975. Coring was stopped in hole 7B on October 3, 1975.

Six coal beds were found in these drill holes. Five of them were cored and the other was a thin seam drilled from 138.5 to 139.0 feet. The coal intervals from 78.5-82.8 feet and 167.8-171.3 feet were sampled (samples WP-7-1 and WP-7-2 respectively) and submitted for testing. Core recovery was 100 percent.

The 6.8-foot interval between 78.5 and 85.3 feet is thought to be the upper Ivie(?) seam. The coal bed is split and the upper bench is 4.3 feet thick. If mined, this upper coal would be overlain by 3.6 feet of sandstone, 0.2 foot of shale, 0.9 foot of sandstone, 1.1 feet of siltstone, 0.7 foot of sandstone, and 1.3 feet of siltstone. The split between the coals consists of 0.1 foot of bone coal and 1.1 feet of shale. The lower coal is 1.3 feet thick. Underneath this coal interval is 0.7 foot of shale and 27 feet of fine-grained sandstone that should make a good mine floor.

The black lustrous coal bed, 3.5 feet thick from 167.8 to 171.3 feet, may also be minable, although marginally. This bed has been tentatively correlated with the lower Ivie coal bed. If ever mined, the roof would consist of thin-bedded shales and siltstone, 3.1 feet of shale, and 3.6 feet of siltstone. Underneath the coal bed is 0.1 foot of shale followed by 30.3 feet of sandstone that would be a good mine floor.

At drill hole 7 the Blackhawk Formation was 444.1 feet thick of which 224.2 feet was above the site (plate 6). In the drill hole from the surface to 38.0 feet was alluvium and from 38.0 to 219.9 feet was Blackhawk strata. Thus only 181.9 feet of the lower part of the unit was drilled or cored. The lithologies and their percentages for this interval are given in table 3.

Drill Hole 8, Johns Peak

Drill hole 8 was drilled at the western base of Johns Peak in the NE¼SE¼ sec. 21, T. 24 S., R. 4 E. The elevation of the collar was 8,570 feet. Drilling started on September 24, 1975. Coring began at a depth of 100 feet on the same date. Coring was stopped at a depth of 495.1 feet on September 30, 1975.

Twelve coal beds were cored in this drill hole. They ranged in thickness from 0.1 to 4.0 feet. Coal cores from the 274.4- to 278.4-foot interval (sample WP-8-1) and the 369.8- to 372.9-foot interval (sample WP-8-2) were submitted for testing. Core recovery was 97.3 percent in this drill hole.

The upper Ivie(?) coal bed from 274.4 to 278.4 feet is a black lustrous coal 4.0 feet thick. If mined,

Table 6. Quality characteristics of the Hiawatha bed from mines in the Trail Mountain area. (from Doelling, 1972)

	Trail Mountain mine	Black Diamond mine	Oliphant mine	Wilburg mine	Black Magic mine
Location	SE¼ sec. 25, T. 17 S., 6 E.	NW¼ sec. 12, T. 18 S., R. 6 E.	NE¼ sec. 11, T. 18 S., R. 6 E.	NE¼ sec. 27, T. 17 S., R. 7 E.	SW¼ sec. 28, T.16 S.,R.7E.
Run-of-mine	9 samples	5 samples	1 sample	19 samples	14 samples
Moisture	5.0%	6.8%	4.6%	5.6%	4.9%
Volatile matter	41.6%	42.1%	40.4%	40.8%	42.4%
Fixed carbon	47.1%	44.9%	46.2%	44.5%	46.0%
Ash	6.3%	6.2%	8.8%	9.1%	6.7%
Sulfur	0.6%	0.5%	0.6%	0.6%	0.5%
Btu/lb.	12,850	12,720	12,520	12,300	12,880

Table 7. Proximate analysis of a rider seam above the Hiawatha bed at drill hole 4.

	As received	Moisture free	Moisture-ash free
Moisture	3.3%	–	–
Volatile matter	39.7%	41.1%	47.5%
Fixed carbon	43.9%	45.4%	52.5%
Ash	13.1%	13.5%	–
Sulfur	0.8%	0.83%	0.96%
Btu/lb.	11,920	12,327	14,258

Table 8. Proximate analyses for the Blind Canyon bed and an overlying rider from drill hole 4.

	Rider	Main bed
Moisture	3.0%	2.9%
Volatile matter	43.9%	43.9%
Fixed carbon	42.8%	46.0%
Ash	10.3%	7.2%
Sulfur	0.6%	0.5%
Btu/lb.	12,610	13,070

The upper bed of Grimes Wash appears in drill hole 4 where it is 2.1 feet thick. The Castlegate "A"? coal bed in drill hole 2 is 4.0 feet thick. The Castlegate "A" is an important coal bed that has been mined in areas to the north. The locality probably represents its southernmost extent. At a depth of 641 feet it has a free-swelling index of 2½. Proximate analyses of these coal beds are given in table 10.

West North Horn Mountain Area

Since the coal intersected in drill hole 6, Rock Canyon, is marginal in minable thickness, an examination of coal quality is perhaps academic. The Hiawatha coal, however, thickens eastward and is 13 feet thick at the Axel Anderson mine, SE¼NE¼ sec. 7, T. 19 S., R. 7 E. Only one analysis is available from this mine. Three tests were made of the thin beds at drill hole 6 (table 11).

Johns Peak Area

Four tests were made from two coal beds cored in the Johns Peak area. The two beds are thought to be the upper Ivie and lower Ivie seams. The quality, notably in ash content, diminishes southward. The

Table 9. Proximate analyses of the Bear Canyon group of beds from drill holes 2 and 3.

	Drill hole 2			Drill hole 3	
	Upper Bear Canyon	Upper split Bear Canyon	Lower split Bear Canyon	Bear Canyon	Average of four samples
Moisture	3.2%	3.0%	3.1%	3.0%	3.1%
Volatile matter	38.9%	44.7%	40.7%	44.0%	42.1%
Fixed carbon	47.9%	45.1%	46.4%	42.5%	45.4%
Ash	10.0%	7.2%	9.8%	10.5%	9.4%
Sulfur	0.6%	0.7%	0.8%	0.8%	0.73%
Btu/lb.	12,650	13,260	12,610	12,550	12,768
Free-swelling index	2½	2½	3½	1	

Moist-mineral free Btu/lb. = 14,107 (all 4 samples)

Table 10. Proximate analyses of the Castlegate A? and the upper bed of Grimes Wash.

	Drill hole 2 Castlegate "A"?	Drill hole 4 upper bed of Grimes Wash
Moisture	3.6%	3.2%
Volatile matter	42.0%	38.4%
Fixed carbon	50.8%	43.0%
Ash	3.6%	15.4%
Sulfur	0.6%	0.6%
Btu/lb.	13,470	11,630

tests are compared with an analysis of a sample collected from a semiweathered face in an old mine in a reentrant to Clear Creek Canyon, NW¼ sec. 10, T. 24 S., R. 4 E. (table 12). Proximate analyses for the lower Ivie(?) coal bed in drill holes 7 and 8 are given in table 13.

RESERVE ESTIMATIONS

Although the drill holes for this project were placed far apart as an exploratory effort, nevertheless some calculations can be made to improve the existing reserve estimates. Additional information may refine these figures, but the present estimates are useful for interim decisions. It is important to define terms. Measured, indicated, and inferred reserves have various meanings. In the calculations made for this report a circle with a radius of ½ mile from a reliable control point was drawn and the area within considered the measured reserve. A circle drawn with a radius of 1½ miles from the control point eliminating the measured reserve area provides the area for the indicated reserve. Since the overall areas considered did not exceed 4½ miles from a control point, all other areas not considered for measured or indicated reserve were placed in the inferred category.

Trail Mountain

Four of the seven drill holes partially surrounded Trail Mountain. Additional control points were acquired from reliable outcrops and mines (figure 11). The area considered for reserve calculation is shown on the map, plate 1. The area includes secs. 22, 23, 26, 27, 33-35 in T. 16 S., R. 6 E., secs. 2-4, 8-11, 13-17, 20-29, 32-36 in T. 17 S., R. 6 E., secs. 1-5, T. 18 S., R. 6 E., and sec. 6, T. 18 S., R. 7 E. Isopach contours were drawn for the Hiawatha bed, which underlies the entire area, by using control points with some interpretation by us. The large inferred area (secs. 16, 17, 20-22, 27-29 in T. 17 S., R. 6 E.) is considered to be underlain with 7.5 feet of Hiawatha coal. In the reserve estimation only the areas on the east side of the Joes Valley fault zone were considered.

The condition of the Hiawatha bed in every hole drilled showed it to be without splits. As the outcrop

Table 11. Quality characteristics of coal in drill hole 6 and at the Axel Anderson mine.

	Drill hole 6			Axel Anderson mine
Interval	843.4-844.7	922.2-924.7	970.3-973.8	–
Thickness	1.3	2.3	3.5	12.5
Moisture	4.0%	4.3%	4.3%	6.4%
Volatile matter	41.2%	39.2%	43.0%	40.7%
Fixed carbon	50.5%	48.4%	48.5%	46.6%
Ash	4.3%	8.1%	4.2%	6.3%
Sulfur	0.9%	0.6%	0.6%	0.8%
Btu/lb.	12,720	12,150	12,880	12,200
Free-swelling index	1	1	0	–

Table 12. Proximate analyses for the upper Ivie(?) bed in drill holes 7, 8, and a nearby mine.

	Old mine	Drill hole 7 4.3 feet thick	Drill hole 8 4.0 feet thick
Moisture	12.1%	13.1%	13.7%
Volatile matter	36.2%	32.0%	25.6%
Fixed carbon	47.3%	39.2%	26.3%
Ash	4.4%	15.7%	34.4%
Sulfur	0.4%	0.8%	0.6%
Btu/lb.	10,850	9,440	6,440

Table 13. Proximate analyses for the lower Ivie(?) bed in drill holes 7 and 8.

	Drill hole 7 3.5 feet thick	Drill hole 8 3.1 feet thick
Moisture	11.9%	13.0%
Volatile matter	34.6%	28.3%
Fixed carbon	44.8%	29.1%
Ash	8.7%	29.6%
Sulfur	2.3%	0.5%
Btu/lb.	10,500	7,430

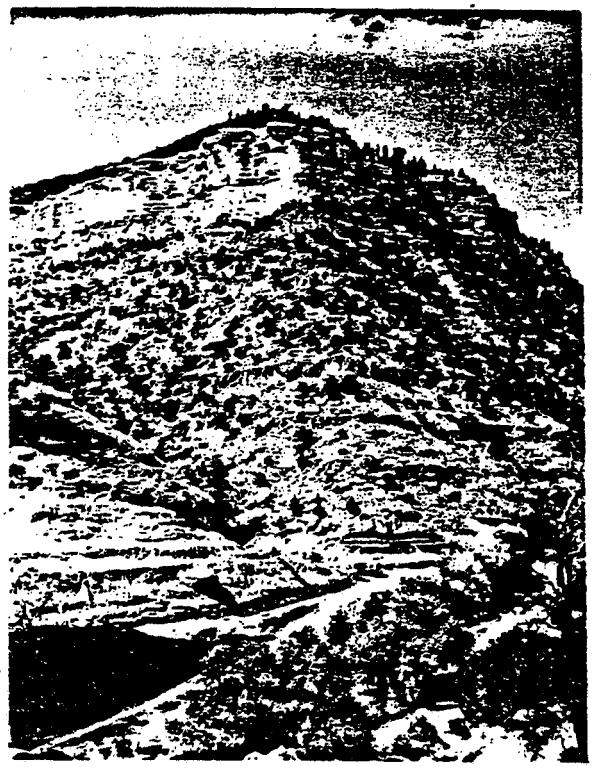

Figure 11. The Trail Mountain mine in Cottonwood Canyon. The Hiawatha coal bed is mined here.

vees into Straight Canyon the bed is split by 1.5 feet of rock with the total coal being 4.8 feet thick (figure 12). This split pinches out before reaching the Oliphant mine where the coal is 5 feet thick. Along the outcrop the Hiawatha bed is oxidized or burned out in many places. In assessing these areas a percentage (usually 15 percent) of the reserve is thrown out and not used in the total estimate. Areas were calculated by using a planimeter on the U. S. Geological Survey topographic map. Rounding and compensatory planimeter error should provide a reasonable reserve estimate. The calculated area amounts to about 23,000 acres (about one 36-square mile township) and the total in place reserve is about 304 million short tons. Tabulated calculations are shown in table 14.

West North Horn Mountain

Plate 1 also shows the West North Horn Mountain area. Not enough data is available to properly evaluate coal reserves. Along the outcrop in Rock Canyon the Hiawatha coal bed thins from approximately 12.5 feet at the Axel Anderson mine westward to 2.5 feet at the canyon vee. At drill hole 6, if correlations are correct, it is only 0.6 foot thick. At present it is our opinion that only the easternmost part of North Horn Mountain will contain thick coal

Figure 12. A view of the Hiawatha coal bed exposed on the north side of Straight Canyon just west of the old Oliphant mine. The man's hand is on a prominent split that pinches out in all directions from this locality.

beds and that little, if any, thick coal can be expected under South Horn Mountain. Additional drill holes are necessary to substantiate this, however.

Johns Peak

Two drill holes and a few reliable outcrops or mine control points permit a reserve estimate of 5¼ sections in the Johns Peak area. Outlying outcrop and mine control points were used to draw the isopach contours on the upper Ivie coal bed (plate 2). The isopach contours show a thinning to the southeast and a thickening to the northwest. It would be folly to extend this thickening northwestward, however, until additional drill hole data are obtained. In previous reports (Spieker, 1931) it appears that the coal bed splits to the northwest.

The mechanics of calculating the Johns Peak area reserve are essentially the same as used for Trail Mountain. Because the area is faulted, a percentage of the acreage was removed to take care of possible shattered zones. Acreages that include closely spaced faults were excluded altogether. The total acreage considered was about 3,080 (4.8 square miles) and the total tonnage a little under 20 million (table 15). The lower limit of minable coal considered is 3.5 feet.

CONCLUSIONS

Trail Mountain Area

The drilling program has shown that the Hiawatha coal bed is minable throughout the area, and calculations provide in place reserves of about 304 million tons. No splits are present except in a small area to the south where the bed vees out in Straight

Table 14. In place reserves, Trail Mountain area.

	Acres	Average coal bed thickness (feet)	Thousands of short tons		
			Measured	Indicated	Inferred
	19.2	10.5	—	351	—
	38.4	10.5	—	—	702
	601.6	9.5	9,957	—	—
	2,124.8	9.5	—	35,163	—
	313.6	9.5	—	—	5,190
	356.8	8.5	7,661	—	—
	2,392.8	8.5	—	35,431	—
	652.8	8.5	—	—	9,665
	806.4	7.5	9,696	—	—
	4,723.2	7.5	—	61,495	—
	6,208.0	7.5	—	—	81,108
	364.8	6.5	4,130	—	—
	1,193.6	6.5	—	13,515	—
	860.8	6.5	—	—	9,747
	211.2	5.5	2,024	—	—
	1,196.8	5.5	—	11,466	—
	102.4	5.5	—	—	982
	332.8	4.5	2,609	—	—
	403.2	4.5	—	3,161	—
Measured	2,873.6		36,077		
Indicated	12,053.6		—	160,582	
Inferred	8,176.0		—	—	107,394
Total	23,103.2			304,053	

Canyon. The thickness ranges from 4.5 to 9.3 feet and averages a little over 7 feet. In most places the mine roof will consist of thin beds of shale, siltstone, and sandstone that may require long rock bolts; however, this is common practice in coal mines. In most places the mine floor would be excellent. It would be a thick siltstone or the Star Point Sandstone. Analyses indicate that the Hiawatha bed contains high volatile B bituminous coal with low sulfur (0.4-0.6 percent), moderately low ash (4.8-9.1 percent), and high heat value (12,300-12,800 Btu/lb.). The area appears to be free of faults, and dips are gentle to moderate (0-7 degrees). The maximum amount of overburden is close to 2,800 feet; the average thickness would be about 2,000 feet. Only the Hiawatha bed is continuous under the area, and any other beds appear to be local.

Table 15. In place reserves, Johns Peak area.

	Acres	Average coal bed thickness (feet)	Thousands of short tons	
			Measured	Indicated
	28.76	7.5	320	—
	66.16	6.5	637	—
	8.63	6.5	—	98
	273.26	5.5	2,225	—
	91.83	5.5	—	748
	620.91	4.5	4,197	—
	693.21	4.5	—	4,671
	283.95	3.5	1,619	—
	1,012.84	3.5	—	4,361
Measured	1,273.04		8,998	
Indicated	1,806.51			10,878
Total	3,079.55		19,876	

North Horn Mountain

Only one drill hole provides information about the coal of North Horn Mountain. Coupled with outcrop data it appears that the Hiawatha bed thins westerly from the Axel Anderson mine in the eastern North Horn Mountain area to the drill site at the head of Rock Canyon. At the Anderson mine the coal seam is 12.5 feet thick, and in the drill hole it is only 0.6 foot thick, if correlations are correct. At present it is our opinion that only the easternmost part of North Horn Mountain contains minable coal. Additional drill holes are recommended to substantiate this and to delineate the minable portions of the area. As at Trail Mountain, faulting has not been detected east of Joes Valley graben. Dips are gentle to moderate. The amount of overburden on the Hiawatha bed ranges from 1,100 to 2,800 feet.

Johns Peak Area

Two drill holes and a few reliable outcrops provide data to partly evaluate the Johns Peak area.

One minable bed was intersected and is believed to be the upper Ivie. The coal bed appears to thin from the northwest to the southeast from 7 to 3.5 feet. Enough data were collected to calculate the reserves of 5¼ sections in the central part of the area surrounding the drill holes. The estimated reserves amount to a little under 20 million tons. The average thickness of the bed is 3.75 feet. The area must be judged marginal, considering present mining technology and economics. The area is further plagued by several east-west trending faults, some of which are very close, possibly creating shatter zones. Such areas were eliminated from the reserve determinations. These faults have displacements large enough to hamper mining. The quality of the coal is relatively good. The rank is high volatile C bituminous with low sulfur (about 0.5 percent), low ash (about 5 percent), but high moisture (about 12 percent), and as-received heat value of 10,850 Btu/lb. In most places the mine roof will consist of thin-bedded sandstone, shale, and siltstone. In general, the mine floor will be good, a fairly thick siltstone or sandstone.

The dips in the area are moderate (3-10 degrees), and overburden will range from 500 to 1,500 feet. Additional drill holes are recommended north of drill hole 7 and south of Interstate Highway 70 where the best chance of finding thicker coal occurs. Faulting seems to be less prevalent in this area as well.

ACKNOWLEDGEMENTS

The U. S. Geological Survey provided funds for the project under contract number 14-08-0001-G-178. We are especially indebted to Howard Albee and Daniel Jobin of the U. S. Geological Survey, Conservation Division, Salt Lake City, Utah, and Denver, Colorado. Mr. Albee was instrumental in obtaining the project funds as well as endorsing and corroborating the drilling program. We appreciate the cooperation of the officials of the Manti-La Sal and Fishlake National Forests, especially John Niebergall, Ira Hatch, and Fred Peck. We extend our gratitude to Leon Green, Dan Purvance, and Jay Call who assisted in logging cores and cuttings and measuring sections and to Sharon Brenner who assisted in preparing drill logs and measured sections.

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APPENDIX I

LOGS OF DRILL HOLES 2,3,4,5,6,7,8

PROJECT Wasatch Plateau Drilling LOCATION SE¼SW¼ sec. 22, T. 16 S., R. 6 E. SHEET 1 OF 12

BEGAN August 26, 1975 COMPLETED September 18, 1975 TOTAL DEPTH OF HOLE 889.4 feet

CORE RECOVERY (%) 100 FEET 289.4 feet GROUND ELEVATION 8,750 feet

HOLE LOGGED BY F. Davis, L. Green, H. Doelling DRILLER Boyles Brothers DRILL HOLE 2

ELEVAT.	DEPTH	LOG	DESCRIPTION
			0 Alluvium: silt, sand and gravel
8740	10		
8730	20		
8720	30		
			33 Shale and shaly sandstone, gray, fine-grained
			39 Sandstone, gray, medium-grained, calcareous, some siltstone
8710	40		
8700	50		
			52 Sandstone, tan, medium-grained, friable, loosely cemented
8690	60		
			64 Shale, gray
			65 Sandstone, light gray, fine-grained; light gray siltstone
8680	70		

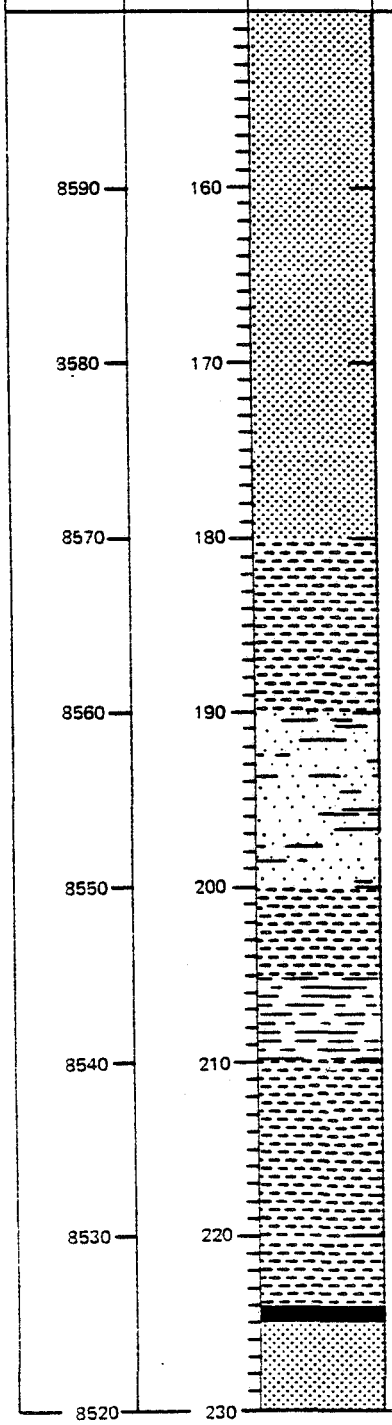
PROJECT Wasatch Plateau Drilling SHEET 2 OF 12

SITE Little Joes Valley D.H. 2

ELEVATION	DEPTH	LOG	DESCRIPTION
			71 Shale, black, fissile
8670	80		81 Sandstone, gray, fine-grained, calcareous
8660	90		
8650	100		
			105 Sandstone, gray, fine-grained, calcareous; some coaly specks
8640	110		
8630	120		
			125 Sandstone, gray, fine-grained, calcareous; some siltstone cuttings
8620	130		
8610	140		140 Sandstone, gray, fine-grained, calcareous, carbonaceous
8600	150		

PROJECT Wasatch Plateau Drilling SHEET 3 OF 12

SITE Little Joes Valley D.H. 2



ELEVATION	DEPTH	DESCRIPTION
		150 Sandstone, gray, fine-grained, calcareous; some dark brown siltstone cuttings
8590	160	
		165 Sandstone, gray, fine-grained, calcareous
8580	170	170 Sandstone, tan, fine-grained, calcareous
		175 Sandstone, tan, fine-grained, calcareous, carbonaceous
8570	180	180 Shale, medium gray to brown
		185 Shale, dark brown to gray, fissile
8560	190	190 Sandstone, medium gray to brown, fine-grained; medium gray to brown siltstone
		195 Sandstone, gray; interbedded with gray shale and siltstone
8550	200	200 Shale, medium gray, fissile
		205 Siltstone, slightly sandy, light to medium gray, calcareous
8540	210	210 Shale, clayey, light gray to black, fissile
8530	220	220 Shale, medium gray to black, fissile
		224 Coal, black
		225 Sandstone, medium gray, fine-grained, calcareous
8520	230	

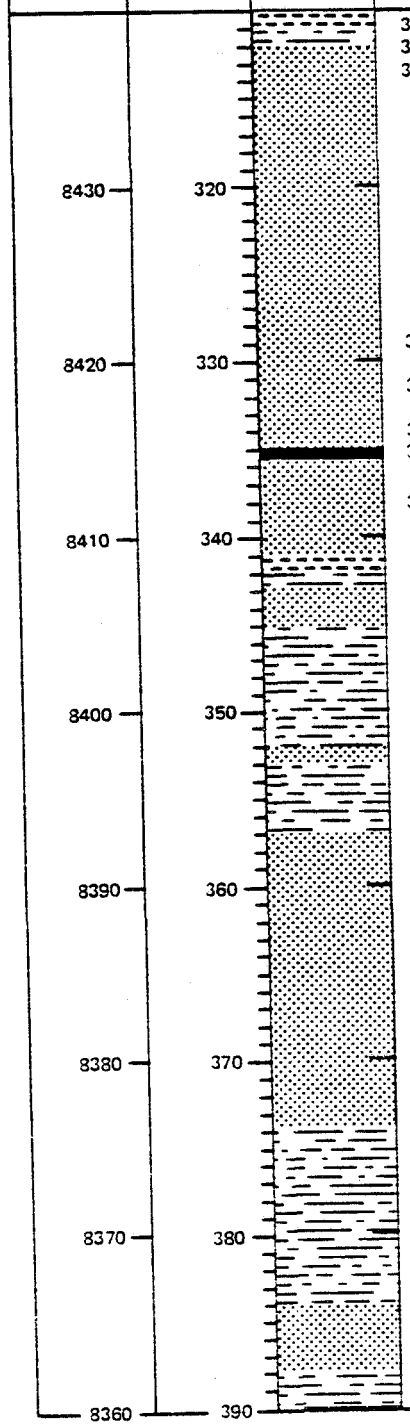
PROJECT Wasatch Plateau Drilling SHEET 4 OF 12

SITE Little Joes Valley D.H. 2

ELEVATION	DEPTH	LOG	DESCRIPTION
			234 Siltstone, dark gray
			236 Sandstone, medium gray, fine-grained, calcareous
			237 Shale, medium gray
8510	240		238 Sandstone and shale interbedded
			241.5 Coal, black
			242 Sandstone, medium gray, fine-grained, calcareous
8500	250		
			257 Coal, black, thin
			257.5 Sandstone, light to medium gray, fine-grained, calcareous
8490	260		
			267 Shale, dark gray
			269 Sandstone, light to medium gray, fine-grained, calcareous
8480	270		270 Shale, medium gray
			271 Sandstone, light to medium gray, fine-grained, calcareous
			277 Siltstone, sandy, medium gray, calcareous
8470	280		281 Shale, dark brown, fissile, highly organic
			283 Sandstone, medium gray, fine-grained, calcareous
			285 Siltstone, dark gray, calcareous
			288 Sandstone, medium gray, fine-grained, calcareous
8460	290		291 Siltstone, medium gray, calcareous
			292 Sandstone, medium gray, fine-grained
			298 Shale, dark gray, organic
			298.5 Coal, black
8450	300		299 Claystone, light gray, calcareous
			303 Sandstone, medium gray, fine-grained, calcareous
			306 Siltstone, medium gray, calcareous
8440	310		

PROJECT Wasatch Plateau Drilling SHEET 5 OF 12

SITE Little Joes Valley D.H. 2



DESCRIPTION

310 Shale, dark gray, fissile
311 Siltstone, medium gray, calcareous
312 Sandstone, medium gray, fine-grained, calcareous

327 Sandstone, medium gray, medium-grained
330 Sandstone, medium gray, fine-grained
332 Sandstone, medium gray, medium-grained
335 Coal, black
335.5 Sandstone, medium gray, fine-grained, calcareous

341 Shale, dark gray, fissile, calcareous
342 Siltstone, light gray, calcareous
343 Sandstone, medium gray, fine-grained, calcareous
345 Siltstone, medium gray, calcareous

352 Sandstone, light gray, fine-grained
353 Siltstone, sandy, medium gray
357 Sandstone, light gray, fine-grained, carbonaceous

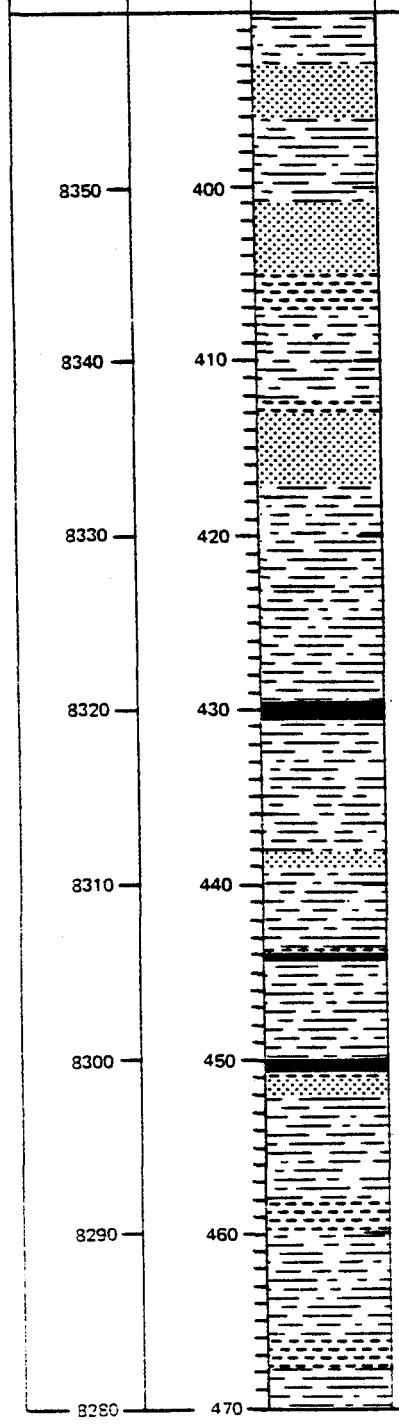
367 Sandstone, medium gray, fine-grained, carbonaceous

374 Siltstone, sandy, medium gray, calcareous

384 Sandstone, light gray, fine-grained, calcareous
388 Siltstone, sandy, dark gray, calcareous

PROJECT Wasatch Plateau Drilling SHEET 6 OF 12

SITE Little Joes Valley D.H. 2



DESCRIPTION

393 Sandstone, light gray, fine-grained, calcareous

396 Siltstone, sandy, dark gray, calcareous

401 Sandstone, light gray, fine-grained, calcareous

405 Shale, black, fissile

407 Siltstone, medium gray

410 Siltstone, dark gray to black, calcareous

412 Shale, black, fissile

413 Sandstone, light gray, fine-grained, calcareous

417 Siltstone, sandy, dark brownish gray

423 Siltstone, sandy, dark brown

426 Siltstone, sandy, dark gray, calcareous

429.5 Coal, black

430 Coal, bone, black; and carbonaceous black shale

430.5 Siltstone, dark gray, calcareous

438 Sandstone, light gray, calcareous

439 Siltstone, dark gray, calcareous

443.5 Shale, black

444.0 Coal, black

444.2 Siltstone, light gray, calcareous

450 Coal, black

450.5 Shale, dark gray

451 Sandstone, light gray, fine-grained

452 Siltstone, medium gray

458 Shale, dark gray, fissile, calcareous

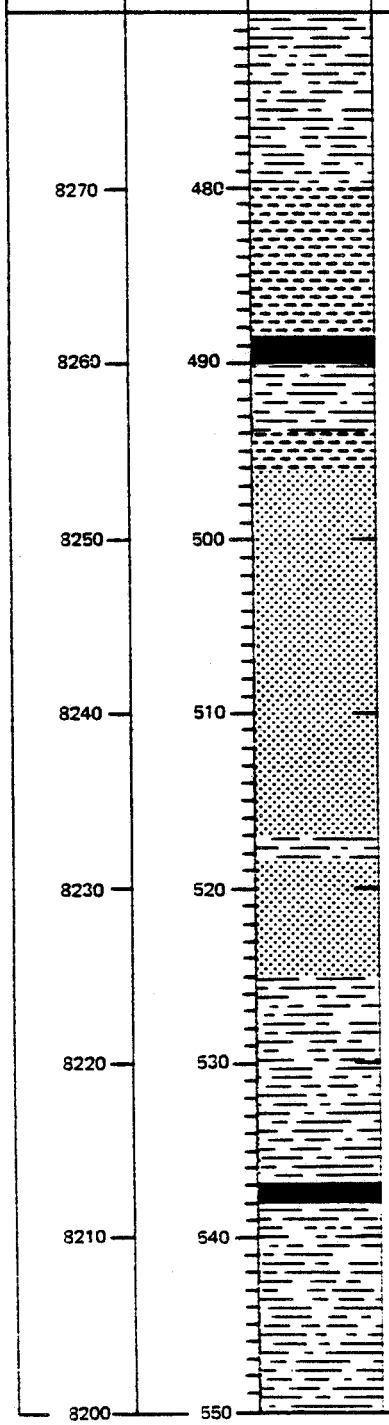
460 Siltstone, medium gray, calcareous

466 Shale, dark gray, calcareous

468 Siltstone, sandy, light gray, calcareous

PROJECT Wasatch Plateau Drilling SHEET 7 OF 12

SITE Little Joes Valley D.H. 2



DESCRIPTION

480 Shale, dark gray, calcareous, thin-bedded

488.5 Coal, black

490 Siltstone, medium gray, calcareous

494 Shale, dark gray, calcareous

496 Sandstone, medium gray, fine-grained, calcareous

509 Sandstone, medium gray, fine-grained, calcareous

517 Siltstone, medium gray, calcareous

518.5 Sandstone, medium gray, fine-grained, calcareous

525 Siltstone, dark gray; shale partings

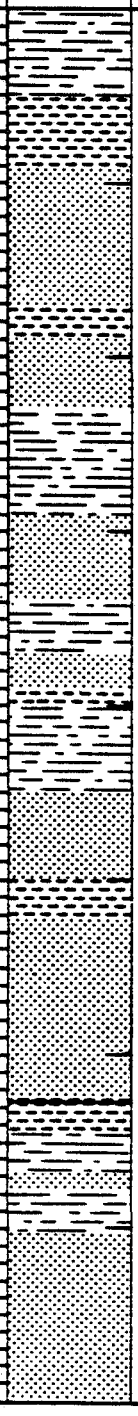
532 Siltstone, sandy, medium gray, calcareous

537 Coal, brownish black

538 Siltstone, dark gray, calcareous; shale partings

PROJECT Wasatch Plateau Drilling SHEET 8 OF 12

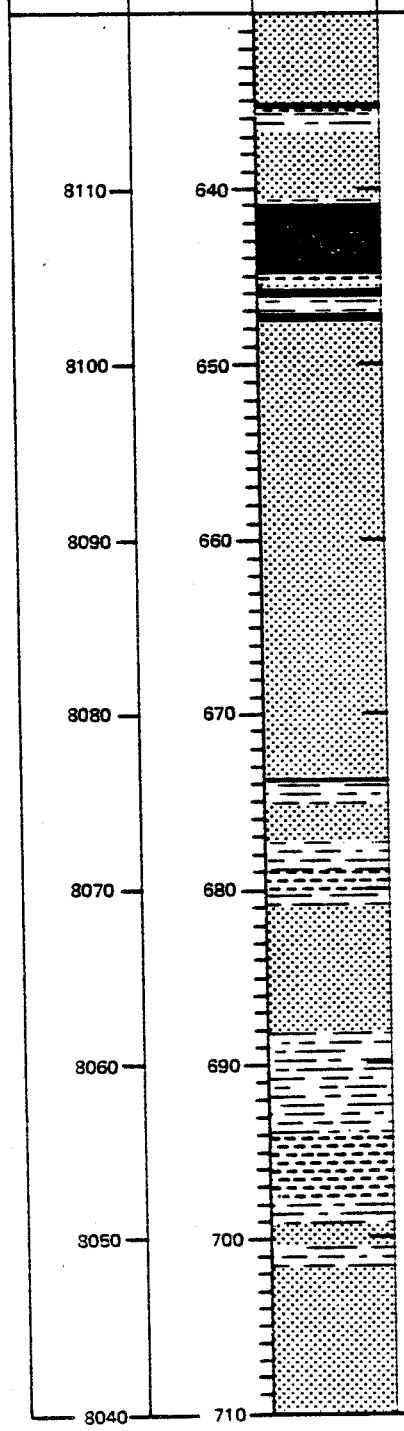
SITE Little Joes Valley D.H. 2



ELEVATION	DEPTH	DESCRIPTION
		555 Shale, dark gray, organic
8190	560	559 Sandstone, light gray, fine-grained, calcareous
		567 Shale, black, fissile, carbonaceous
8180	570	569 Sandstone, light gray to tan, fine-grained, calcareous
		573 Siltstone, sandy, gray to brown, carbonaceous
8170	580	579 Sandstone, light gray, fine-grained, calcareous
		584 Siltstone, sandy, brown, calcareous
		587 Sandstone, light gray, fine-grained, calcareous
8160	590	589 Shale, black, fissile, carbonaceous
		590 Siltstone, sandy, dark gray, carbonaceous
		595 Sandstone, light gray, fine-grained, carbonaceous; interbedded with siltstone
		Began coring
8150	600	600 Shale, silty, black; contains coaly fragments and fossils
		602 Sandstone, medium to light gray, fine-grained, calcareous; irregular laminations
		604.2 Sandstone, light gray, medium-grained, calcareous
		607.9 Sandstone, light to medium gray, medium-grained, calcareous
8140	610	609.3 Sandstone, medium gray, fine- to medium-grained; contains blebs and pieces of siltstone irregularly scattered throughout
		611.6 Sandstone, medium gray, medium-grained, calcareous
		612.4 Shale, black, carbonaceous; contains small bodies of marcasite and coaly twigs
		612.7 Coal, black, marcasitic
		612.8 Shale, dark brown, carbonaceous
		614.2 Siltstone, dark brownish gray, fossiliferous, calcareous
		616.5 Sandstone, medium gray, fine-grained, calcareous
8130	620	617.9 Siltstone, dense, medium gray, calcareous, carbonaceous on bedding planes, fossiliferous
		620.2 Sandstone, medium gray, fine-grained
		621.2 Same but lighter in color, calcareous, becoming coarse grained
		621.6 Sandstone, light grayish tan, fine-grained, calcareous
		623.6 Sandstone, light gray, fine- to medium-grained, calcareous; contorted bedding; carbonaceous material on bedding planes
		626.4 Water saturated
8120	630	

PROJECT Wasatch Plateau Drilling SHEET 9 OF 12

SITE Little Joes Valley D.H. 2



DESCRIPTION

635.1 Coal, hard, black, resinous
635.3 Shale, coaly, blackish brown, fissile
635.5 Siltstone, dark gray, carbonaceous
636.2 Sandstone, dense, medium gray, fine-grained, calcareous, fossiliferous, carbonaceous
636.5 Sandstone, light gray, fine-grained, highly calcareous, resinous; original bedding is highly contorted; becomes more organic
640.4 Siltstone, sandy, dark gray, resinous; marcasitic, coaly partings
640.9 Coal, black, resinous, marcasitic
644.9 Shale, dark brown to black, fissile, highly organic; leaf and wood imprints; gradually becomes sandy
645.3 Sandstone, light gray, fine-grained, slightly calcareous; contorted bedding
645.4 Shale, same as above
645.6 Coal, bone, marcasitic
646.0 Siltstone, sandy, dark brown, carbonaceous; twig and leaf imprints on bedding planes; contorted bedding
647.5 Sandstone, light gray, fine-grained, calcareous
648.8 Same but medium-grained and only occasional carbonaceous material, porous, friable
651.6 Same, medium-grained, no carbonaceous partings

672.8 Same but numerous coaly partings and woody debris
673.5 Shale, black, fissile; numerous coaly partings
673.6 Coal, bony
673.7 Siltstone, dark gray to black, calcareous; wood imprints after 0.2 foot; grades into fine-grained sandstone; contorted bedding
675.3 Sandstone, medium gray, medium-grained, calcareous; some carbonaceous films on bedding planes
676.5 Same, dense, fine-grained
677.1 Siltstone, medium dark gray, calcareous, sandy; numerous shaly partings; marcasitic, coaly specks, pelecypod
679.0 Shale, dark brown to black, fissile; coaly partings; marcasitic partings
679.4 Coal, bone, marcasitic, resinous
679.8 Shale, black; carbonaceous with thin streaks of coal; vegetative debris
680.5 Siltstone, dark brown, carbonaceous
681.0 Sandstone, medium gray, fine-grained, calcareous
688.1 Siltstone, sandy, dense, dark gray, calcareous, fossiliferous (gastropods)
690.1 Siltstone, sandy, dense, light gray to tan, calcareous, fossiliferous (gastropods)
691.2 Siltstone, sandy, dense, dark gray, calcareous, fossiliferous (gastropods)
694.0 Shale, black, coaly, marcasitic, fossiliferous, argillaceous, fissile

697.9 Siltstone, sandy, brown-black, carbonaceous; vegetal material on bedding planes
698.7 Silstone, dark gray, slightly calcareous; fractures filled with pyrite and coal; marcasitic
699.3 Sandstone, medium gray, calcareous, fine-grained; vegetal material on bedding planes
700.6 Siltstone, slightly sandy, dark gray, calcareous; carbonaceous material on bedding planes
701.7 Sandstone, dense, medium gray, fine-grained, some carbonaceous material and coaly specks; marcasitic

706.7 Sandstone, light gray, fine-grained, calcareous, friable; contorted bedding; carbonaceous films; shaly partings; several coaly partings

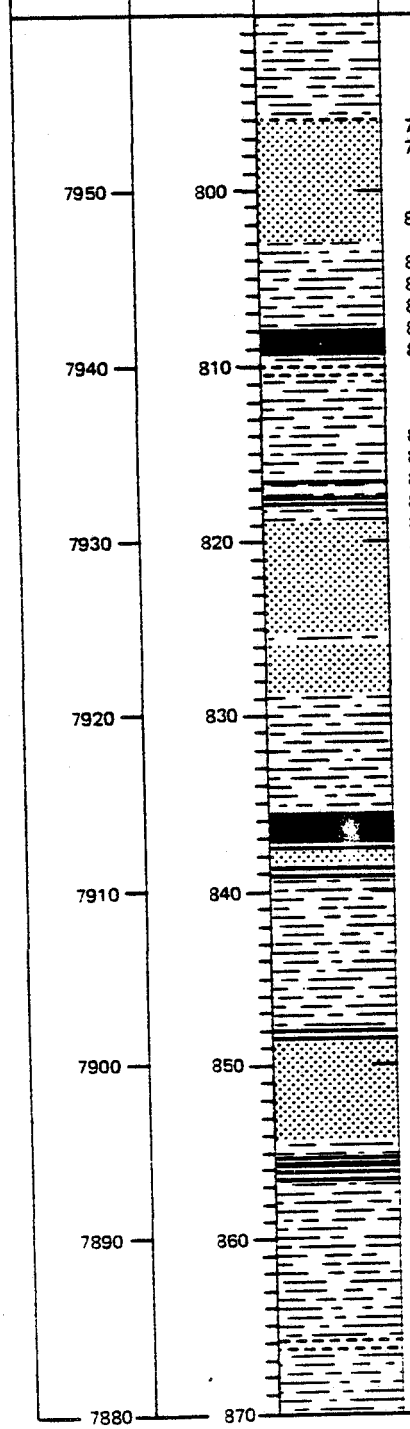
PROJECT Wasatch Plateau Drilling SHEET 10 OF 12

SITE Little Joes Valley D.H. 2

ELEVATION	DEPTH	LOG	DESCRIPTION
			717.0 Sandstone, light to medium gray, fine- to coarse-grained, calcareous, friable; contorted bedding, carbonaceous; shaly partings; several coaly partings
8030	720		
			728.5 Shale, black, coaly
			728.7 Coal, bone
8020	730		728.9 Coal, black, resinous
			732.5 Coal, bone
			732.6 Siltstone, dark gray, carbonaceous, calcareous
			735.7 Sandstone, light gray, fine-grained, calcareous; carbonaceous film on bedding planes
			736.7 Sandstone, light gray, fine-grained, calcareous; carbonaceous film on bedding planes; contorted bedding
8010	740		
			748.0 Sandstone, medium gray, medium-grained, calcareous, porous, friable; contorted bedding; shaly partings
8000	750		
			752.0 Sandstone, medium gray, coarse-grained, calcareous, porous, friable; contorted bedding, massive; shaly partings
7990	760		
			766.0 Shale, brown black, fissile
			766.2 Sandstone, light gray, fine-grained, calcareous; blebs of shaly clay; carbonaceous films on bedding planes
			766.7 Coal, bone
7980	770		766.75 Coal, black, shiny, resinous
			769.65 Coal, bone; some coaly partings
			770.0 Siltstone, medium gray, calcareous; coaly partings
			770.9 Shale, black, carbonaceous; argillaceous in places; fissile in places
			771.3 Siltstone, medium gray to tan, carbonaceous; contorted bedding
			772.2 Sandstone, medium gray, fine-grained, calcareous; contorted bedding; carbonaceous films on bedding planes
			773.8 Siltstone, slightly sandy, medium gray, resinous
7970	780		773.95 Coal, bone
			774.05 Coal, black, brittle
			777.7 Siltstone, dense, medium gray, calcareous; several coaly partings; contorted bedding
			780.2 Siltstone, sandy, dense, medium gray, calcareous; several coaly partings; contorted bedding
7960	790		

PROJECT Wasatch Plateau Drilling SHEET 11 OF 12

SITE Little Joes Valley D.H. 2



DESCRIPTION

795.7 Shale, gray, fissile, carbonaceous
796.0 Sandstone, medium gray, fine-grained, calcareous; contorted bedding

802.9 Siltstone, medium gray, calcareous; contorted bedding; shaly partings; few thin sandstone beds
807.6 Coal, bone
807.9 Coal, black, granular, shiny
809.2 Siltstone, medium gray, calcareous; carbonaceous material on bedding planes
809.9 Shale, dark gray, fissile
810.5 Siltstone, medium gray, calcareous; carbonaceous material; coaly and shaly partings

816.4 Shale, black, carbonaceous
816.6 Siltstone, medium gray, carbonaceous
817.1 Shale, black, carbonaceous; some coaly partings
817.4 Coal, hard, black
817.5 Shale, black to brown, carbonaceous; some coaly partings
817.8 Siltstone, dark gray, calcareous; carbonaceous material; some shaly partings
818.8 Sandstone, medium gray, fine-grained, calcareous
822.9 Sandstone, dense, medium gray, fine-grained, calcareous; contorted bedding, carbonaceous films; some coaly partings
825.0 Siltstone, medium gray, calcareous; carbonaceous material; coaly partings
825.6 Sandstone, medium gray, fine-grained; shaly partings

828.6 Siltstone, slightly sandy, medium gray, calcareous; carbonaceous material throughout; some shaly partings; some coaly partings; also thin sandstone lenses

835.5 Shale, black, fissile, carbonaceous
835.7 Coal, bone
835.9 Coal, black, shiny, blocky
837.0 Coal, bone
837.1 Shale, dark gray, fissile, carbonaceous
837.7 Sandstone, medium gray, fine-grained; contorted bedding
838.3 Shale, black, fissile, carbonaceous
839.4 Siltstone, dense, medium gray, calcareous; wood and leaf imprints on bedding planes

847.8 Shale, black, fissile, carbonaceous
848.3 Sandstone, medium gray, fine-grained, calcareous; contorted bedding; wood and leaf imprints on bedding planes

854.1 Siltstone, dense, medium gray, calcareous; wood and leaf imprints on bedding planes
855.1 Shale, black, fissile, carbonaceous
855.3 Coal, black, brittle
855.6 Coal, bone
855.7 Shale, black, fissile, carbonaceous
856.4 Siltstone, dark gray; carbonaceous matter on bedding planes

865.8 Shale, black, fissile, coaly
866.4 Siltstone, dark gray, calcareous, fossiliferous, carbonaceous

ELEVATION	DEPTH	LOG	PROJECT Wasatch Plateau Drilling SHEET 12 OF 12 SITE Little Joes Valley D.H. 2 DESCRIPTION
			870.5 Shale, black, fissile, carbonaceous 870.7 Coal, bone 870.8 Coal, black, shiny, brittle; the Hiawatha bed 875.4 Coal, bone 875.5 Siltstone, medium gray; wood and leaf imprints on bedding planes; contorted bedding; shaly partings
7870	880		
			884.0 Sandstone, light gray, medium- to coarse-grained, calcareous; mostly rounded quartz grains (Star Point Sandstone) 889.4 Total depth drill hole 2
7860	890		
	900		

PROJECT Wasatch Plateau Drilling LOCATION SE¼SE¼ sec. 3, T. 17 S., R. 6 E. SHEET 1 OF 9

BEGAN August 13, 1975 COMPLETED August 24, 1975 TOTAL DEPTH OF HOLE 632.5 feet

CORE RECOVERY (%) 100 FEET 332.5 feet GROUND ELEVATION 8,350 feet

HOLE LOGGED BY F. Davis, L. Green, J. Call DRILLER Boyles Brothers DRILL HOLE 3

ELEVAT.	DEPTH	LOG	DESCRIPTION
			0-72 Alluvium; silt, sand and gravel
8340	10		
8330	20		
8320	30		
8310	40		
8300	50		
8290	60		
8280	70		

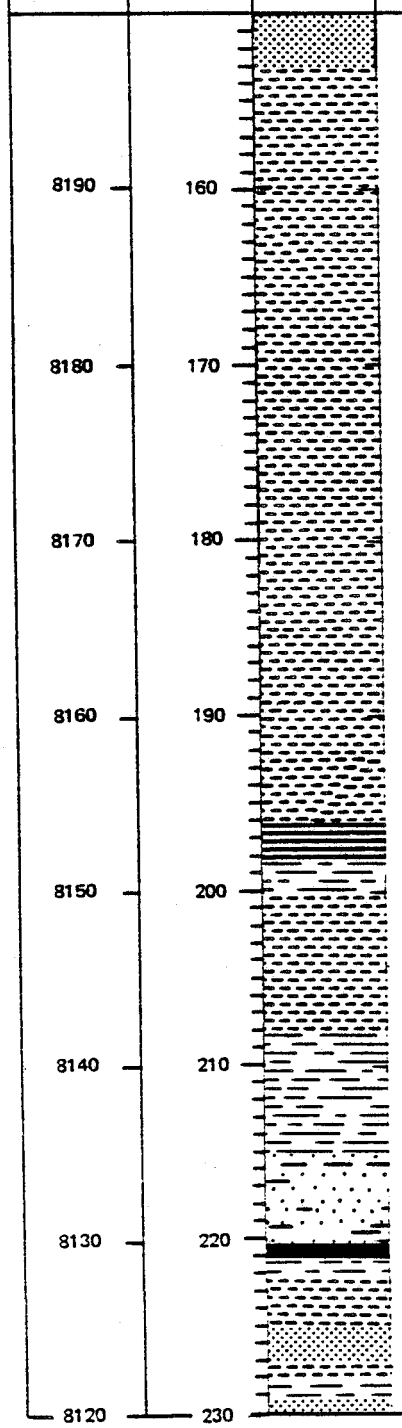
PROJECT Wasatch Plateau Drilling SHEET 2 OF 9

SITE Dairy Canyon D.H. 3

ELEVATION	DEPTH	LOG	DESCRIPTION
			72 Sandstone boulder, gray, fine-grained
8270	80		82 Alluvium; silt, sand and gravel; water entering hole
8260	90		
8250	100		
8240	110		
8230	120		120 Shale, gray, fissile
8220	130		129 Sandstone, tan, fine-grained, water-saturated; artesian flow of 150 gallon/minute
8210	140		143 Shale, gray, fissile
			145 Coal
			146 Shale, gray, fissile
8200	150		

PROJECT Wasatch Plateau Drilling SHEET 3 OF 9

SITE Dairy Canyon D.H. 3



DESCRIPTION

157 Sandstone, medium gray, fine-grained

160 Shale, light gray, fissile

196 Shale, black, fissile, carbonaceous
198 Siltstone, gray, nonfissile
200 Shale, black, fissile

208 Siltstone, medium gray

215 Siltstone; interbedded with light gray, fine-grained sandstone

220 Coal, hard, black
221 Siltstone, sandy, light gray
222 Shale, black, fissile

225 Sandstone, light gray, fine-grained
227 Shale, hard, black
228 Siltstone, sandy, brown
229 Sandstone, light gray, fine-grained

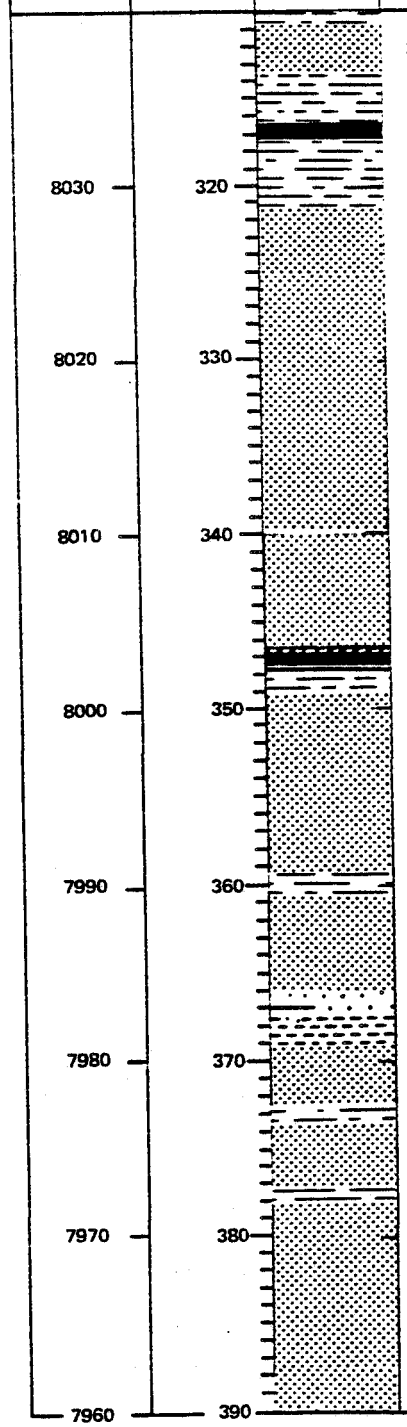
PROJECT Wasatch Plateau Drilling SHEET 4 OF 9

SITE Dairy Canyon D.H. 3

ELEVATION	DEPTH	LOG	DESCRIPTION
			231 Shale, dark gray, fissile
			233 Siltstone, light gray
			236 Shale, dark gray, fissile
			238 Siltstone, dark brown
8110	240		240 Sandstone, light gray, fine-grained
			244 Shale, dark gray, fissile
			246 Siltstone, light gray
			248 Shale, dark gray, fissile
8100	250		250 Sandstone, light gray, fine-grained
			255 Shale, dark gray, fissile
8090	260		
			264 Sandstone, light gray, fine-grained
			266 Shale, black, carbonaceous; some coaly specks
8080	270		269 Siltstone, gray
			271 Sandstone, light gray, fine-grained; coal specks
			273 Shale, dark gray, fissile
			278 Sandstone, light gray
8070	280		280 Siltstone, slightly sandy, light gray
			282 Sandstone, light gray, fine-grained
			284 Siltstone, light gray
8060	290		290 Sandstone, light gray, fine-grained
			292 Shale, dark gray to black, fissile
			294 Siltstone, slightly sandy, light gray
			296 Shale, black, fissile
8050	300		300.0 Coring began
			300.3 Siltstone, medium gray, fossiliferous
			303.4 Coal, black, brittle, fractured
			304.1 Coal, bone
			304.5 Siltstone, dark gray
			305.2 Sandstone, light gray, fine-grained
			306.7 Siltstone, medium gray, calcareous
			308.6 Sandstone, light gray, fine-grained
8040	310		309.9 Siltstone, soft, dark gray

PROJECT Wasatch Plateau Drilling SHEET 5 OF 9

SITE Dairy Canyon D.H. 3



DESCRIPTION

310.7 Sandstone, medium gray, fine-grained
313.7 Siltstone, medium gray, calcareous

316.6 Coal, black, shiny, resinous
317.4 Siltstone, dark gray

321.3 Sandstone, dark gray; shale and coal partings

346.5 Coal, bone, resinous
346.9 Coal, black, brittle; some resin
347.6 Shale, black, carbonaceous, fissile
348.1 Siltstone, light to medium gray
349.0 Sandstone, light gray, fine-grained, friable

359.6 Siltstone, dark gray, carbonaceous
360.4 Sandstone, medium gray, fine-grained, calcareous

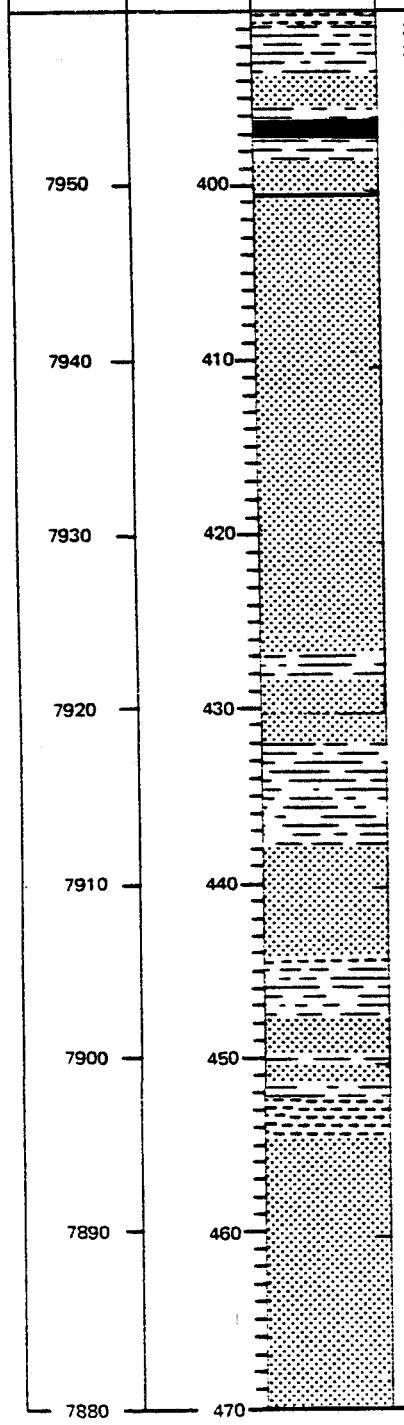
366.5 Siltstone and interbedded sandstone; medium gray
367.2 Shale, black, fissile
368.9 Sandstone, light gray, fine-grained
372.6 Siltstone, dark brown; coaly streaks
373.6 Sandstone, light gray, fine-grained

377.6 Siltstone, medium to dark gray, calcareous
378.2 Sandstone, medium gray, fine-grained

389.8 Shale, gray, fissile
390.5 Siltstone, dark gray

PROJECT Wasatch Plateau Drilling SHEET 6 OF 9

SITE Dairy Canyon D.H. 3



DESCRIPTION

393.3 Sandstone, medium gray, fine-grained
395.4 Siltstone, medium gray; shale and coal partings

396.3 Coal, black, granular
397.1 Siltstone, dark gray; coaly streaks
398.7 Sandstone, light to medium gray, fine-grained
400.1 Shale, black, carbonaceous; coaly partings
400.6 Sandstone, porous, medium gray, fine-grained, water-saturated

426.4 Siltstone, dark gray, carbonaceous
428.0 Sandstone, medium gray, fine-grained

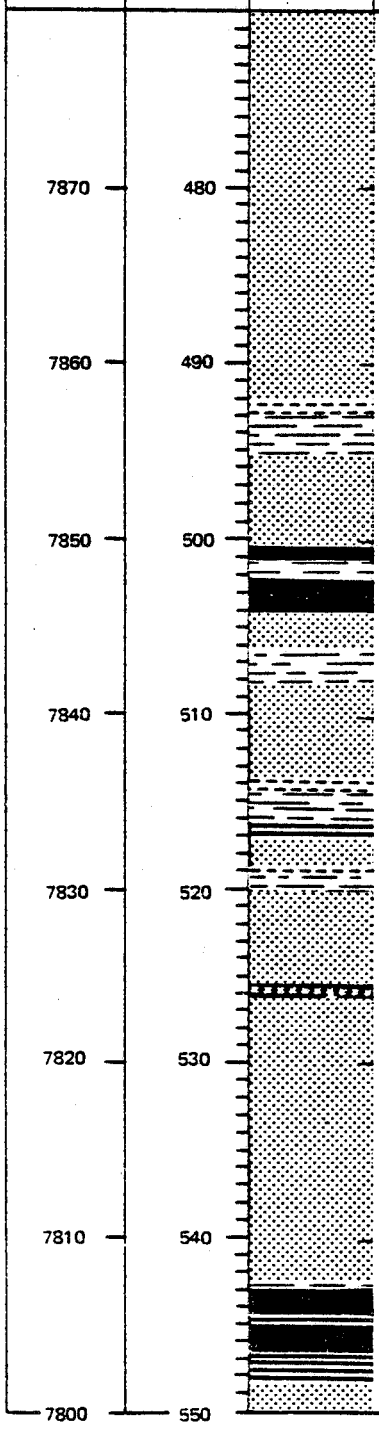
431.8 Siltstone, dark gray to brown; coaly partings

437.5 Sandstone, medium gray, fine-grained

443.9 Shale, dark gray; coaly partings
444.4 Siltstone, dark gray, highly organic
447.5 Sandstone, medium gray, fine-grained
449.4 Siltstone, dark brownish gray; wood imprints
450.2 Sandstone, medium gray, fine-grained
451.0 Siltstone, medium gray, organic
452.3 Shale, sandy, medium gray; coaly partings
454.2 Sandstone, light gray, medium-grained

PROJECT Wasatch Plateau Drilling SHEET 7 OF 9

SITE Dairy Canyon D.H. 3



DESCRIPTION

492.2 Shale, dark brown, fissile; coaly partings
493.2 Siltstone, dark brown; wood imprints
495.6 Sandstone, light gray, fine-grained

500.6 Coal, black
501.1 Siltstone, dark gray; coal partings
501.9 Coal, black, resinous; sample WP-3-1
503.9 Sandstone, medium gray, fine-grained

506.3 Siltstone, medium gray, thinly laminated
508.0 Sandstone, medium gray, fine-grained

513.8 Shale, gray, fissile; coaly partings
514.3 Siltstone, light gray
516.3 Shale, black, carbonaceous, resinous
517.3 Sandstone, medium gray, fine-grained
518.7 Shale, black, fissile

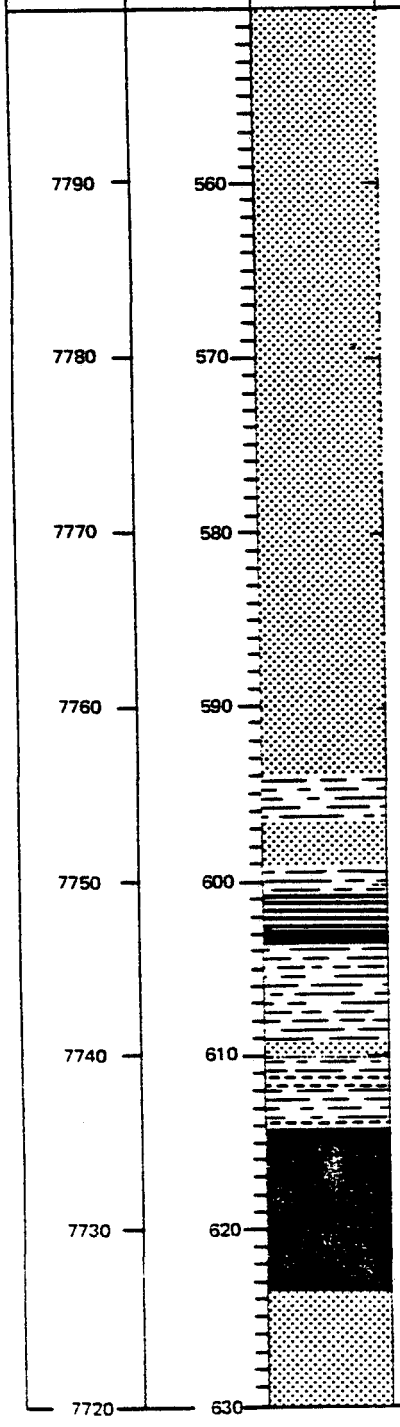
519.2 Siltstone, slighty sandy, dark gray
520.3 Sandstone, medium gray, fine-grained

525.5 Coal, bone
526.2 Sandstone, light gray, fine-grained

542.4 Siltstone, light gray, calcareous
542.9 Coal, black, shiny, resinous
544.3 Shale, black, coaly
545.1 Coal, black, dull
546.4 Shale, black, carbonaceous
548.1 Sandstone, light gray, fine-grained

PROJECT Wasatch Plateau Drilling SHEET 8 OF 9

SITE Dairy Canyon D.H. 3



DESCRIPTION

593.9 Siltstone, dark brownish gray
596.3 Sandstone, light gray, fine-grained; contorted bedding
599.0 Siltstone, medium gray; coal specks

600.7 Shale, dark brown, fissile, carbonaceous
602.5 Coal, black, resinous, highly fractured
603.4 Siltstone, dark gray; fossiliferous, wood imprints
609.2 Sandstone, silty, medium gray, fine-grained

610.3 Siltstone, medium gray; wood imprints
610.9 Shale, dark brown, fissile
611.8 Siltstone, sandy, medium gray; wood imprints
613.5 Shale, dark gray, fissile; coaly partings
614.1 Coal, black, resinous; Hiawatha bed; samples WP-3-2, WP-3-3, WP-3-4

623.5 Sandstone, tan, medium-grained; Star Point Sandstone

ELEVATION	DEPTH	LOG	PROJECT Wasatch Plateau Drilling SHEET 9 OF 9 SITE Dairy Canyon D.H. 3 DESCRIPTION
			632.5 Total depth, August 24, 1975
7710	640		

PROJECT Wasatch Plateau Drilling LOCATION SW¼SE¼ sec. 24, T. 17 S., R. 6 E. SHEET 1 OF 5

BEGAN August 5, 1975 COMPLETED August 9, 1975 TOTAL DEPTH OF HOLE 369.6 feet

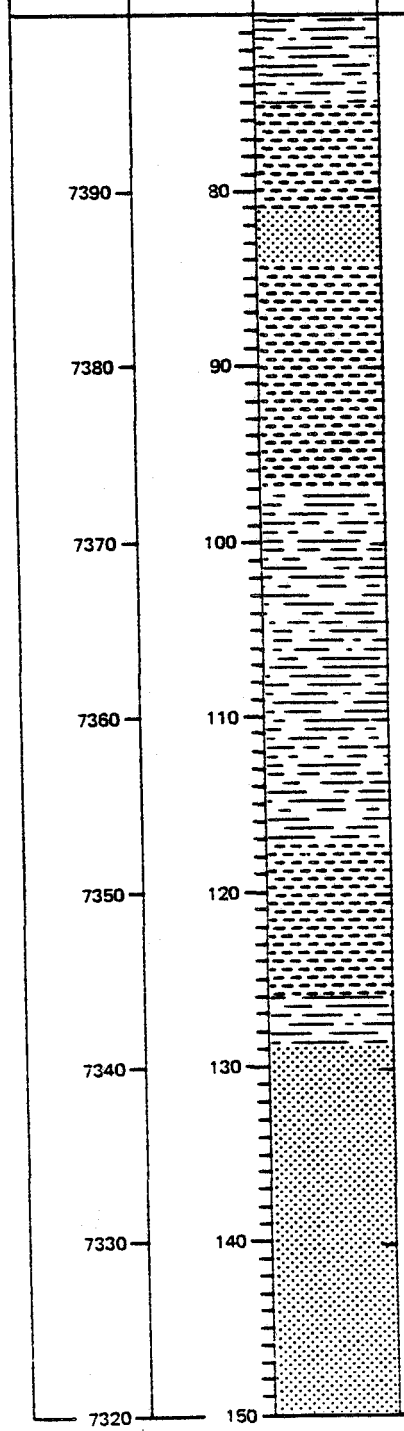
CORE RECOVERY (%) 100 FEET 210.8 feet GROUND ELEVATION 7,470 feet

HOLE LOGGED BY H. Doelling, F. Davis, L. Green, J. Call DRILLER Boyles Brothers DRILL HOLE No. 4

ELEVAT.	DEPTH	LOG	DESCRIPTION
			0 Alluvium; silt, sand and gravel
7460	10		
7450	20		
7440	30		
7430	40		
7420	50		
7410	60		60 Sandstone, tan, medium-grained
			67 Siltstone, black
7400	70		

PROJECT Wasatch Plateau Drilling SHEET 2 OF 5

SITE Roans Canyon D.H. No. 4



DESCRIPTION

75 Shale, black, fissile

81 Sandstone, medium gray, fine-grained

84 Shale, gray, fissile

97 Siltstone, dark gray, calcareous

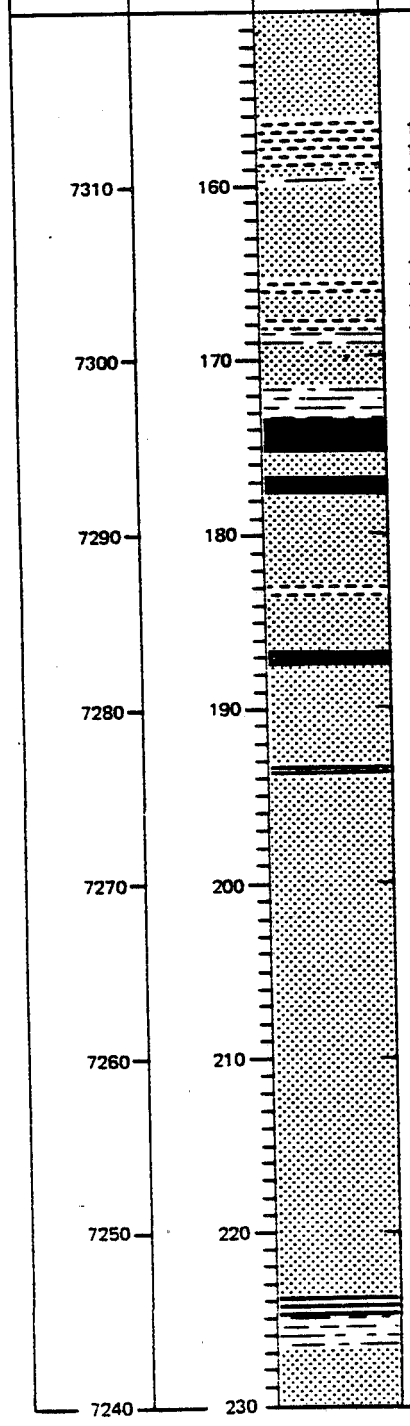
117 Shale, dark gray, fissile

126 Siltstone, medium gray

128.5 Sandstone, medium gray, fine-grained

PROJECT Wasatch Plateau Drilling SHEET 3 OF 5

SITE Roans Canyon D.H. No. 4



DESCRIPTION

156 Shale, black to dark gray, fissile
158.8 Sandstone, medium gray, fine-grained Coring began
159.3 Siltstone, sandy, dark gray; coaly streaks
160.1 Sandstone, dark gray, fine- to medium-grained

165.4 Mudstone, black, argillaceous
166.4 Sandstone, dark gray, fine-grained
167.7 Shale, black, carbonaceous
168.5 Siltstone, sandy, dark gray
169.4 Sandstone, fine-grained
171.4 Siltstone, dark gray; coaly particles
173.6 Coal, black, shiny; sample WP-4-1
175.65 Sandstone, dark gray, fine-grained
176.65 Coal, brittle, shiny; scattered pyrite
177.6 Sandstone, fine- to medium-grained

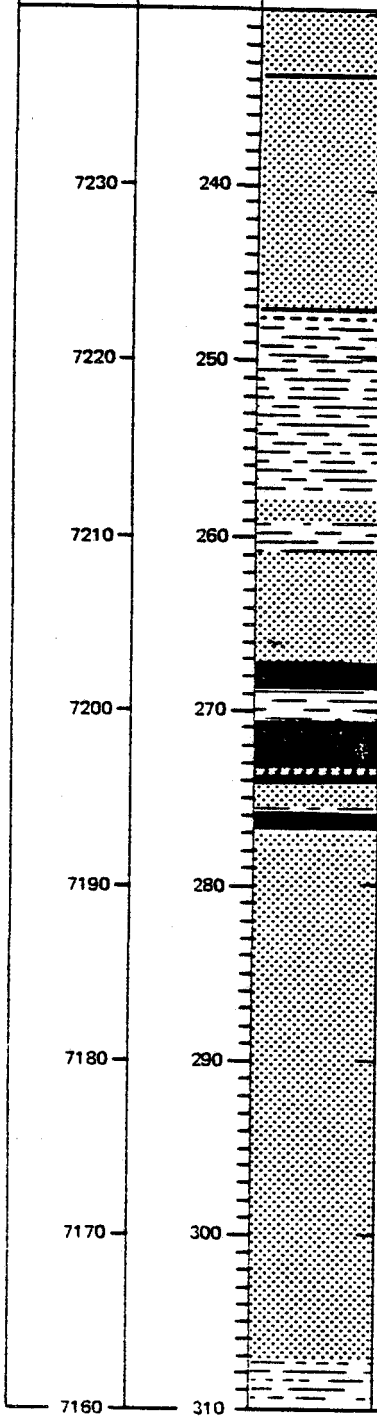
183.1 Mudstone, dark gray; contorted laminations
183.8 Sandstone, medium gray, fine-grained
186.8 Coal, black, resinous (upper 2 inches), shiny
187.8 Sandstone, medium gray, fine-grained

193.7 Shale, dark brown, carbonaceous
194.2 Sandstone, medium gray, fine- to medium-grained

223.8 Shale, dark brown, carbonaceous, argillaceous
224.9 Siltstone, sandy, medium gray to brown
226.4 Sandstone, medium gray, fine-grained

PROJECT Wasatch Plateau Drilling SHEET 4 OF 5

SITE Roans Canyon D.H. No. 4



DESCRIPTION

233.5 Shale, dark brown, carbonaceous
233.9 Sandstone, dark gray to dark brown, fine-grained, carbonaceous

246.8 Shale, black, carbonaceous, coaly, fissile
247.3 Shale, gray, argillaceous, fissile
247.8 Siltstone, light brown, fossiliferous

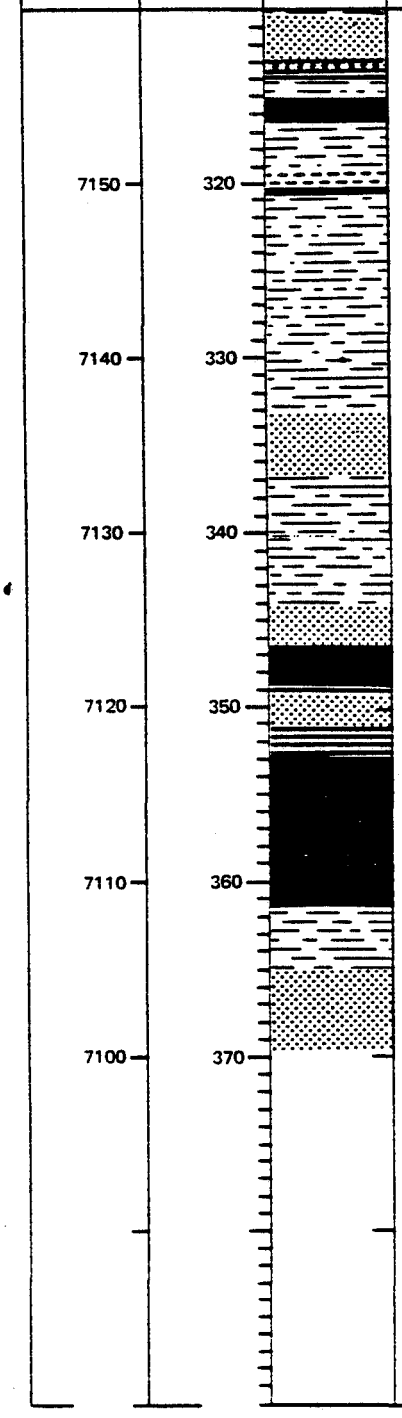
257.9 Sandstone, dark gray, fine-grained; marcasite films
259.4 Siltstone, dense, calcareous; fossil leaves
260.9 Sandstone, medium gray, fine-grained

267.5 Coal, black, resinous; sample WP-4-2
268.9 Siltstone; shaly partings; coaly specks
270.4 Coal, black, resinous; sample WP-4-3
273.3 Coal, bony, resinous; shaly partings
273.7 Coal, black; not as resinous
274.3 Sandstone, light gray, fine-grained
275.4 Siltstone, dark gray; coaly partings
275.8 Coal, black, resinous
276.9 Sandstone, light gray, fine-grained

307.4 Siltstone, medium to dark gray; marcasite films

PROJECT Wasatch Plateau Drilling SHEET 5 OF 5

SITE Roans Canyon D.H. No. 4



DESCRIPTION

310.5 Sandstone, light to medium gray, fine-grained
313.0 Coal, bony; coaly streaks
313.4 Shale, carbonaceous, dark brownish black
313.9 Siltstone, medium gray; carbonaceous matter on bedding planes
315.2 Coal, brittle, black, shiny
316.6 Siltstone, medium gray
319.0 Clay, soft, medium gray, gummy, sticky
320.1 Coal, black, shiny, blocky
320.6 Siltstone, medium gray, carbonaceous

333.0 Sandstone, medium gray, fine-grained

336.6 Siltstone, medium gray, carbonaceous

344.3 Sandstone, medium gray, fine-grained
346.6 Coal, black, shiny, blocky; sample WP-4-4

348.9 Shale, dark gray, carbonaceous, fissile
349.3 Sandstone, medium gray, fine-grained
351.3 Shale, dark gray, carbonaceous, fissile
352.7 Coal, black, shiny, blocky; samples WP-4-5, WP-4-6, WP-4-7

361.6 Siltstone, dark gray, carbonaceous

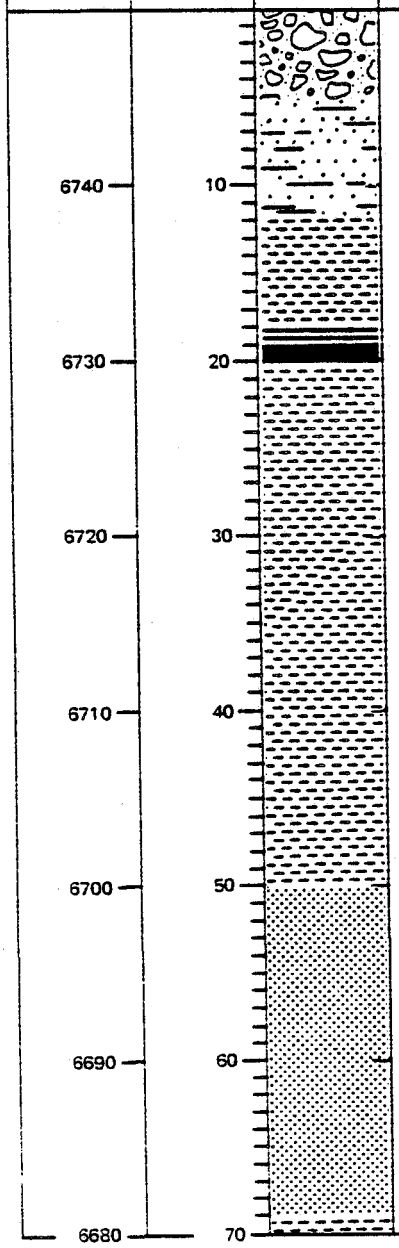
365.2 Sandstone, tan to dark gray, medium-grained; Star Point Sandstone
369.6 Drilling stopped, August 9, 1975
Total depth—369.6 feet

PROJECT Wasatch Plateau Drilling LOCATION SW¼NW¼ sec. 3, T. 18 S., R. 6 E. SHEET 1 OF 6

BEGAN July 7, 1975 COMPLETED July 12, 1975 TOTAL DEPTH OF HOLE 460.0 feet

CORE RECOVERY (%) 100 FEET 200 feet GROUND ELEVATION 6,750 feet

HOLE LOGGED BY H. Doelling, F. Davis, L. Green DRILLER Boyles Brothers DRILL HOLE No. 5



DESCRIPTION

0.0 Alluvium

5.0 Sandstone interbedded with shale

12.0 Shale, gray, fissile

18.0 Shale, dark gray, carbonaceous

19.0 Coal, black

20.0 Shale, light gray, fissile

50.5 Sandstone, light gray, fine-grained, calcareous

69.0 Shale, light gray, fissile

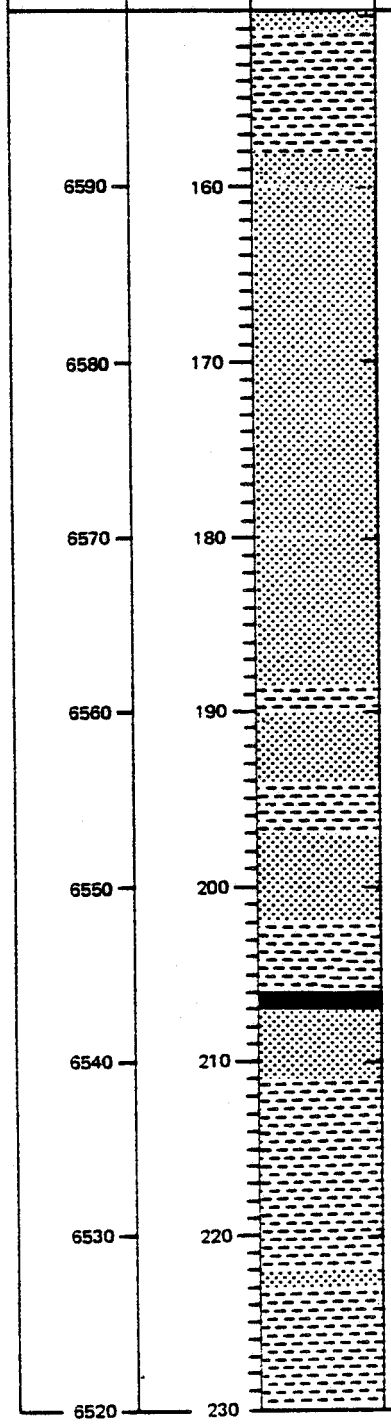
PROJECT Wasatch Plateau Drilling SHEET 2 OF 6

SITE Straight Canyon D.H. No. 5

ELEVATION	DEPTH	LOG	DESCRIPTION
			71.0 Sandstone, light gray, fine-grained
6670	80		
			83.0 Shale, black, fissile
6660	90		
			92.0 Sandstone, light gray, fine-grained
			95.0 Sandstone, gray; interbedded with dark gray shale
6650	100		
			102.0 Shale, black, carbonaceous
			107.0 Coal, black
			108.5 Shale, dark gray, fissile
6640	110		
			118.0 Sandstone, light gray, fine-grained
6630	120		
			122.0 Shale, dark gray, fissile
			126.5 Sandstone, light gray, fine-grained
6620	130		
6610	140		
			145.0 Shale, black, fissile
			146.5 Sandstone, light gray, fine-grained
6600	150		

PROJECT Wasatch Plateau Drilling SHEET 3 OF 6

SITE Straight Canyon D.H. No. 5



DESCRIPTION

151.0 Shale, black, fissile

158.0 Sandstone, light gray, fine-grained

188.5 Shale, black, fissile

190.0 Sandstone, light gray, fine-grained

194.0 Shale, black, fissile

197.0 Sandstone, light gray, fine-grained

202.0 Shale, black, fissile

206.0 Coal, black

207.0 Sandstone, light gray, fine-grained

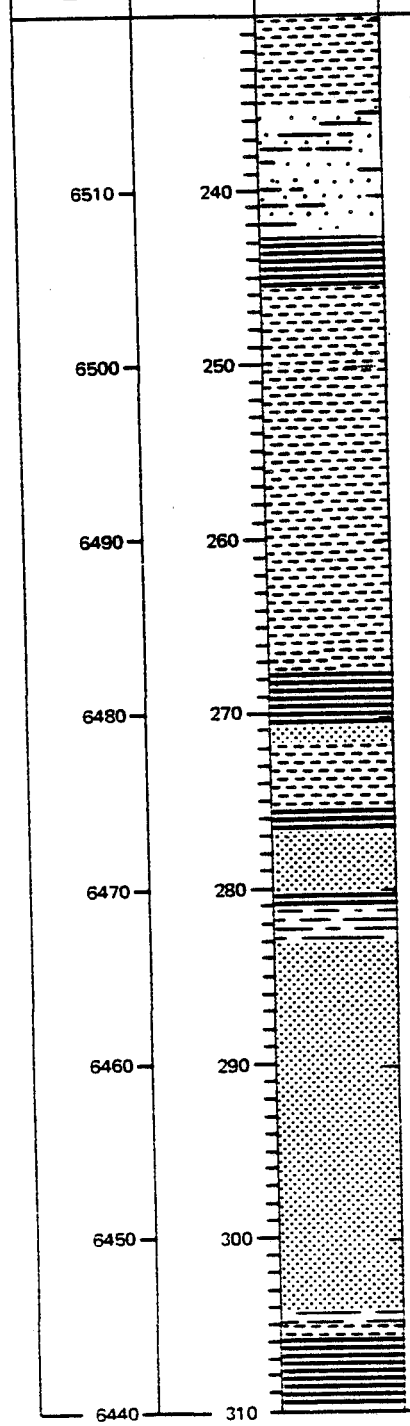
211.0 Shale, dark gray to black

222.0 Sandstone, gray, thin

223.0 Shale, dark gray to black

PROJECT Wasatch Plateau Drilling SHEET 4 OF 6

SITE Straight Canyon D.H. No. 5



DESCRIPTION

235.0 Sandstone, gray; interbedded with black shale

242.0 Shale, black, carbonaceous

245.5 Shale, dark gray to black, fissile

Coring began

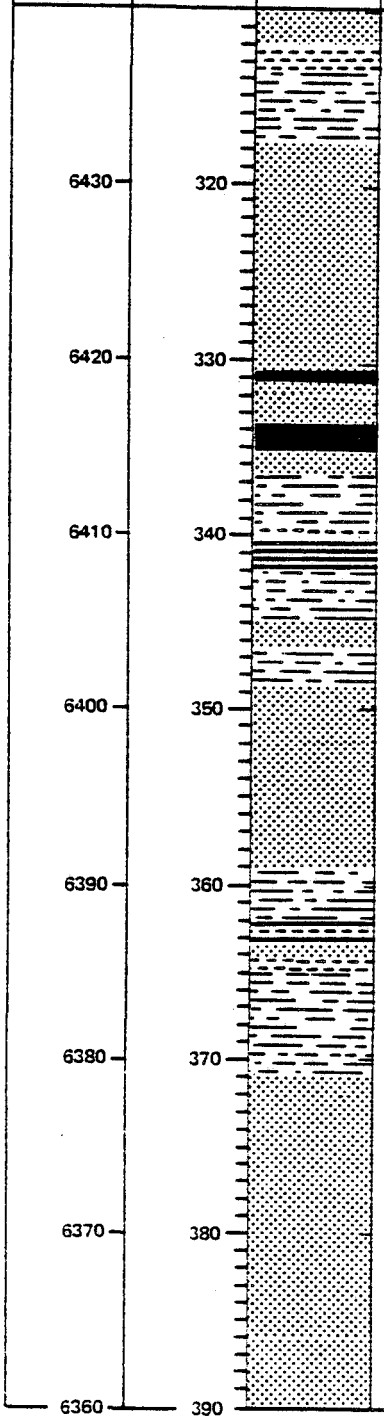
266.5 Shale, black, carbonaceous; contains leaves and twigs

270.5 Sandstone, medium brown, fine-grained, carbonaceous
271.5 Shale, sandy, medium gray; contains twigs
275.0 Shale, dark gray, carbonaceous
276.5 Sandstone, medium gray, fine-grained, calcareous
280.0 Shale, medium gray, carbonaceous
281.0 Siltstone, medium gray; black streaks
283.0 Sandstone, gray, fine- to medium-grained; occasional thin coaly laminations

304.0 Siltstone
305.0 Shale, dark gray; coaly partings
305.5 Shale, silty, gray, carbonaceous
309.6 Sandstone, light tan, fine-grained

PROJECT Wasatch Plateau Drilling SHEET 5 OF 6

SITE Straight Canyon D.H. No. 5



DESCRIPTION

312.0 Shale, silty, dark gray; leaf imprints
313.5 Siltstone, medium gray; coaly fragments

317.4 Sandstone, tan to gray, fine-grained; carbonaceous layers

330.4 Coal, brittle, black, pyritic
330.9 Sandstone, medium gray, fine-grained
333.6 Coal: 333.6—bony; 333.65—resinous; 334.2—not as resinous
335.2 Sandstone, medium gray, fine-grained
337.5 Siltstone, medium gray; organic debris

339.0 Shale, medium gray to black; stem and leaf imprints
340.5 Shale, medium gray to black, carbonaceous; occasional thin coal seams
342.1 Siltstone, medium gray; stem imprints
344.8 Sandstone, light gray, fine-grained
346.4 Siltstone, medium gray; leaf and stem imprints
348.8 Sandstone interbedded with siltstone; medium gray; occasional shaly layers

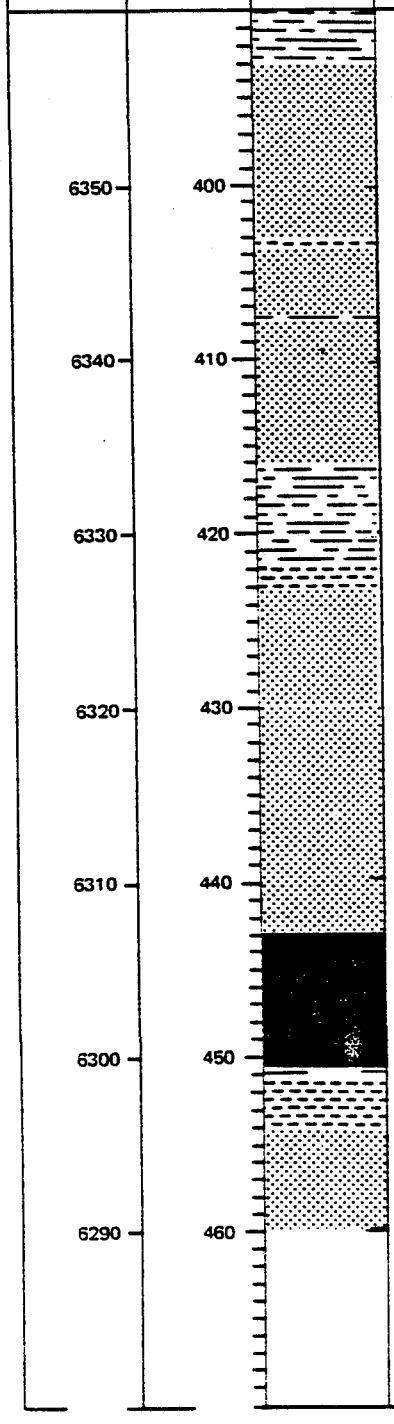
359.1 Siltstone, medium gray; leaf imprints
362.3 Shale, gray to black, coaly and carbonaceous
363.6 Sandstone, medium gray, fine-grained
364.2 Shale, dark gray to black; a few coaly partings
365.2 Siltstone, medium gray; organic matter

370.9 Sandstone, medium gray, fine-grained; occasional thin layers of siltstone and shale

389.8 Siltstone, dark gray to black; numerous coaly shale partings

PROJECT Wasatch Plateau Drilling SHEET 6 OF 6

SITE Straight Canyon D.H. No. 5



DESCRIPTION

392.6 Sandstone, medium gray, fine-grained

403.1 Shale, sandy, light gray
403.6 Sandstone, light gray, fine-grained

407.6 Siltstone, light gray
408.1 Sandstone, light gray, fine-grained; some coal imprints on bedding planes

416.3 Siltstone, medium gray to black; shaly partings; leaf and stem imprints

421.9 Shale, black; bony coal streaks
423.1 Sandstone, medium gray, fine-grained; leaf and stem imprints

443.6 Coal, hard, black; Hiawatha coal bed

450.9 Coal, bony
451.1 Siltstone, medium gray
452.4 Shale, dark gray; specks of coal
453.9 Sandstone, light gray, medium- to coarse-grained; Star Point Sandstone
460.0 Total depth

PROJECT Wasatch Plateau Drilling LOCATION SE¼SE¼ sec. 3, T. 19 S., R. 6 E. SHEET 1 OF 15

BEGAN July 14, 1975 COMPLETED July 29, 1975 TOTAL DEPTH OF HOLE 1,158.3 feet

CORE RECOVERY (%) 100 FEET 358.3 feet GROUND ELEVATION 8,050 feet

HOLE LOGGED BY H. Doelling, F. Davis, L. Green, J. Call DRILLER Boyles Brothers DRILL HOLE No. 6

ELEVAT.	DEPTH	LOG	DESCRIPTION
			0 Alluvium
8040	10		
			18 Conglomerate; gray limestone and white quartzite pebbles; Castlegate Sandstone
8030	20		
8020	30		
			35 Sandstone, yellow, medium-grained
			39 Sandstone, white, coarse-grained
8010	40		
8000	50		
			52 Sandstone, yellow, medium-grained
			55 Sandstone, light gray, coarse-grained
			58 Conglomerate
7990	60		60 Sandstone, yellow, medium-grained
			67 Sandstone, light grayish white, coarse-grained
7980	70		

PROJECT Wasatch Plateau Drilling SHEET 2 OF 15

SITE Rock Canyon D.H. No. 6

ELEVATION	DEPTH	LOG	DESCRIPTION
7970	80		82 Sandstone, yellow, fine-grained
			87 Sandstone, white, fine-grained
7960	90		92.5 Sandstone, white, medium-grained
7950	100		101.5 Sandstone, yellow, fine-grained
			104 Sandstone, white, fine-grained
7940	110		111 Sandstone, yellow, medium-grained
			114.5 Sandstone, white, fine-grained
7930	120		
7920	130		
7910	140		
			147.5 Sandstone, orange, medium-grained
7900	150		

PROJECT Wasatch Plateau Drilling SHEET 3 OF 15

SITE Rock Canyon D.H. No. 6

ELEVATION	DEPTH	LOG	DESCRIPTION
			150 Sandstone, dark gray, medium-grained
			152.5 Sandstone, white, fine-grained
7890	160		
			163 Sandstone, yellowish brown, medium-grained
			165.5 Sandstone, white, coarse-grained
7880	170		
			178.5 Sandstone, yellowish orange, medium-grained
			180 Sandstone, dark gray, medium-grained
7870	180		182 Sandstone, white, fine-grained
7860	190		
			196.5 Sandstone, yellowish orange, fine-grained
			197.5 Sandstone, black, asphaltic
			201 Sandstone, dark gray, medium-grained
7850	200		202 Sandstone, yellowish orange, medium-grained
			203 Sandstone, white, fine-grained
			205.5 Sandstone, dark gray, medium-grained
			207 Sandstone, white, fine-grained
7840	210		
			211.5 Sandstone, orange brown, medium-grained
			212.5 Sandstone, dark gray, medium-grained
			213.5 Sandstone, white, fine-grained
			217 Sandstone, dark gray, medium-grained
7830	220		
7820	230		

PROJECT Wasatch Plateau Drilling SHEET 4 OF 15

SITE Rock Canyon D.H. No. 6

ELEVATION	DEPTH	LOG	DESCRIPTION
			235 Sandstone, light gray, medium-grained
7810	240		
			245 Sandstone, gray, fine-grained; Blackhawk Formation
			247 Sandstone, hard, dark gray, fine-grained, thinly laminated
7800	250		250 Sandstone, gray, fine-grained
			253 Sandstone, light gray, medium-grained
			258 Sandstone, medium gray, medium-grained
7790	260		
			262 Sandstone, medium gray, fine-grained
			265 Sandstone, light gray, medium-grained
7780	270		
			272 Sandstone, gray, fine-grained
			277 Sandstone, medium gray, medium-grained
7770	280		
			283 Sandstone, light gray, fine-grained
7760	290		290 Sandstone, light gray to tan, fine-grained
			297 Sandstone, dark brown, medium-grained
			298 Sandstone, gray, medium-grained
7750	300		300 Sandstone, light gray to white, fine-grained
			305 Shale, medium gray; interbedded with fine sand
			307 Sandstone, medium gray, fine-grained
			308 Shale, clayey; interbedded with gray, fine-grained sandstone
7740	310		

PROJECT Wasatch Plateau Drilling SHEET 5 OF 15

SITE Rock Canyon D.H. No. 6

ELEVATION	DEPTH	LOG	DESCRIPTION
			310 Sandstone, light gray, fine-grained
			311 Sandstone; shale; medium gray
			312 Sandstone, light gray, fine-grained
			313 Sandstone, light gray, medium-grained
			314 Sandstone, gray, fine-grained
7730	320		320 Sandstone, light gray to tan, fine-grained
			325 Sandstone, medium gray, fine-grained
			326 Sandstone, light gray, fine-grained
7720	330		
7710	340		
7700	350		
7690	360		
7680	370		
			373 Shale, hard, gray; interbedded with sandstone
			375 Sandstone, light gray, fine-grained
7670	380		
7660	390		

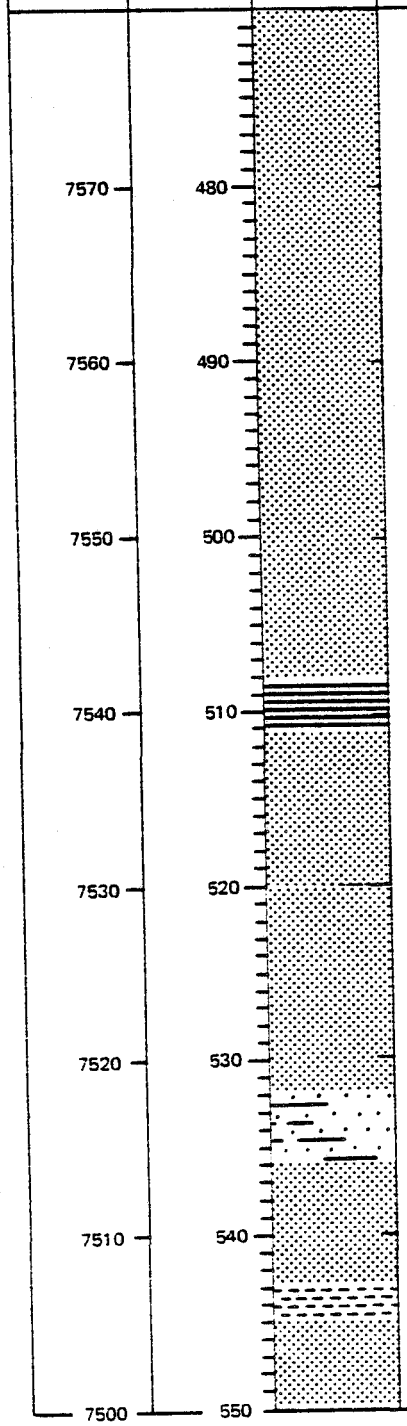
PROJECT Wasatch Plateau Drilling SHEET 6 OF 15

SITE Rock Canyon D.H. No. 6

ELEVATION	DEPTH	LOG	DESCRIPTION
			391 Shale, dark gray, fissile
7650	400		
7640	410		
			412.5 Sandstone, light gray, fine-grained
			415 Coal, black, brittle
			416 Sandstone, brownish gray; interbedded with thin shales
7630	420		
7620	430		
			434.5 Coal, black
			435 Shale, black, carbonaceous
			437 Shale, dark gray, fissile
			438.5 Sandstone, light gray, fine-grained
7610	440		
7600	450		
			453.5 Shale, dark brownish gray, carbonaceous, coaly
			455 Sandstone, light gray, fine-grained
7590	460		
7580	470		

PROJECT Wasatch Plateau Drilling SHEET 7 OF 15

SITE Rock Canyon D.H. No. 6



DESCRIPTION

508 Shale, black, carbonaceous, thinly laminated

511 Sandstone, brownish gray, fine-grained

532 Sandstone, brown; interbedded with gray shales

536 Sandstone, light tan, fine-grained

541 Sandstone, brownish gray, fine-grained

543 Shale, dark gray to black

545 Sandstone, light tan, fine-grained

550 Shale, medium gray to black

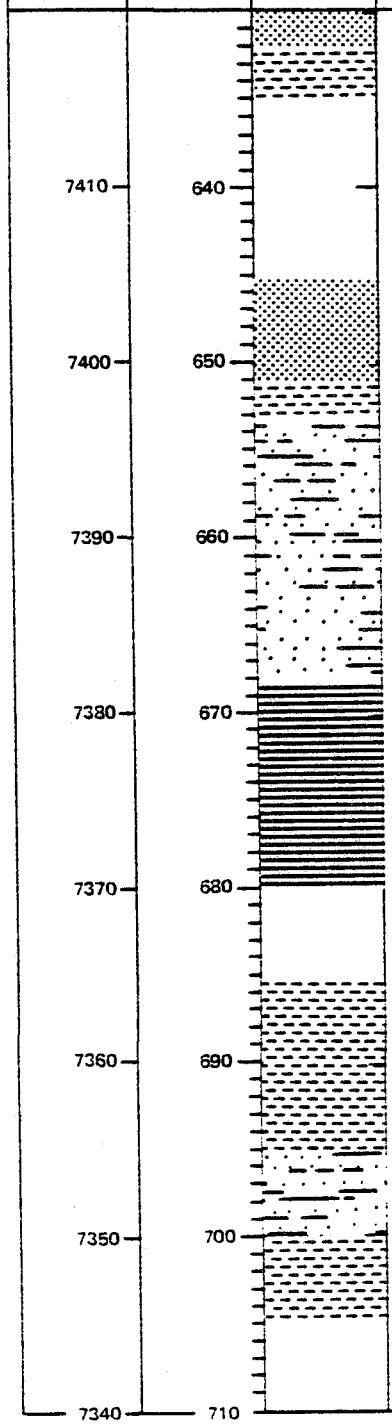
PROJECT Wasatch Plateau Drilling SHEET 8 OF 15

SITE Rock Canyon D.H. No. 6

ELEVATION	DEPTH	LOG	DESCRIPTION
7490	560		
			564 Shale, clayey, soft, black to brown
			568 Shale, black to medium gray
7480	570		570 Shale, black, carbonaceous
7470	580		
7460	590		590 Shale, black, fissile
7450	600		
			603 Sandstone, light gray, fine-grained
7440	610		610 Sandstone, tan, fine-grained
			617 Shale, black to medium gray
7430	620		
			622 Sandstone, light gray, fine-grained
7420	630		

PROJECT Wasatch Plateau Drilling SHEET 9 OF 15

SITE Rock Canyon D.H. No. 6



DESCRIPTION

632 Shale, dark gray, fissile

635 Lost circulation; no cuttings

645 Sandstone, light gray, fine-grained

651 Shale, black, fissile

653 Sandstone, light gray, thin-bedded; interbedded with dark gray shales

668 Shale, black, coaly; oil show

680 Lost circulation; no cuttings

685 Shale, black, fissile

695 Sandstone, brown, thin-bedded; interbedded with dark gray shales

700 Shale, black, fissile

705 No cuttings; using air only to drill; oil show when flushing hole

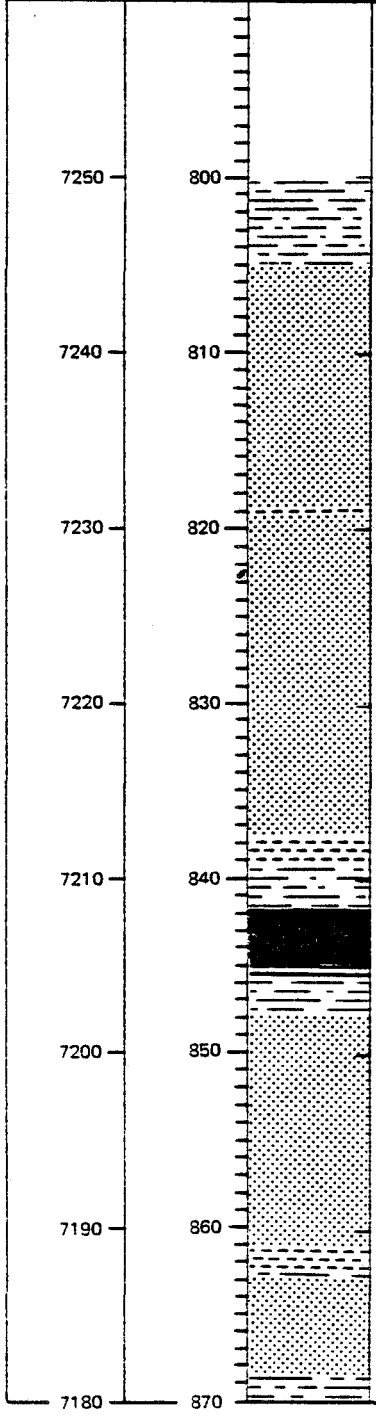
PROJECT Wasatch Plateau Drilling SHEET 10 OF 15

SITE Rock Canyon D.H. No. 6

ELEVATION	DEPTH	LOG	DESCRIPTION
			712 Shale, black, carbonaceous; small coal pieces
			715 Sandstone, grayish brown, fine-grained; some coal pieces
			718 Shale, brown, fissile
7330	720		722 Sandstone, light gray, fine-grained
7320	730		
			738 Coal, black
7310	740		739 Shale, black, fissile
			745 Sandstone, dark gray, fine-grained
7300	750		750 Shale, slightly gritty, black
			755 No cuttings
7290	760		
7280	770		770 Shale, black, fissile
			775 No cuttings; drills like shale
7270	780		
			785 Shale, black, fissile
7260	790		

PROJECT Wasatch Plateau Drilling SHEET 11 OF 15

SITE Rock Canyon D.H. No. 6



DESCRIPTION

790 No cuttings; drills like interbedded thin shale and sandstone

Coring began

800 Siltstone, sandy, dense, medium gray, calcareous

805.3 Sandstone, light gray; carbonaceous imprints

818.8 Shale, black, thinly laminated

819.0 Sandstone, light gray, medium- to coarse-grained

837.7 Shale, dark gray, fissile, carbonaceous

839.0 Siltstone, dark gray, fine-grained, calcareous

841.4 Coal, black, brittle, resinous, pyritic

844.8 Shale, black, carbonaceous, fissile

845.3 Siltstone, dense, medium gray; wood imprints

847.5 Sandstone, medium gray, fine-grained

860.9 Shale, dark gray, thinly laminated

862.2 Siltstone, dense, dark gray

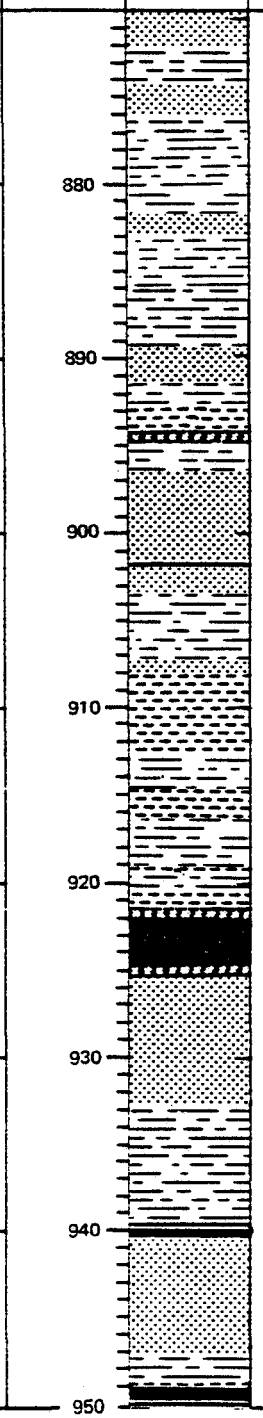
862.8 Sandstone, light gray, fine-grained

868.2 Siltstone, dense, medium gray

869.5 Sandtone, medium gray, fine-grained

PROJECT Wasatch Plateau Drilling SHEET 12 OF 15

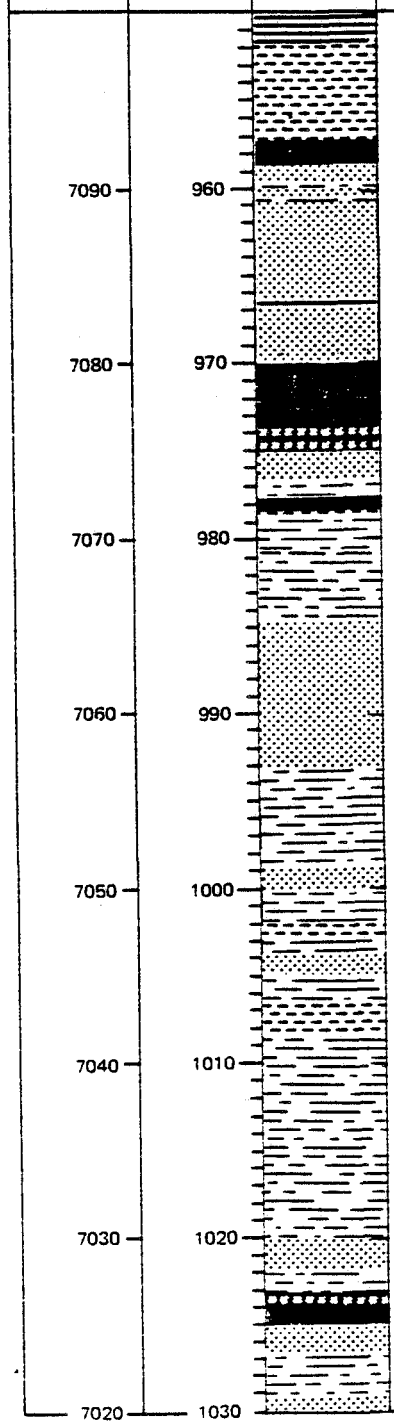
SITE Rock Canyon D.H. No. 6



ELEVATION	DEPTH	DESCRIPTION
		872.1 Siltstone, sandy, medium gray, calcareous
		874.0 Sandstone, medium gray, fine-grained
		876.4 Siltstone, dense, medium gray
7170	880	
		882.0 Sandstone, medium gray, fine-grained
		883.0 Siltstone, dense, medium gray; coal specks
		886.5 Siltstone, medium gray; occasional coal specks
		889.4 Sandstone, medium gray, fine-grained
7160	890	
		891.6 Siltstone, dark gray, calcareous
		892.5 Shale, medium gray to black
		894.2 Coal, bony
		894.5 Siltstone, dense, medium to light gray
		896.6 Sandstone, light gray, thinly laminated
7150	900	
		901.6 Shale, black, carbonaceous
		902.1 Sandstone, light gray, fine-grained
		903.5 Siltstone, light gray, thinly laminated
		907.7 Sandstone, light gray, fine-grained
		908.3 Shale, medium gray, carbonaceous
7140	910	
		912.8 Siltstone, light gray, fine-grained
		914.9 Shale, medium gray, thinly laminated
		916.2 Siltstone, light gray, fine-grained
		918.8 Shale, medium gray, calcareous
		919.3 Siltstone, light gray, fine-grained
7130	920	
		920.3 Shale, medium gray, thinly laminated
		921.2 Coal, bony
		922.3 Coal, brittle, black, resinous
		924.7 Coal, bony
		925.5 Sandstone, light gray, fine-grained
7120	930	
		932.8 Siltstone, dense, dark gray
		933.4 Siltstone, sandy, light gray, limy
7110	940	939.3 Shale, carbonaceous
		939.9 Coal, shiny black, resinous
		940.4 Sandstone, gray to black, fine-grained
		941.1 Sandstone, medium gray, fine- to medium-grained
		947.2 Siltstone, dark gray, laminated
		948.5 Shale, dark gray
		948.9 Coal, bony, dull, black
7100	950	949.5 Shale, carbonaceous

PROJECT Wasatch Plateau Drilling SHEET 13 OF 15

SITE Rock Canyon D.H. No. 6



DESCRIPTION

951.7 Shale, black

957.3 Coal, black, dull
958.3 Sandstone, light gray, fine-grained
959.2 Siltstone, sandy, medium gray
959.6 Sandstone, light gray, fine-grained
960.2 Siltstone, black, calcareous
960.8 Sandstone, light gray to medium gray
966.2 Shale, black, carbonaceous
966.9 Sandstone, light gray, fine-grained

970.3 Coal, brittle, black, resinous
973.8 Coal, bone
974.9 Sandstone, light gray, fine-grained
976.4 Siltstone, dense, medium gray
977.6 Coal, brittle, black
978.3 Shale, black, carbonaceous, fissile
978.7 Siltstone, dense, dark gray; coal specks

980.6 Siltstone, dense, medium gray, calcareous

984.7 Sandstone, medium gray, medium-grained

993.1 Siltstone, dense, black; numerous partings

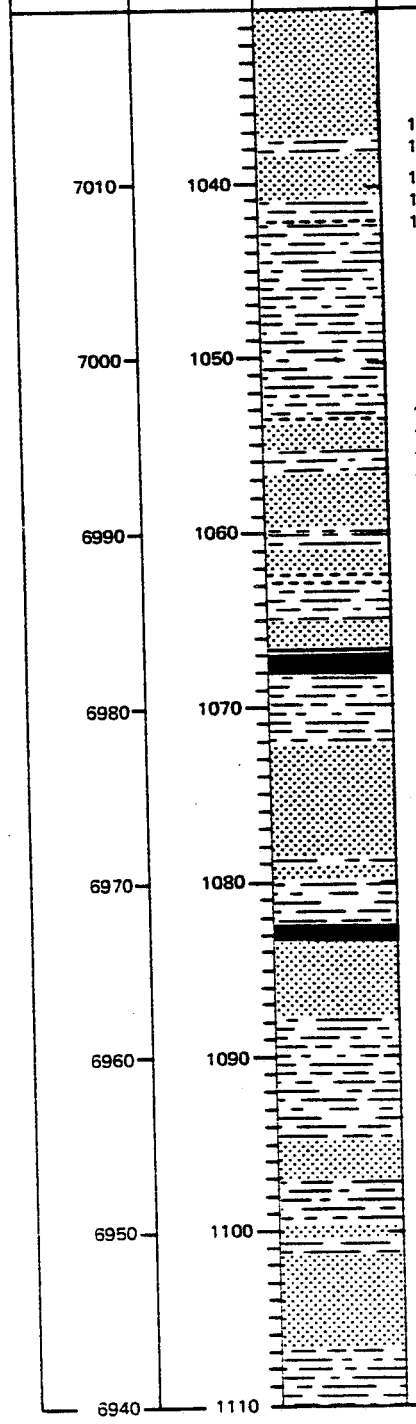
997.6 Siltstone, dense, dark gray
998.6 Sandstone, light gray, fine-grained
999.8 Siltstone, dense, dark gray

1001.9 Shale, black, fissile
1002.8 Siltstone, dense, dark gray
1003.9 Sandstone, brownish gray, fine-grained
1005.0 Siltstone, dense, dark gray
1006.6 Shale, dark gray, fissile, carbonaceous
1008.2 Siltstone, dense, medium gray

1020.0 Sandstone, light gray, medium-grained
1021.7 Siltstone, dark gray, calcareous
1023.0 Coal, bony, resinous
1023.7 Coal, brittle, black, resinous
1025.0 Sandstone, medium gray, fine-grained
1026.5 Siltstone, light gray; shaly partings
1029.0 Sandstone, light gray, fine-grained

PROJECT Wasatch Plateau Drilling SHEET 14 OF 15

SITE Rock Canyon D.H. No. 6



DESCRIPTION

1037.2 Siltstone, dark gray, carbonaceous
1038.1 Sandstone, medium gray, fine-grained
1040.8 Siltstone, dense, medium gray
1041.6 Shale, black, fissile
1042.2 Siltstone, dark gray, slightly calcareous

1053.2 Shale, black, carbonaceous
1053.6 Sandstone, light gray, fine-grained
1054.9 Siltstone, dense, light gray
1056.4 Sandstone, brownish black, fine-grained
1059.5 Siltstone, dense, brownish gray

1061.0 Sandstone, light gray, fine-grained
1062.3 Shale, black, carbonaceous, fissile
1063.0 Siltstone, dense, medium gray
1065.2 Sandstone, medium gray, fine-grained
1066.4 Shale, black, carbonaceous
1066.9 Coal, brittle, black, shiny, nonresinous
1067.9 Siltstone, dense, medium gray, pyritic

1072.3 Sandstone, light to medium brown, fine-grained

1078.6 Siltstone, dense, dark gray
1079.2 Sandstone, medium gray, fine-grained
1079.7 Siltstone, medium gray, fossiliferous
1082.4 Coal, brittle, black, shiny
1083.3 Sandstone, light gray to tan, calcareous

1087.7 Siltstone, dense, medium gray

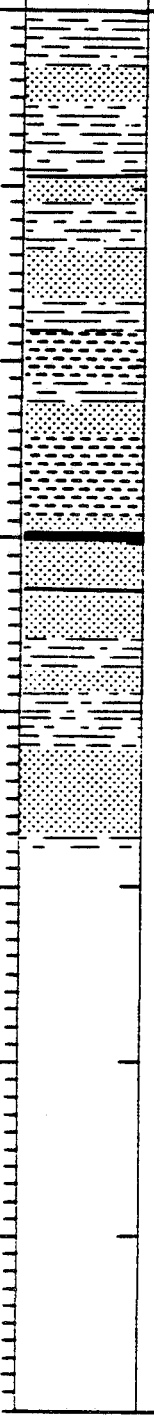
1094.6 Sandstone, medium gray, fine-grained
1096.9 Siltstone, dense, medium gray, limy

1099.6 Sandstone, medium gray, fine-grained
1100.3 Siltstone, dense, medium gray
1101.3 Sandstone, medium gray, fine-grained

1106.7 Siltstone, dense, medium gray

PROJECT Wasatch Plateau Drilling SHEET 15 OF 15

SITE Rock Canyon D.H. No. 6



ELEVATION	DEPTH	DESCRIPTION
		1113.3 Sandstone, medium gray to tan, fine-grained
		1115.1 Siltstone, hard, dense, medium gray
		1119.2 Shale, dark gray to black, fissile, carbonaceous
		1119.7 Sandstone, light gray, fine-grained
6930	1120	1120.7 Siltstone, medium gray, calcareous
		1123.4 Sandstone, light gray, fine-grained
		1126.3 Siltstone, sandy, dense, light to medium gray
		1128.2 Shale, black, carbonaceous, fissile
6920	1130	
		1130.5 Siltstone, medium gray, calcareous
		1132.2 Sandstone, light gray to tan, fine-grained
		1134.0 Shale, dark brown; coaly plant material
		1138.5 Sandstone, fine-grained, carbonaceous
		1139.1 Coal, black, shiny
6910	1140	1139.7 Sandstone, medium gray, fine- to medium-grained
		1142.6 Shale, dark gray, carbonaceous
		1143.3 Sandstone, light gray, fine-grained
		1145.6 Siltstone, sandy, fossiliferous
		1147.3 Sandstone, light gray, fine-grained
6900	1150	1148.8 Siltstone, medium gray, calcareous
		1152.1 Sandstone, light gray, fine-grained
		1157.1 Siltstone, dense, dark gray, laminated
		1158.3 Hole shut down, July 29, 1975
6890	1160	Total depth—1,158.3 feet

PROJECT Wasatch Plateau Drilling LOCATION NW¼NE¼ sec. 15, T. 24 S., R. 4 E. SHEET 1 OF 4

BEGAN September 22, 1975 COMPLETED October 3, 1975 TOTAL DEPTH OF HOLE 276.4 feet

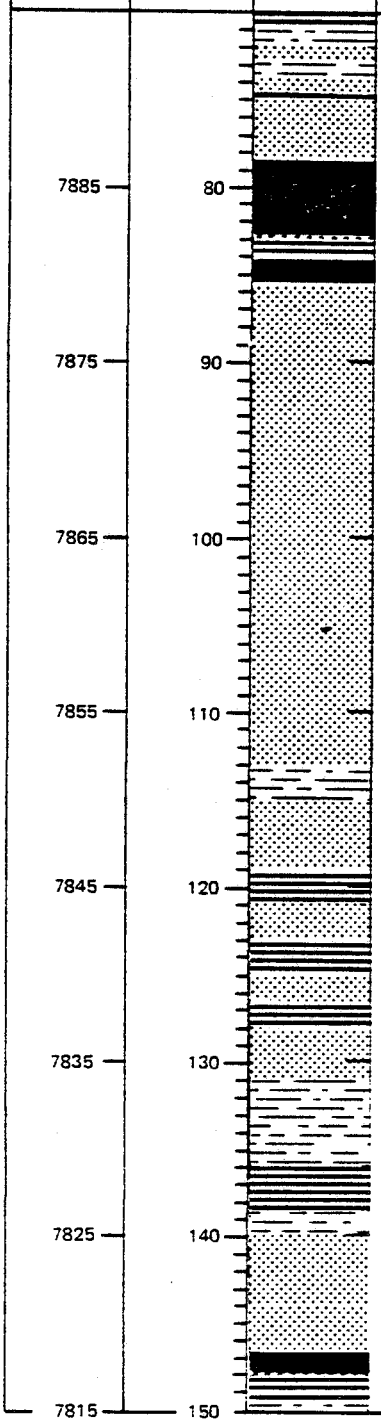
CORE RECOVERY (%) 100 FEET 146.9 feet GROUND ELEVATION 7,965 feet

HOLE LOGGED BY F. Davis, L. Green DRILLER Boyles Brothers DRILL HOLE 7

ELEVAT	DEPTH	LOG	DESCRIPTION
			1.0 Alluvium; silt, sand and gravel
7955	10		
7945	20		
7935	30		
			38.0 Bedrock-shale, gray, fissile
7925	40		
			46.0 Sandstone, yellowish brown, fine-grained
7915	50		
			58.0 Shale, medium gray, fissile
7905	60		
			62.0 Siltstone, light gray
			65.0 Siltstone, sandy, light gray, calcareous, carbonaceous; some shaly partings
			67.1 Shale, gray, argillaceous
			67.5 Siltstone, dark gray, calcareous, carbonaceous
			68.6 Shale, gray, fissile, argillaceous
			70.7 Siltstone, slightly sandy, light gray; carbonaceous debris on bedding planes
7895	70		

PROJECT Wasatch Plateau Drilling SHEET 2 OF 4

SITE Horse Fork D.H. 7



DESCRIPTION

72.0 Sandstone, light gray, fine-grained, calcareous
72.7 Siltstone, medium gray, calcareous, thinly laminated, carbonaceous; shaly partings
73.8 Sandstone, medium gray, fine-grained, calcareous, friable; coaly partings
74.7 Shale, black, carbonaceous, fissile
74.9 Sandstone, medium gray, fine-grained, calcareous, friable; coaly partings
78.5 Coal, black, shiny, resinous, marcasitic
82.8 Coal, bone
82.9 Shale, black, carbonaceous, fissile, argillaceous
84.0 Coal, black, dull, resinous
85.3 Shale, black, coaly
85.5 Total depth hole No. 7B
86.0 Sandstone, light gray, fine-grained, calcareous (from hole No. 7A)
113.0 Siltstone, sandy, medium gray
115.0 Sandstone, medium gray, fine-grained
119.0 Shale, black, fissile
121.0 Sandstone, medium gray, fine-grained
123.0 Shale, black, fissile
125.0 Sandstone
126.5 Shale, black, fissile
128.0 Sandstone, medium gray, fine-grained
131.0 Siltstone, dark gray
136.0 Shale, black
138.5 Coal, black
139.0 Siltstone, dark gray
140.0 Sandstone, dark gray, fine-grained, friable
144.1 Sandstone, dark gray, fine-grained, friable, highly carbonaceous
146.8 Coal, black, shiny
148.0 Coal, bone
149.0 Shale, soft, black, fissile, carbonaceous
149.5 Siltstone, medium gray; carbonaceous debris on bedding planes

PROJECT Wasatch Plateau Drilling SHEET 3 OF 4

SITE Horse Fork D.H. 7

ELEVATION	DEPTH	LOG	DESCRIPTION
			151.7 Shale, soft, black, fissile, carbonaceous
			152.5 Siltstone, dense, medium gray, calcareous, carbonaceous
			156.1 Shale, soft, black, fissile, carbonaceous
7805	160		159.2 Siltstone, dense, mottled brown and gray, calcareous; contorted bedding
			163.0 Shale, soft, dark gray, fissile, carbonaceous
			163.5 Siltstone, dense, medium gray, calcareous; carbonaceous debris on bedding planes
			164.2 Shale, soft, banded dark gray and black, fissile, carbonaceous
			166.4 Siltstone, dense, medium gray, calcareous
			167.2 Shale, dark gray to black, fissile, carbonaceous
7795	170		167.8 Coal, black, shiny
			171.3 Coal, bone
			171.4 Shale, black, fissile, coaly
			171.5 Sandstone, dark gray, fine-grained
			175.3 Sandstone, grayish brown, fine-grained
			176.0 Sandstone, medium gray, fine-grained; contorted bedding
7785	180		
7775	190		
7765	200		201.1 Sandstone, dark gray, fine-grained, carbonaceous, calcareous; contorted bedding
			201.8 Siltstone, dark gray, fossiliferous; organic debris on bedding planes
			203.0 Shale, black, carbonaceous, fissile
			203.3 Coal, bone
			203.4 Coal, black, shiny
			204.5 Shale, dark gray, fissile, carbonaceous
			204.6 Siltstone, dense, medium gray, calcareous, pyritic
7755	210		
7745	220		219.9 Sandstone, tan, coarse-grained, water-saturated; Star Point Sandstone
7735	230		230.0 Sandstone, tan, coarse-grained, friable, calcareous

PROJECT Wasatch Plateau Drilling SHEET 4 OF 4

SITE Horse Fork D.H. 7

ELEVATION	DEPTH	LOG	DESCRIPTION
			234.5 Sandstone, light gray, medium-grained, calcareous
7725	240		
			247.8 Sandstone; mostly subrounded quartz and feldspar grains
			247.9 Sandstone, medium gray, fine-grained, calcareous, fractured
7715	250		250.8 Sandstone, tan, fine- to medium-grained, friable, calcareous
7705	260		
			266.4 Sandstone, tan, fine- to medium-grained, friable, calcareous; fractures lined with gypsum
7695	270		
			276.4 Total depth hole No. 7
7685	280		

PROJECT Wasatch Plateau Drilling LOCATION NE¼SE¼ sec. 21, T. 24 S., R. 4 E. SHEET 1 OF 7

BEGAN September 24, 1975 COMPLETED September 30, 1975 TOTAL DEPTH OF HOLE 495.1 feet

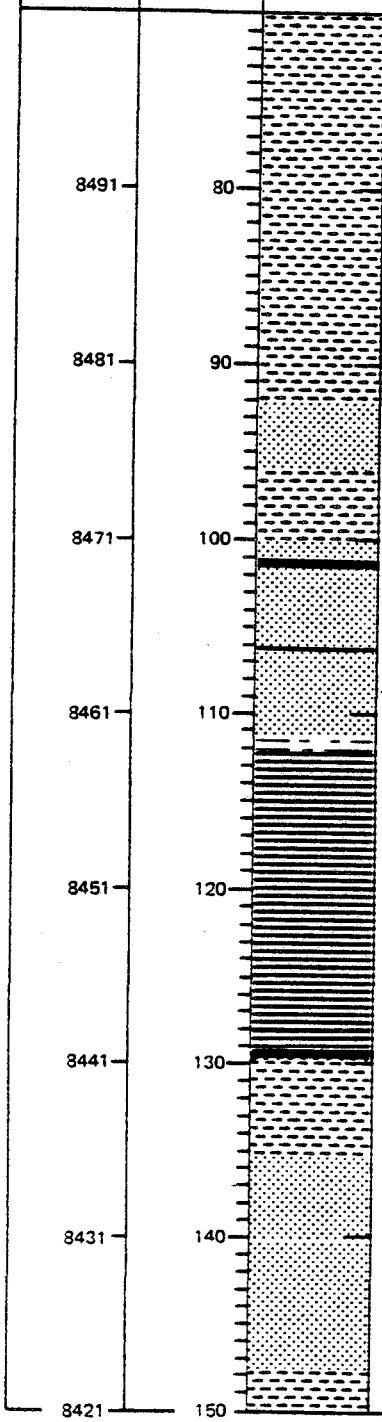
CORE RECOVERY (%) 97.3 FEET 395.1 feet GROUND ELEVATION 8,571 feet

HOLE LOGGED BY F. Davis, L. Green, H. Doelling DRILLER Boyles Brothers DRILL HOLE No. 8

ELEVAT.	DEPTH	LOG	DESCRIPTION
			1.0 Glacial drift; silt, sand, gravel, and boulders
8561	10		
8551	20		
8541	30		
8531	40		
			45.0 Bedrock; medium gray, fine-grained sandstone
8521	50		51.0 Shale, black, fissile
			54.0 Sandstone, medium gray, fine-grained
8511	60		61.0 Shale, grayish brown, fissile
			68.0 Shale, medium gray, fissile
8501	70		

PROJECT Wasatch Plateau Drilling SHEET 2 OF 7

SITE Johns Peak D.H. No.8



DESCRIPTION

92.0 Sandstone, medium gray, fine-grained

96.0 Shale, dark brown, fissile
98.0 Shale, medium gray, fissile; coring began at 100 feet
100.0 Sandstone, medium gray, fine-grained, calcareous, friable, water-saturated
101.1 Coal, hard, black, shiny
101.4 Sandstone, medium gray, fine-grained, calcareous, friable, water-saturated; some contorted bedding; carbonaceous material on bedding planes; some coaly streaks

106.1 Coal, crumbly, black
106.2 Sandstone, medium gray, fine-grained, friable, calcareous, water-saturated; carbonaceous films on bedding planes

111.4 Siltstone, sandy, clayey, medium gray; shaley partings; carbonaceous material on bedding planes
112.1 Shale, clayey, dark gray; carbonaceous material; some coaly streaks
115.1 Shale, clayey, dark gray; carbonaceous material; some coaly streaks; becoming less clayey on last 1 foot

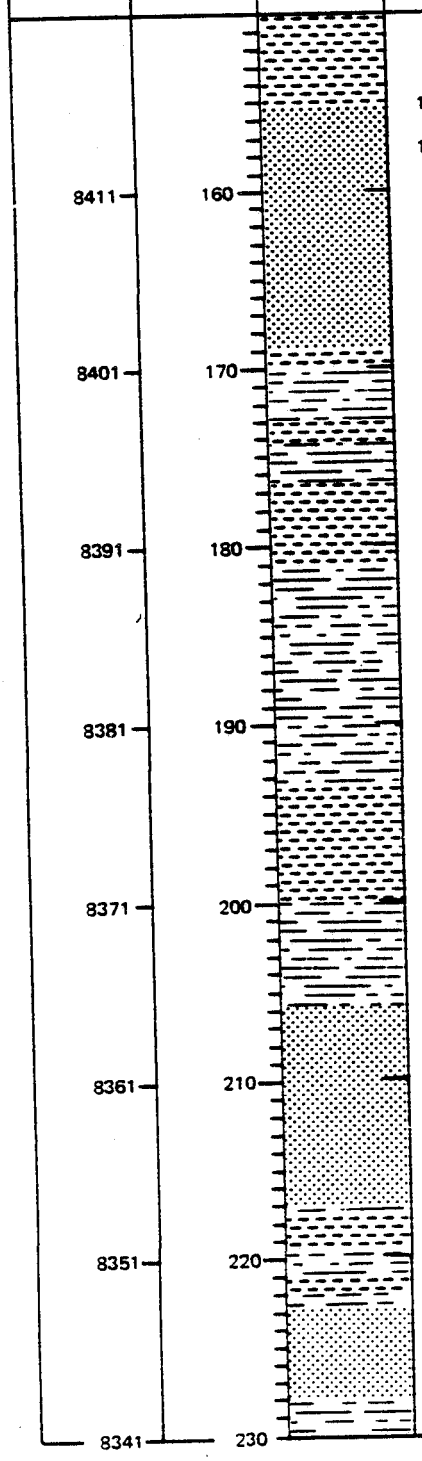
129.3 Coal, black; thin bony section in middle
129.6 Coal, bone
129.8 Shale, black, carbonaceous, fissile
129.9 Shale, black, less carbonaceous, fissile

134.0 Shale, sandy, clayey, black, carbonaceous, fissile
135.2 Sandstone, medium gray, fine-grained, calcareous, friable; carbonaceous films on bedding planes; contorted bedding

140.2 Sandstone, medium gray, fine-grained, calcareous, friable; carbonaceous films on bedding planes; contorted bedding
144.2 Sandstone, medium gray, fine-grained, calcareous, friable; carbonaceous films on bedding planes; contorted bedding; blebs of clay included
145.7 Sandstone, medium gray, fine-grained, calcareous
147.7 Shale, clayey, dark gray, fissile

PROJECT Wasatch Plateau Drilling SHEET 3 OF 7

SITE Johns Peak D.H. No.8



DESCRIPTION

155.4 Sandstone, medium gray, fine-grained, calcareous, friable, water-saturated; a few coaly streaks; much carbonaceous matter

159.2 Sandstone, medium gray, fine-grained, calcareous, friable, water-saturated; a few coaly streaks; less carbonaceous material

166.2 Sandstone, medium gray, fine- to medium-grained, calcareous, friable, water-saturated; a few coaly streaks

169.0 Shale, clayey, dark gray, fissile

169.9 Shale, clayey, sandy, dark gray, fissile

170.0 Siltstone, brown to black, carbonaceous, fossiliferous; lenses of shale

173.0 Shale, clayey, light gray, fissile

174.4 Siltstone, light gray; carbonaceous trash

176.6 Shale, clayey, light gray, fissile

177.0 Shale, clayey, light to medium gray, fissile

181.0 Siltstone, dense, hard, light to medium gray, calcareous; carbonaceous debris on bedding planes

193.5 Shale, clayey, sticky, dark gray, carbonaceous, fissile

200.5 Siltstone, soft, medium gray, fossiliferous; carbonaceous material on bedding planes; contorted bedding

204.5 Siltstone, soft, medium gray, fossiliferous, calcareous; carbonaceous material on bedding planes; contorted bedding

205.9 Sandstone, medium gray to brown, fine-grained, calcareous; carbonaceous films on bedding planes; contorted bedding; blebs of shale

209.5 Sandstone, medium gray to brown, fine-grained, calcareous; carbonaceous films on bedding planes; contorted bedding; shaly partings

217.2 Siltstone, brown, fossiliferous, calcareous; coaly partings; marcasite films

217.5 Shale, clayey, brownish black, carbonaceous, fissile

219.6 Siltstone, sandy, medium gray, slightly calcareous

221.3 Shale, black, carbonaceous, fissile, resinous; some coaly streaks

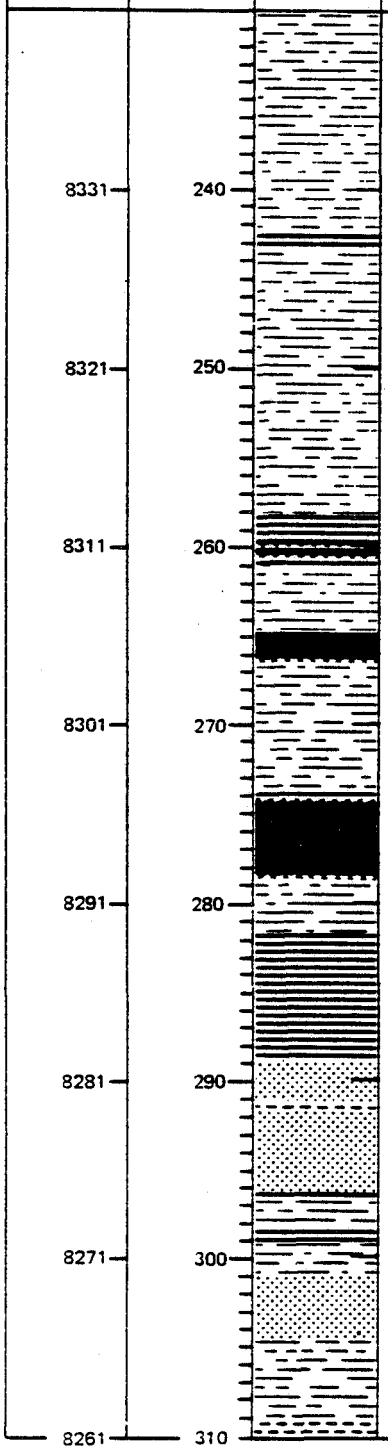
222.2 Siltstone, brownish black, carbonaceous; marcasite films on bedding planes

222.8 Sandstone, light gray, fine-grained, calcareous; contorted bedding; carbonaceous films on bedding planes

228.1 Siltstone, medium gray to tan, calcareous; thin lenses of sandstone; contorted bedding; carbonaceous film on bedding planes; coaly streaks

PROJECT Wasatch Plateau Drilling SHEET 4 OF 7

SITE Johns Peak D.H. No. 8



DESCRIPTION

233.4 Lost core—probably medium gray siltstone

241.0 Siltstone, medium gray

242.6 Shale, soft, dark gray, fissile, carbonaceous
243.3 Siltstone, crumbly, dark gray, carbonaceous; contorted bedding

258.1 Shale, black, fissile, carbonaceous
259.9 Coal, bone
260.0 Coal, black, shiny
260.5 Coal, bone
260.6 Shale, black, fissile, carbonaceous
261.0 Siltstone, dense, medium gray; carbonaceous matter on bedding planes; contorted bedding
265.8 Shale, black, carbonaceous, fissile
265.9 Coal, black, shiny, resinous
266.3 Coal, bone
266.4 Shale, black, fissile, carbonaceous; coal specks on bedding planes
267.2 Siltstone, dense, medium gray, calcareous; carbonaceous debris on bedding planes

273.8 Shale, black, fissile, carbonaceous
274.2 Coal, bone
274.4 Coal, black, shiny, resinous
278.4 Coal, bone
278.7 Siltstone, dense, medium gray, carbonaceous

281.8 Shale, soft, dark gray, fissile, carbonaceous, gummy

287.6 Shale, soft, dark gray, fissile, carbonaceous, gummy, resinous
288.8 Sandstone, tan, fine-grained, friable; contains irregular coaly partings
289.6 Sandstone, light gray to medium brown, fine-grained; fewer coal partings than previous unit

291.2 Shale, tan gray to brown
291.9 Sandstone, silty, medium brown, argillaceous; occasional thin coaly streaks; poorly cemented
296.1 Shale, medium gray; some carbonaceous material
296.6 Siltstone, sandy, medium gray, slightly calcareous; coaly streaks; some shaly partings
298.1 Shale, black, carbonaceous, argillaceous
299.1 Siltstone, sandy, light gray

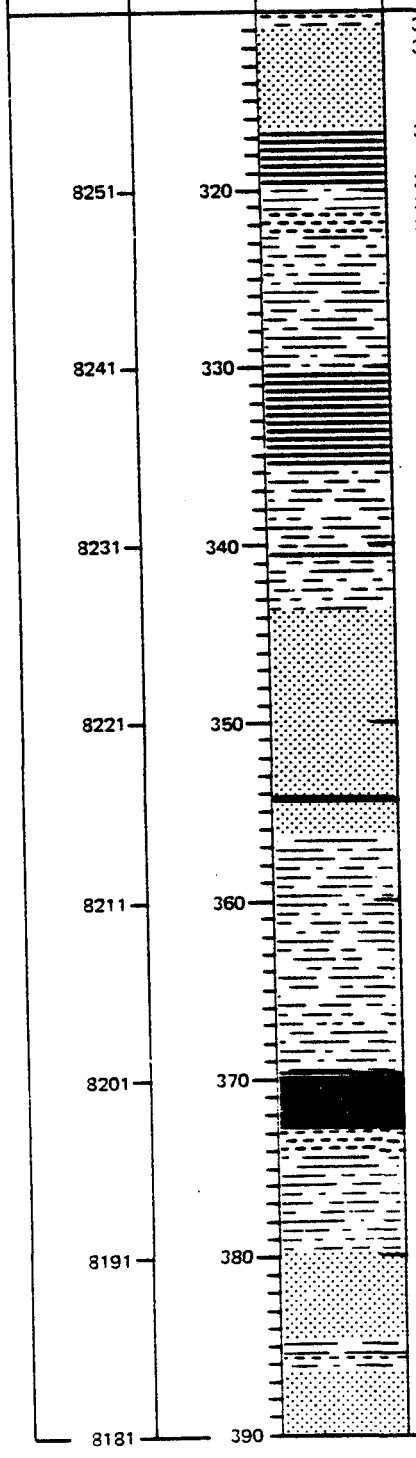
301.0 Sandstone, light gray, fine-grained, calcareous; contorted bedding

304.7 Siltstone, medium gray, calcareous

309.2 Shale, dark gray, argillaceous

PROJECT Wasatch Plateau Drilling SHEET 5 OF 7

SITE Johns Peak D.H. No. 8



DESCRIPTION

310.4 Siltstone, sandy, medium gray
311.0 Sandstone, light gray, fine-grained; some carbonaceous debris

316.4 Shale, black, carbonaceous, argillaceous

319.9 Siltstone, sandy, medium gray
321.3 Shale, dark gray, argillaceous
322.7 Siltstone, medium gray, fossiliferous; contorted bedding
325.7 Siltstone, medium gray, fossiliferous; contorted bedding; some coaly streaks; thin sandstone lenses

330.1 Shale, dark gray black, carbonaceous, argillaceous

335.7 Siltstone, sandy, medium gray

340.4 Shale, crumbly, gray, argillaceous
340.7 Siltstone, sandy, medium gray
343.7 Sandstone, light gray, fine-grained, friable, clean

346.0 Sandstone, light gray, fine-grained, friable, clean; becoming calcareous at 351 feet

354.1 Coal, crumbly, black, shiny
354.3 Sandstone, light gray, fine-grained, friable, calcareous; coaly streaks; carbonaceous film on bedding planes; contorted bedding
356.3 Siltstone, sandy, light gray; carbonaceous material on bedding planes
360.8 Siltstone, dark brown black; carbonaceous, coaly streaks
361.6 Siltstone, sandy, light gray; carbonaceous material on bedding planes

369.3 Siltstone, dark gray, carbonaceous
369.6 Shale, black, carbonaceous
369.8 Coal, brittle, black

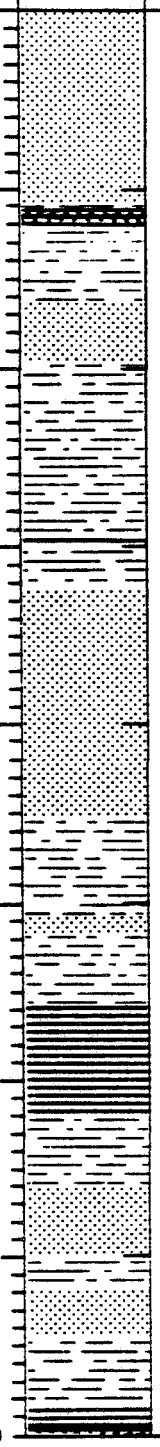
372.9 Shale, dark gray, argillaceous
374.1 Siltstone, sandy, light gray; less carbonaceous

379.9 Sandstone, medium gray, fine-grained, calcareous, thinly laminated; carbonaceous films on bedding planes

384.8 Siltstone, sandy, light to medium gray; carbonaceous films; thinly laminated; thin lenses of sandstone; some shaly partings
385.5 Shale, gray, argillaceous, fissile
385.8 Siltstone, sandy, dense, medium gray, calcareous; contorted bedding; carbonaceous films on bedding planes

PROJECT Wasatch Plateau Drilling SHEET 6 OF 7

SITE Johns Peak D.H. No. 8



DESCRIPTION

386.5 Sandstone, light gray, fine-grained, calcareous; carbonaceous films on bedding planes; contorted bedding; friable in places

400.8 Siltstone, dense, medium gray, calcareous; carbonaceous debris on bedding planes
401.1 Shale, dark gray, fissile, carbonaceous
401.2 Coal, bone
401.3 Coal, black, shiny
401.5 Coal, bone
401.7 Shale, black, fissile, carbonaceous
402.0 Siltstone, dense, medium gray, carbonaceous, calcareous; shaly partings
406.3 Sandstone, medium gray, fine-grained, calcareous; carbonaceous films; contorted bedding

409.6 Siltstone, medium gray, calcareous; carbonaceous films on bedding planes; contorted bedding

413.5 Siltstone, medium gray, calcareous; thinly laminated; carbonaceous films on bedding planes; contorted bedding; several shaly partings; some thin sandstone lenses

419.2 Shale, black, carbonaceous, argillaceous
420.0 Siltstone, black, carbonaceous, argillaceous

422.3 Sandstone, light gray, fine-grained, calcareous, friable, sugary
423.8 Sandstone, light gray, fine-grained, calcareous, friable, sugary; carbonaceous films on bedding planes; contorted bedding; coaly streaks

435.3 Siltstone, light gray, fine-grained, calcareous, friable; carbonaceous films on bedding planes; contorted bedding; coaly streaks

440.8 Sandstone, light gray, fine-grained, calcareous
441.8 Siltstone, light gray, calcareous

446.0 Shale, black to brown, carbonaceous, gummy

452.0 Siltstone, black, brown, carbonaceous, sticky

456.2 Sandstone, medium gray, fine-grained, friable; coaly streaks; carbonaceous material

460.0 Siltstone, medium gray, friable; coaly streaks; carbonaceous material
461.9 Sandstone, medium gray, fine-grained, calcareous; carbonaceous material on bedding planes
464.6 Siltstone, dark gray, thinly laminated

468.4 Shale, black, carbonaceous, argillaceous
469.3 Coal, hard, black, shiny, crumbly
469.8 Coal, bone

PROJECT Wasatch Plateau Drilling SHEET 7 OF 7

SITE Johns Peak D.H. No. 8

ELEVATION	DEPTH	LOG	DESCRIPTION
			470.0 Coal, black, shiny
			470.5 Coal, bone
			470.7 Shale, black, carbonaceous, fissile
			471.4 Siltstone, dense, medium gray, calcareous
			472.6 Coal, bone
			472.7 Coal, black, shiny
			473.2 Coal, bone
8091	480		473.3 Siltstone, dense, medium gray, calcareous
			473.5 Sandstone, medium gray, fine-grained, calcareous
			475.5 Sandstone, tan, medium-grained, friable; (sample saved) Star Point Sandstone
			478.1 Sandstone, gray, medium-grained, calcareous, friable
			485.1 Sandstone, light gray, medium- to coarse-grained
8081	490		
			495.1 Total depth hole No. 8
8071	500		

APPENDIX II

MEASURED SECTIONS OF THE BLACKHAWK FORMATION

Locations shown on Plates 4,5, and 6

GENERAL
STOREHOUSE
CHEVRON
GASOLINE

Section of Blackhawk Formation measured in the left fork Huntington Creek Canyon, sec. 18, T. 15 S., R. 7 E., SLBM, by F. Davis and L. Green, June 26, 1975.[1]

Castlegate Sandstone: sandstone, white to light gray, cross-bedded, medium-grained, calcareous.

Blackhawk Formation	Thickness, in feet
Sandstone, tan, fine-grained, cross-bedded, calcareous, thin-bedded, weathers light gray; some beds weather brown	21.4
Covered slope	41.6
Sandstone, tan, fine-grained, cross-bedded, calcareous, thin- to medium-bedded, ledge-forming; weathers light gray	49.0
Covered slope	155.0
Sandstone, tan, fine-grained, cross-bedded, calcareous, medium-bedded, ledge-forming; weathers light gray	6.6
Covered slope	136.5
Sandstone, yellowish gray, fine-grained, calcareous, ledge-forming; weathers light gray	1.3
Covered slope	72.4
Sandstone, tan, fine-grained, calcareous, ledge-forming; weathers yellow gray	5.8
Covered slope	199.4
Sandstone, tan, fine-grained; weathers light gray	2.2
Coal, black, weathered	0.9
Sandstone, tan, fine-grained, calcareous; weathers light gray	1.8
Shale, gray, thin-bedded	1.3
Sandstone, yellow gray, fine-grained, calcareous, medium- to thick-bedded, cliff-forming; weathers light gray	43.7
Shale, black, carbonaceous, thin-bedded	1.5
Coal, soft, black, weathered	3.4
Sandstone, tan, fine-grained, calcareous, thin-bedded, ledge-forming; weathers brown	23.1
Coal, black, weathered	7.4
Sandstone, tan, weathers light gray, fine-grained, calcareous, cliff-forming; weathers light gray	30.1
Coal, black, weathered	10.6
Total	815.0

Star Point Sandstone

Section of Blackhawk Formation measured in Crandall Canyon, NE¼ sec. 6, T. 16 S., R. 6 E., by F. Davis and L. Green, June 24, 1975.

Castlegate Sandstone: sandstone, orange-yellow brown, coarse- to medium-grained, cross-bedded; cliff-forming.

Blackhawk Formation	Thickness, in feet
Covered slope	129.1
Sandstone, tan, fine-grained, thin-bedded, ledge-forming; weathers reddish brown	16.8
Covered slope	23.8
Sandstone, tan, fine-grained, thin- to massive-bedded, cliff-forming; weathers brown	35.5
Covered slope	12.7
Sandstone, tan, fine-grained, thin-bedded, ledge-forming; weathers brown	43.3
Covered slope	16.0
Sandstone, tan, fine-grained, cross-bedded, calcareous, cliff-forming; weathers yellow brown	38.8
Covered slope	12.5
Sandstone, tan, fine-grained, cross-bedded, ledge-forming; weathers brown to light gray	18.5
Covered slope	30.0
Sandstone, tan, fine-grained, cross-bedded, cliff-forming; weathers yellow brown	26.6
Covered slope	35.2
Sandstone, tan, fine-grained, cross-bedded, cliff-forming; weathers brown	17.9
Covered slope	8.1
Sandstone, tan, fine-grained, calcareous, ledge-forming; weathers light gray	4.6
Covered slope	43.1
Sandstone, tan, fine-grained, calcareous, thin-bedded, ledge-forming; weathers yellow tan	6.2
Covered slope	15.6
Sandstone, tan, fine-grained, thin- to medium-bedded, ledge-forming; weathers yellow brown	3.8
Shale, carbonaceous, thin-bedded	1.0
Covered slope	39.6
Sandstone, tan, fine-grained, thin- to medium-bedded, ledge-forming; weathers brown	20.8
Covered slope	16.5
Sandstone, tan, fine-grained, cross-bedded, medium-bedded, ledge-forming; weathers brown	26.0
Covered slope	32.1
Sandstone, tan, fine-grained, ledge-forming; weathers brown	4.2
Covered slope	13.1
Sandstone, brown, fine-grained, calcareous, ledge-forming; weathers reddish brown	11.6
Covered slope	6.7
Sandstone, tan to brownish red, fine-grained, calcareous, ledge-forming	6.5
Sandstone, brownish red, fine-grained, thin-bedded, ledge-forming	5.6
Covered slope	10.7
Sandstone, tan to reddish brown, fine-grained, thin-bedded, ledge-forming	2.8
Covered slope	36.4
Sandstone, tan, fine-grained, calcareous, ledge-forming; weathers reddish brown	22.6
Covered slope	33.3
Sandstone, tan, fine-grained, calcareous, ledge-forming; weathers brown	3.4
Covered slope	16.5
Sandstone, tan, fine-grained, calcareous, ledge-forming; weathers brown	4.4
Covered slope	29.0
Sandstone, tan, fine-grained, ledge-forming; weathers brown	2.0
Covered slope	16.5
Sandstone, tan, fine-grained, calcareous, ledge-forming	2.5
Shale, dark gray, thin-bedded, carbonaceous	1.5
Coal, black; weathers gray brown; base not exposed; measured in mine ventilation tunnel	5.3
Total	908.7

Star Point Sandstone

[1] All legal descriptions of locations in this report are from the Salt Lake Base and Meridian (SLBM).

Section of Blackhawk Formation measured in Rilda Canyon, N½ sec. 29, T. 16 S., R. 7 E., by F. Davis, D. Purvance, and L. Green, June 12, 1975.

Castlegate Sandstone: sandstone, orange brown, fine- to medium-grained, cross-bedded, cliff-forming.

Blackhawk Formation	Thickness, in feet
Shale, gray, thin-bedded; lenses and streaks of alum	2.5
Sandstone, tan, fine-grained, thin-bedded, ledge-forming; weathers yellow brown	3.2
Covered slope	98.4
Sandstone, tan, fine-grained, calcareous, ledge-forming; weathers brown	6.3
Covered slope	61.0
Sandstone, tan, fine-grained, cross-bedded, cliff-forming; weathers brown	18.0
Covered slope	15.5
Sandstone, tan, fine-grained, cross-bedded, calcareous, cliff-forming; weathers yellow brown	14.2
Covered slope	89.2
Sandstone, tan, fine-grained, ledge-forming; weathers brown	1.4
Covered slope	36.9
Sandstone, tan, fine-grained, calcareous, cross-bedded, ledge-forming; weathers yellow brown	8.4
Covered slope	8.3
Sandstone, tan, cross-bedded, fine-grained, calcareous, ledge-forming; weathers brown	11.6
Covered slope	31.4
Shale, carbonaceous; weathered light gray to black	1.5
Covered slope	2.5
Shale, carbonaceous; weathered dark gray to black	1.5
Covered slope	66.3
Sandstone, brown, fine-grained, cross-bedded, calcareous, ledge-forming; weathers reddish brown	10.9
Shale, sandy, light gray, thin-bedded, slope-forming	12.3
Sandstone, reddish brown, fine-grained, medium-bedded to massive, calcareous, cliff-forming	49.5
Sandstone, reddish brown, fine-grained, thin- to medium-bedded, ledge-forming	8.0
Shale, light gray, thin-bedded; weathers cream color	1.2
Covered slope	79.8
Shale, gray, thin-bedded; salmon-colored to tan, thin-bedded sandstone; thin bed of coal, 0.5 foot	7.9
Coal bed	6.0
Total	653.7

Star Point Sandstone

Partial section of Blackhawk Formation and complete section of Castlegate Sandstone measured northwest of drill site 2, from Joes Valley fault to the top of the Castlegate Sandstone, NE¼SW¼ sec. 22, T. 16 S., R. 6 E., by J. Call and L. Green, September 6, 1975.

Castlegate Sandstone	Thickness, in feet
Sandstone, tan, medium-grained, calcareous, ledge-forming; weathers light tan	48.3
Sandstone, tan, medium-grained, contorted bedding, weathers to light tan; calcareous, friable, cliff-forming; contorted bedding	98.0
Sandstone, tan, medium-grained, calcareous, cross-bedded, ledge-forming; becomes coarser on bedding planes; weathers light tan	51.3
Total	197.6

Blackhawk Formation	Thickness, in feet
Covered slope	54.1
Sandstone, tan, fine-grained, calcareous, ledge-forming; weathers tan	4.7
Covered slope	40.0
Sandstone, light tan, fine-grained, calcareous, ledge-forming	9.3
Covered slope	128.9
Sandstone, light tan, fine-grained, calcareous, slope-forming; interbedded with shales and siltstones	18.2
Sandstone, light tan, fine-grained, calcareous, cliff-forming; weathers light tan	20.7
Sandstone, tan, fine-grained, calcareous; weathers light tan; interbedded with thin-bedded shales and siltstones	4.0
Covered slope	7.6
Total	287.5

Joes Valley Fault

Partial section of Blackhawk Formation and complete section of Castlegate Sandstone measured from fault line on west side of Joes Valley, just north of Black Canyon, to top of Castlegate Sandstone, NW¼ sec. 32, T. 16 S., R. 6 E., by F. Davis, J. Call, and L. Green, September 9, 1975.

Castlegate Sandstone	Thickness, in feet
Sandstone, yellow tan, medium-grained, calcareous, cross-bedded, cliff-forming; coarse-grained material on bedding planes	114.0
Covered slope	121.2
Sandstone, yellowish brown, fine-grained, calcareous, cliff-forming	35.0
Total	270.2

Blackhawk Formation	Thickness, in feet
Covered slope	15.5
Sandstone, gray, medium-grained, calcareous, ledge-forming; weathers brown	17.4
Covered slope	4.4
Sandstone, gray, fine-grained, cross-bedded, calcareous, cliff-forming; weathers tan	18.3
Covered slope	30.8
Sandstone, medium gray, medium-grained, calcareous, cliff-forming; weathers tan	15.7
Covered slope	229.1
Sandstone, brownish gray, fine- to medium-grained, calcareous, ledge-forming; weathers brown	11.3
Covered slope	226.9
Total	569.4

Fault line

Partial section of Blackhawk Formation and complete section of Castlegate Sandstone measured in NW¼SW¼ sec. 4, T. 17 S., R. 6 E., by F. Davis, J. Call, and L. Green, September 10, 1975.

	Thickness, in feet
Castlegate Sandstone	
Sandstone, yellowish gray, medium- to coarse-grained, calcareous, cross-bedded, cliff-forming; weathers light gray	122.7
Blackhawk Formation	
Covered slope	37.9
Shale, gray, weathered	0.9
Sandstone, light gray, fine-grained, calcareous, ledge-forming; weathers grayish tan	11.9
Covered slope	58.1
Sandstone, light gray, medium-grained, calcareous; weathers tan	14.0
Covered slope	224.5
Total	347.3
Joes Valley Fault	

Partial section of Blackhawk Formation and complete section of Castlegate Sandstone measured from drill site 2 to the top of Castlegate Sandstone, SW¼SE¼ sec. 22, T. 16 S., R. 6 E., by J. Call and L. Green, September 3, 1975.

	Thickness, in feet
Castlegate Sandstone	
Sandstone, tan, ledge-forming; intermittent covered slopes	19.3
Covered slope	49.4
Sandstone, white to light tan, fine- to medium-grained, calcareous, friable, cross-stratified; weathers white	9.8
Covered slope	47.2
Sandstone, light to medium tan, medium-grained, cross-stratified, friable, calcareous; coarse materials on cross stratification; weathers light tan	10.9
Covered slope	8.7
Sandstone, light to medium tan, medium-grained, cross-stratified, friable, calcareous, cliff-forming; coarse material on cross stratifications; weathers light tan	64.7
Total	210.0
Blackhawk Formation	
Covered slope	154.8
Drill Site 2	

Section of Blackhawk Formation and Castlegate Sandstone measured from drill site 3 to top of Castlegate Sandstone, SE¼SE¼ sec. 3, T. 17 S., R. 6 E., by J. Call and L. Green, September 3, 1975.

	Thickness, in feet
Castlegate Sandstone	
Sandstone, dark brown, medium-grained, friable, calcareous, cross-bedded, cliff-forming; weathers light tan	80.5
Covered slope	18.3
Sandstone, dark brown, medium-grained, friable, calcareous, cross-bedded, cliff-forming; weathers light tan; becomes conglomeratic on bedding planes	17.2
Covered slope	35.9
Sandstone, dark tan, medium-grained, friable, calcareous, cross-bedded, cliff-forming; weathers light tan; becomes conglomeratic on bedding planes	64.9
Total	216.8
Blackhawk Formation	
Covered slope	288.4
Drill Site 3	

Partial section of Blackhawk Formation measured from drill site 3 to base of Castlegate Sandstone, SW¼SW¼ sec. 2, T. 17 S., R. 6 E., by F. Davis, L. Green, and D. Purvance, June 18, 1975.

Castlegate Sandstone: sandstone, light gray to yellow, medium- to coarse-grained, cliff-forming.

Blackhawk Formation	
Covered slope	165.4
Drill Site 3	

Partial section of Blackhawk Formation measured from drill site 4 to base of Castlegate Sandstone, SE¼SW¼ sec. 24, T. 17 S., R. 6 E., by F. Davis, L. Green, and D. Purvance, June 16, 1975.

Castlegate sandstone: base not exposed; but a few feet above are a few outcrops of brown orange, medium- to coarse-grained sandstone.

	Thickness, in feet
Blackhawk Formation	
Covered slope	21.9
Sandstone, tan, fine-grained, calcareous, ledge-forming; weathers light gray	4.1
Covered slope	15.3
Sandstone, tan, fine-grained, ledge-forming; weathers brown	3.6
Covered slope	7.6
Sandstone, tan, fine-grained, ledge-forming; weathers yellow brown	2.7
Covered slope	156.1
Sandstone, tan, fine-grained, ledge-forming; weathers brown	10.1
Covered slope	160.7
Total	382.1
Drill Site 4	

Section of Blackhawk Formation measured in Cottonwood Canyon, N½ sec. 25, T. 17 S., R. 6 E., by H. Doelling and F. Davis, May 28, 1975.

	Thickness, in feet
Castlegate Sandstone	
Massive sandstone cliff	150.0

Blackhawk Formation

Shale, gray; thin-bedded sandstone	6.0
Sandstone, thin- to thick-bedded, slope-forming	121.8
Sandstone, possibly lower Castlegate	37.3
Covered slope	15.7
Sandstone, platy to blocky; slope-forming, thin shale partings	19.9
Sandstone, thick-bedded, ledge-forming	10.5
Sandstone, shaly; alternating with clayey sandstone and shale	47.4
Sandstone, thick-bedded, ledge-forming	5.4
Sandstone, shaly, thin-bedded	11.7
Sandstone, thick-bedded, ledge-forming	8.7
Sandstone, thin- to medium-bedded; thin- to medium-bedded shale	36.0
Sandstone, cliff-forming	24.2
Shale; shaly sandstone	40.4
Sandstone, tan, medium-bedded, ledge-forming	3.5
Shale	2.9
Sandstone, tan, medium-bedded, ledge-forming	1.7
Shale; shaly sandstone; slope-forming	4.0
Sandstone, medium- to thick-bedded, ledge-forming	5.2
Shale; shaly sandstone; occasional thin coal seam	41.1
Sandstone, medium- to thick-bedded, ledge-forming, blocky-weathering	3.2
Sandstone, thin- to medium-bedded; some shale	7.6
Sandstone, thin- to medium-bedded	14.5
Sandstone, ledge-forming	6.3
Covered slope	44.7
Possible coal bed	2.0
Shale, gray; thin-bedded sandstone	13.0
Sandstone, thick-bedded, cliff-forming	11.0
Covered slope	9.0
Sandstone, massive, cliff-forming	27.1
Covered slope	26.2
Coal, poorly exposed	1.9
Shale; interbedded with sandstone	14.8
Coal, poorly exposed	4.5
Shale; interbedded with shaly sandstone	11.0
Sandstone, tan, cliff-forming	16.9
Covered slope	7.1
Sandstone	8.4
Covered slope	29.7
Sandstone, massive	20.6
Covered slope	5.9
Sandstone	19.3
Sandstone, tan, massive; immediately overlies coal; then covered by landslide slope; much boulder and debris; major part underlain by alternating shale and soft sandstone; one or two thin coal beds	40.1
Coal	0.6
Coal, bone	0.6
Sandstone, thin-bedded; interbedded with shale	0.8
Shale, carbonaceous	0.5
Shale, gray	0.5
Sandstone	2.8
Shale, carbonaceous	0.4
Coal	1.0
Coal, bone	0.2
Sandstone, pinches and swells	2.6
Shale	0.2
Hiawatha coal bed	8.6
Total	807.0

Star Point Sandstone

Section measured from top of Trail Mountain to Joes Valley fault, NE¼ sec. 20, N½ sec. 21, and NW¼ sec. 22, T. 17 S., R. 6 E., by F. Davis and J. Call, September 8, 1975.

Flagstaff Limestone	Thickness, in feet
Limestone, light gray, dense, fossiliferous, thin-bedded	25.2
Covered slope	79.4
Total	104.6

North Horn Formation

Covered slope	117.1
Sandstone, light gray to tan and greenish brown, fine-grained, thin-bedded, calcareous	22.2
Covered slope	256.2
Sandstone, light gray, fine-grained, calcareous, ledge-forming; weathers tan	16.9
Covered slope	92.3
Sandstone, gray, fine-grained, calcareous, thin-bedded; weathers light tan	9.3
Covered slope	69.1
Sandstone, tan, fine-grained, thin-bedded, calcareous, slope-forming	3.1
Covered slope	337.4
Sandstone, light tan gray, fine-grained, thin-bedded, calcareous, cliff-forming	14.5
Covered slope	40.5
Total	978.6

Mesaverde Group Price River Formation Upper Price River Member	Thickness, in feet
Covered slope	81.7
Sandstone, light gray, fine-grained, thin-bedded, calcareous, ledge-forming; weathers tan	8.7
Covered slope	148.5
Sandstone, gray, fine-grained, calcareous, ledge-forming; weathers tan	11.8
Covered slope	68.2
Sandstone, dark tan, fine-grained, calcareous, thin-bedded; some ripple marks; forms ribs on slope; weathers tan	15.3
Covered slope	80.9
Sandstone, tan, fine-grained, calcareous, cross-bedded, thin-bedded; weathers tan gray	16.5
Covered slope	38.5
Sandstone, tan, thin-bedded, calcareous, fine- to medium-grained, cross-bedded; some contorted bedding; forms several ledges in canyon bottom; weathers light tan	19.0
Shale, grayish brown, fissile, ledge-forming	3.5
Sandstone, grayish tan, medium- to coarse-grained, cross-bedded; some contorted bedding; a few thin pebble conglomerate beds	49.0

Shale, gray, fissile 2.4
Covered slope 128.8

Total 672.8

Castlegate Sandstone Member	Thickness, in feet
Sandstone, tan, medium-grained, calcareous, cliff-forming	.39.7
Sandstone, yellow brown, medium- to coarse-grained, cross-bedded, calcareous, cliff-forming; contorted bedding	.42.1
Conglomerate; interbedded with coarse grained, cross-bedded sandstone; cliff-forming	.19.7
Sandstone, tan, medium- to coarse-grained, cross-bedded, cliff-forming; weathers light gray	8.3
Sandstone, tan, coarse-grained, calcareous, cliff-forming; weathers light gray	.63.1
Total	.172.9

Mesaverde Group Blackhawk Formation	Thickness, in feet
Covered slope	.102.1
Sandstone, light gray, fine-grained, calcareous, ledge-forming; weathers tan	.24.9
Covered slope	.72.4
Sandstone, gray, fine-grained, calcareous, ledge-forming; weathers tan	.33.9
Covered slope	.106.6
Total	.339.9

Joes Valley Fault

Section of Blackhawk Formation measured in Straight Canyon, NW¼ sec. 12 and SW¼ sec. 1, T. 18 S., R. 6 E. for stratigraphic and elevation control of drill hole 5, by F. Davis and L. Green, June 3, 1975.

Castlegate Sandstone Member Blackhawk Formation	Thickness, in feet
Covered slope	.26.9
Sandstone, tan, fine-grained, cross-bedded, calcareous, ledge-forming	.12.5
Covered slope	.19.7
Shale, gray, thin-bedded; interbedded with thin-bedded tan sandstone; ledge-forming	6.6
Covered slope	.82.3
Sandstone, tan, fine-grained, ledge-forming; weathers brown	.17.1
Covered slope	.121.7
Sandstone, fine-grained, medium- to to thick-bedded; calcareous, ledge-forming	.12.5
Sandstone, tan, medium- to thick-bedded; interbedded with two thin gray shale beds	.38.0
Covered slope	.32.4
Sandstone, light gray, thin-bedded, ledge-forming; weathers brown	6.2
Shale, gray, fissile; interbedded with thin-bedded tan sandstone	9.0
Covered slope	9.9
Sandstone, tan, fine-grained, calcareous, thin-bedded; weathers brown	5.0
Covered slope	.18.0
Shale, gray, thin-bedded; interbedded with tan sandstone	6.3
Sandstone, light gray, fine-grained, thin- to medium-bedded, calcareous; weathers brown	5.2
Shale, light gray, fissile, slope-forming; weathers brown	.24.5
Sandstone, brown, fine-grained, calcareous, ledge-forming	2.9
Shale, light gray, fissile; weathers reddish brown; interbedded with thin-bedded sandstone	7.4
Sandstone; leached white, cliff-forming	1.5
Sandstone, tan, fine-grained; cliff-forming	.29.7
Covered slope	.47.7
Sandstone, tan, fine-grained, thin-bedded, calcareous, ledge-forming	1.2
Covered slope	8.6
Sandstone, tan, fine-grained, cross-bedded, calcareous, cliff-forming	7.0
Covered slope	.12.7
Sandstone, tan, thin-bedded, ledge-forming; weathers yellow brown	2.1
Covered slope	.30.6
Sandstone, tan, fine-grained, calcareous, thin- to medium-bedded, ledge-forming	3.6
Shale, light gray, thinly laminated; weathers brown	3.1
Sandstone, tan, fine-grained, calcareous, ledge- and cliff-forming; weathers yellow brown	.21.7
Covered slope	7.4
Sandstone, tan to yellow brown, thin-bedded, ledge-forming	1.2
Covered slope	5.8
Sandstone, light gray to yellow brown, thin-bedded, calcareous, ledge-forming	1.0
Covered slope	.11.5
Sandstone, tan, fine-grained, calcareous, thin-bedded	2.4
Shale, gray, carbonaceous	1.9
Sandstone, light gray, ledge-forming; weathers yellow brown	1.0
Covered slope	.15.8
Sandstone, fine-grained, medium- to thick-bedded, calcareous, cross-bedded, ledge-forming	.49.9
Shale, gray, thinly laminated; interbedded with thin-bedded sandstone	4.3
Covered slope	8.1
Sandstone, tan, fine-grained, calcareous, ledge-forming; weathers yellow brown	8.1
Sandstone, tan; interbedded with shale	8.6
Covered slope	.16.3
Sandstone, tan, medium-grained, calcareous	
Shale, thin-bedded; interbedded with sandstone	2.6
Sandstone, tan, fine-grained, ledge-forming	4.2
Covered slope	.41.2
Shale, gray; overlying tan sandstone	.24.9
Coal	0.3
Sandstone, tan, fine-grained	0.7
Shale, soft, gray	0.8
Limestone, hard, gray	0.4
Shale, soft, gray	0.3
Coal, dark gray to black, weathered	0.7
Covered slope	.10.5
Sandstone, tan, thin-bedded, ledge-forming; interbedded with thin-bedded gray shale; weathers tan	6.1
Covered slope	.28.0
Sandstone, tan, thin-bedded; weathers brown	2.8

Covered slope	26.3
Coal, soft, black, crumbly	0.9
Covered slope	2.3
Shale, gray, thinly laminated, slope-forming	3.3
Sandstone, tan, fine-grained, ledge-forming; weathers brown	1.1
Covered slope	38.4
Sandstone, tan, fine-grained, calcareous, ledge-forming; weathers brown	3.4
Covered slope	3.9
Sandstone, tan, fine-grained, ledge-forming; weathers brown	1.0
Covered slope	33.6
Hiawatha coal	5.2
Total	1,030.3

Partial section of Blackhawk Formation measured from drill site 5 to the base of Castlegate Sandstone, SW¼NW¼ sec. 3, T. 18 S., R. 6 E., by F. Davis and J. Call, June 6, 1975.

Castlegate Sandstone: tan to yellow, coarse-grained, cliff-forming.

Blackhawk Formation	Thickness, in feet
Shale, light gray, fissile	59.2
Sandstone, light gray, fine-grained, ledge-forming	1.2
Shale, light gray, carbonaceous	6.3
Sandstone, tan, ledge-forming; weathers yellow brown	11.8
Sandstone, tan; weathers yellow brown	2.3
Shale; pinches out laterally	0.6
Sandstone, tan; weathers yellow brown	0.6
Shale, dark gray, carbonaceous	0.6
Sandstone, tan; weathers yellow brown	1.1
Shale, light gray, thinly laminated, slope-forming	13.1
Sandstone, light gray, fine-grained, calcareous, cross-bedded, ledge-forming; weathers brown	5.7
Covered slope	116.7
Sandstone, tan to light gray, fine-grained, cross-bedded, ledge-forming	13.5
Shale, gray, carbonaceous	0.7
Covered slope	42.5
Sandstone, tan, fine-grained, ledge-forming; weathers brown	3.0
Sandstone, tan, fine-grained, calcareous, cliff-forming	13.6
Covered slope	13.8
Sandstone, tan, fine-grained, calcareous, thin-bedded to massive, ledge-forming; weathers brown	12.0
Shale, fissile, thin-bedded, slope-forming; weathers brown	14.7
Covered slope	50.5
Sandstone, tan, cross-bedded; weathers yellow brown	14.1
Covered slope	26.3
Coal, soft, black, weathered	1.0
Sandstone, light gray, fine-grained, ledge-forming; weathers gray brown	3.9
Total	428.8

Section of the Blackhawk Formation and Castlegate Sandstone measured near the Anderson mine in the NW¼NE¼ sec. 7, T. 19 S., R. 7 E., by H. Doelling and J. Call, July 1975.

Castlegate Sandstone	Thickness, in feet
Sandstone, cliff-forming	215.0
Blackhawk Formation	
Sandstone, shaly, slope-forming	18.1
Sandstone, cliff-forming	50.2
Shale	3.4
Sandstone, massive, cliff-forming	35.6
Sandstone, shaly, slope-forming	84.9
Sandstone, cliff-forming	35.4
Sandstone, shaly, slope-forming	35.9
Sandstone; occasional shaly sandstone partings	145.2
Sandstone, shaly	167.8
Sandstone, massive, cliff-forming	33.1
Shale	44.3
Siltstone	4.6
Covered slope	70.1
Sandstone, cliff-forming	13.0
Coal	2.0
Covered slope	9.6
Sandstone, cliff-forming	25.3
Sandstone, shaly	19.6
Sandstone	3.9
Covered slope	81.7
Coal, Hiawatha bed	11.0
Shale, dark gray	0.5
Total	895.2
Star Point Sandstone	

Partial section of Blackhawk Formation and complete section of Castlegate Sandstone measured in Rock Canyon near drill hole 6, NW¼ sec. 12, T. 19 S., R. 6 E., by L. Green and D. Purvance, June 10 and 18, 1975.

Castlegate Sandstone	Thickness, in feet
Tan, medium- to coarse-grained, cross-bedded, cliff-forming; weathers buff to white	223.0
Blackhawk Formation	
Sandstone, tan, cross-bedded; interbedded with thin-bedded shale	122.0
Covered slope	72.0
Sandstone, tan, fine-grained, cliff-forming; weathers brown	17.9
Covered slope	32.2
Sandstone, fine-grained, cross-bedded, well-sorted, cliff-forming	22.5
Covered slope	52.2
Sandstone, tan, fine-grained; interbedded with carbonaceous shale; slope-forming	9.7
Sandstone, tan, fine- to medium-grained, calcareous, cliff-forming; weathers yellow brown	12.
Shale, gray, carbonaceous, slope-forming	1.
Covered slope	10.
Sandstone, light tan, medium-grained, ledge-forming; weathers brown	4.8

Covered slope 40.2
Sandstone, tan, fine-grained, cross-bedded, calcareous, cliff-forming; weathers brown 33.7
Covered slope 16.9
Sandstone; interbedded with carbonaceous shale; ledge-forming 19.8
Sandstone, dark brown, fine-grained, calcareous, cliff-forming; weathers red brown 2.9
Covered slope 12.7
Sandstone; interbedded with thin-bedded, carbonaceous shale 13.3
Sandstone, tan, ledge-forming; weathers brown 1.2
Covered slope 11.5
Sandstone, tan, thin-bedded, ledge-forming; weathers brown; interbedded with gray shale 3.0
Covered slope 11.2
Shale, gray black, carbonaceous, laminated 0.9
Sandstone, interbedded with laminated shale; yellow brown; weathers brown 8.2
Covered slope 12.1
Sandstone, reddish tan, fine-grained, ledge-forming; weathers brown 3.0
Shale, carbonaceous, thin-bedded 2.0
Sandstone, tan; interbedded with gray shale; thin-bedded 4.0
Sandstone, tan, fine-grained, thin-bedded, calcareous, ledge-forming; weathers brown 4.5
Covered slope 3.7
Coal seam 0.5
Covered slope 37.7
Sandstone, tan, fine-grained, cross-bedded, calcareous, cliff-forming 16.6
Covered slope 28.7
Coal seam 1.0
Sandstone, cliff-forming 16.0
Coal seam 3.6
Sandstone, tan, fine-grained, thin- to medium-bedded, ledge-forming; weathers brown 7.7
Shale, gray, carbonaceous, thin-bedded 0.2
Covered slope 47.8
Shale, gray, thin- and wavy-bedding; weathers tan 2.7
Shale, dark gray, carbonaceous, thin-bedded; leaf and wood stem imprints 0.2
Shale, gray, thin-bedded, wavy bedding; weathers tan 15.1
Coal, dark gray to black, thin-bedded; some beds grade laterally into carbonaceous shale 1.8

Total 742.4

Section of Blackhawk Formation measured from drill site 7 to the base of Castlegate Sandstone, N½ sec. 15, T. 24 S., R. 4 E., by F. Davis, L. Green, and D. Purvance, June 11, 1975.

Castlegate Sandstone: sandstone, yellow brown, medium- to coarse-grained; forms ridge top.

Blackhawk Formation	Thickness, in feet
Covered slope	.10.2
Sandstone, tan, fine-grained, ledge-forming; weathers brown	.19.2
Covered slope	9.8
Sandstone, tan, fine-grained, cross-bedded, cliff-forming; weathers brown	.15.0
Covered slope	.16.1
Sandstone, brown, fine-grained, calcareous	1.0
Covered slope	.48.8
Sandstone, tan, fine-grained, ledge-forming; weathers brown	0.2
Covered slope	.12.0
Sandstone, tan, fine-grained, calcareous, ledge-forming; weathers yellow brown	0.9
Covered slope	.10.2
Sandstone, tan, fine-grained, cross-bedded, ledge-forming; weathers brown	6.3
Covered slope	.12.1
Sandstone, tan to light gray, fine-grained, ledge-forming; weathers gray	1.3
Covered slope	2.6
Sandstone, tan, fine-grained, cross-bedded, calcareous, ledge-forming; weathers brown	2.6
Covered slope	.17.5
Sandstone, tan, fine-grained, calcareous, ledge-forming; weathers light gray	0.9
Covered slope	5.3
Sandstone, tan, fine-grained, ledge-forming; weathers brown	2.6
Covered slope	.49.6
Total	.244.2
Drill Site 7	

Section of Blackhawk Formation measured in Clear Creek Canyon, SW¼ sec. 10 and NW¼ sec. 15, T. 24 S., R. 4 E., by F. Davis and J. Call, June 5, 1975.

Castlegate Sandstone: Sandstone, tan yellow, medium- to coarse-grained, cross-bedded

Blackhawk Formation	Thickness, in feet
Covered slope	.238.1
Sandstone, tan, fine-grained, calcareous, ledge-forming; weathers yellow brown	3.7
Covered slope	.84.8
Shale, gray, carbonaceous	0.6
Covered slope	.104.6
Shale, dark gray, carbonaceous	4.8
Covered slope	.42.8
Sandstone, tan, fine-grained, calcareous, ledge-forming; weathers brown	1.5
Covered slope	.42.4
Coal bed	4.1
Total	.572.2
Star Point Sandstone	

Section of Blackhawk Formation measured from drill site 8 to the base of Castlegate Sandstone, SE¼ sec. 21, T. 24 S., R. 4 E., by F. Davis, D. Purvance, and L. Green, June 11, 1975.

Castlegate Sandstone Blackhawk Formation	Thickness, in feet
Covered slope	.49.8
Drill Site 8	

Section of Blackhawk Formation, south of Johns Peak, measured in sec. 27, T. 24 S., R. 4 E., by F. Davis, L. Green, and D. Purvance, June 19, 1975.

Castlegate Sandstone: sandstone, light gray to orange brown, medium- to coarse-grained; forms ridge top.

Blackhawk Formation	Thickness, in feet
Covered slope	164.1
Coal, dark gray to black, weathered	4.1
Covered slope	126.9
Shale, gray, thin-bedded, weathered; weathers light gray	1.1
Covered slope	93.5
Shale, light gray, thin-bedded	0.4
Covered slope	2.4
Coal, black, weathered	0.4
Total	392.9
Star Point Sandstone	

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CONVERSION TABLE FOR ENGLISH AND METRIC UNITS

Acre	0.4047 hectare
Acre-foot	1233.49 cubic meters
BTU	0.252 kilogram-calorie
Centimeter	0.3937 inch
Cubic meter	264.2 gallons
Foot	30.48 centimeters
Gallon	3.785 liters
Gram	0.03527 ounce
Gram	0.03215 ounce (troy)
Hectare	2.471 acres
Inch	2.540 centimeters
Kilogram	2.205 pounds
Kilogram-calorie	3.968 BTU
Kilometer	3,281 feet
Kilometer	0.6214 mile
Liter	0.2642 gallon
Meter	3.281 feet
Meter	39.37 inches
Mile	1.609 kilometers
Ounce	28.349527 grams
Ounce (troy)	31.103481 grams
Pound	453.5924 grams
Ton (short)	0.907 metric ton
Ton (long)	1.016 metric tons
Ton (metric)	1.1025 short tons
Yard	0.9144 meter

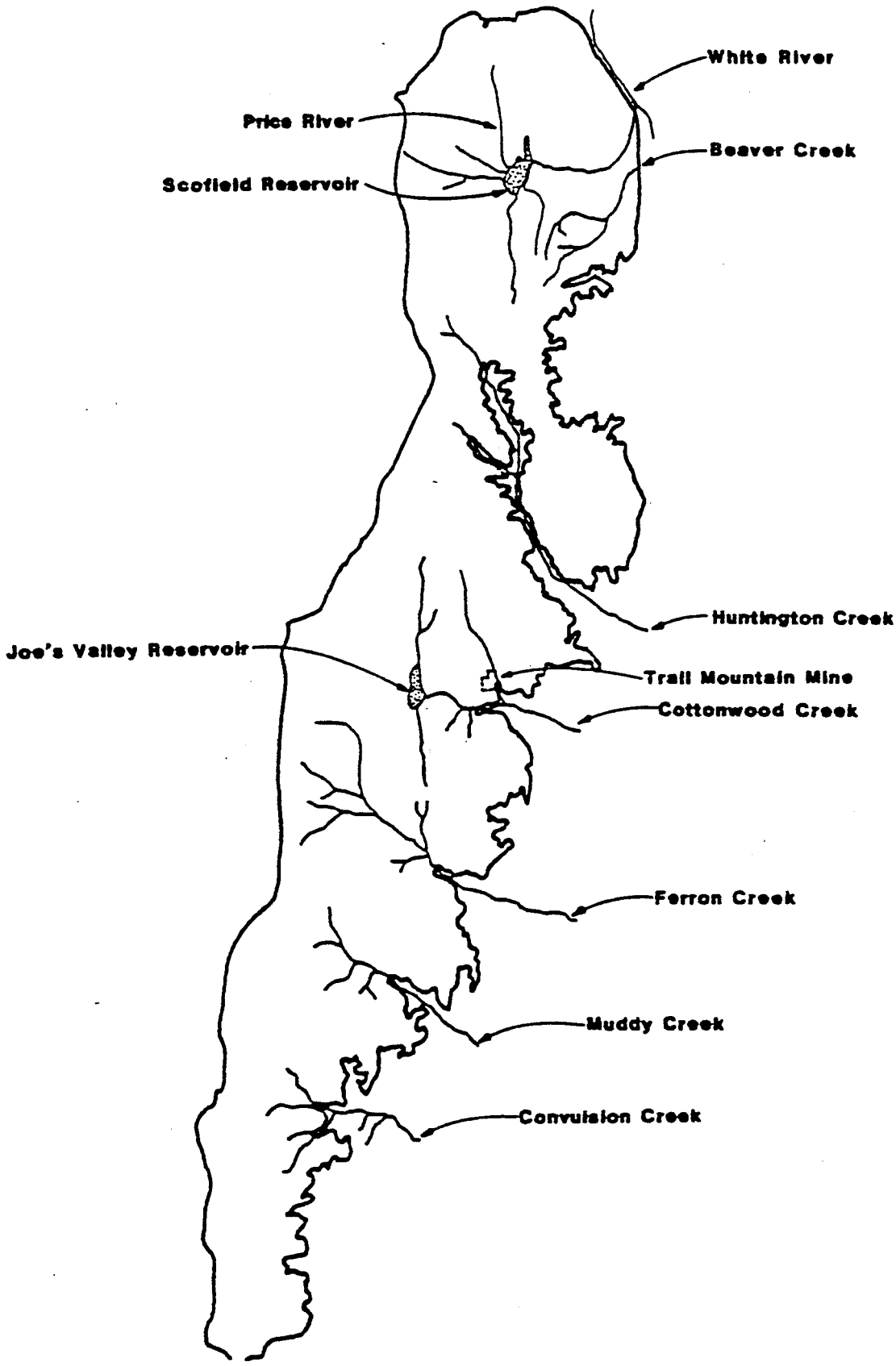

FIGURE 6-1 LOCATION MAP

FIGURE 6-1

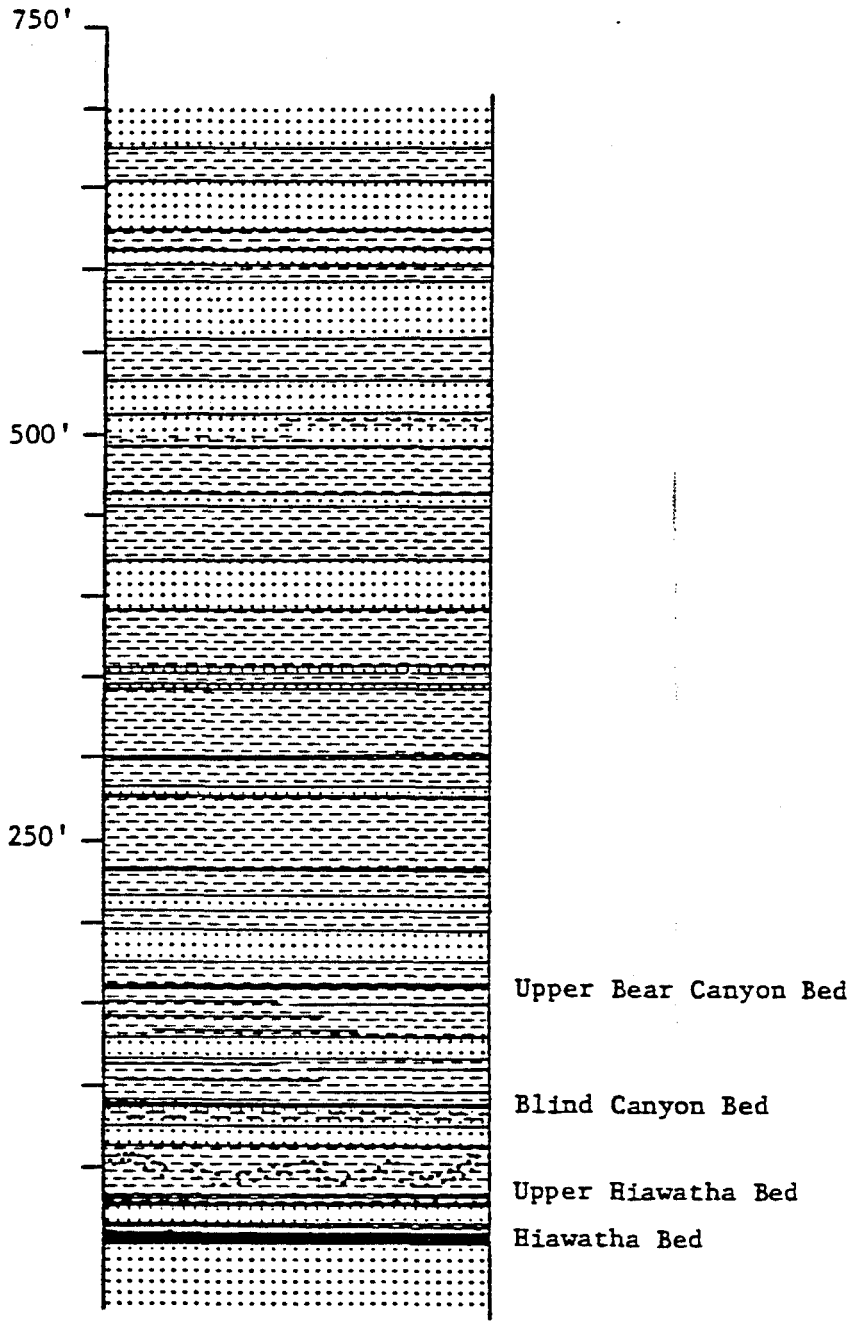

FIGURE 6-7 LOCAL STRATIGRAPHIC COLUMN

FIGURE 6-7

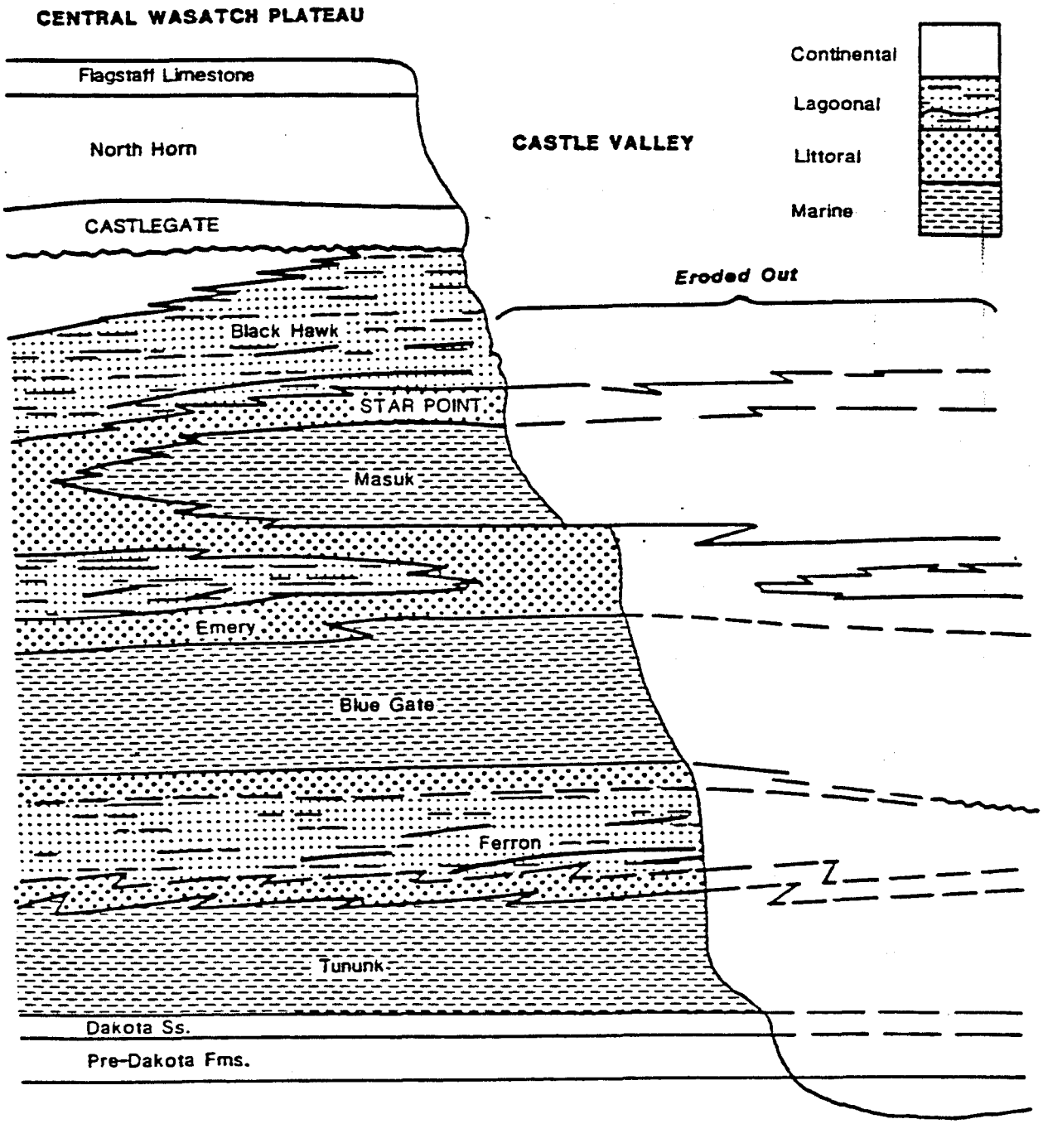

FIGURE 6-3 STRATIGRAPHIC CORRELATION DIAGRAM

FIGURE 6-3

SYSTEM	SERIES	STRATIGRAPHIC UNIT		THICKNESS (feet)	DESCRIPTION
TERTIARY	Paleocene	Wasatch Group	Flagstaff Limestone	200-1,500	Dark yellow-gray to cream limestone, evenly bedded with minor amounts of sandstone, shale and volcanic ash, ledge former.
CRETACEOUS	? Maestrichthian	Wasatch Group	North Horn Formation (Lower Wasatch)	500-2,500	Variegated shales with subordinate sandstone, conglomerate and freshwater limestone, thickens to north, slope former.
	Campanian	Mesaverde Group	Price River Formation	600-1,000	Gray to white gritty sandstone interbedded with subordinate shale and conglomerate, ledge and slope former.
			Castlegate Sandstone	150- 500	White to gray, coarse-grained often conglomeratic sandstone, cliff former, weathers to shades of brown.
			Blackhawk Formation MAJOR COAL SEAMS	700-1,000	Yellow to gray, fine- to medium-grained sandstone, interbedded with subordinate gray and carbonaceous shale, several thick coal seams.
			Star Point Sandstone	90-1,000	Yellow-gray massive cliff-forming sandstone, often in several tongues separated by Masuk Shale, thickens westward.
	Santonian	Mancos Shale	Masuk Shale	300-1,300	Yellow to blue-gray sandy shale, slope former, thick in north and central plateau area, thins southward.
			Emery Sandstone COAL (?)	50- 800	Yellow-gray friable sandstone tongue or tongues, cliff former, may contain coal (?) in south part of plateau if mapping is correct, thickens to west and south. Coal may be present in subsurface to west.

FIGURE 6-2 GENERALIZED STRATIGRAPHIC SECTION

FIGURE 6-2