

CHAPTER VI
GEOLOGY

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- Item 6-3 Regional Structure Map
- Item 6-4 Regional Stratigraphic Section
- Item 6-5 Drilling Results

Plates

- Plate 6-1 Geologic Map
- Plate 6-2 Overburden and Coal Isopach

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PART 6.1 Methodology

PART 6.2 Scope

Field Reconnaissance and previous documentation.

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PART 6.3 Regional Geologic Framework

The drainage basin of Crandall Canyon, covering approximately 5.7 square miles exposes six different geologic types, primarily Cretaceous in age: the North Horn Formation (a fluvial sandstone and mudstone), the Price River Formation (fluvial and marine sandstone and mudstone), the Castlegate Sandstone (deltaic in origin), the Blackhawk Formation (sandstone, mudstone, shale and coal), the Star Point Sandstone (deltaic and beach deposits) and the Masuk Shale Member of the Mancos Shale (marine in origin), refer to Item 6-3 and 6-4 and Figure 7-1. The Hiawatha and Blind Canyon coal seams, which will be the seams of importance in the permit area appear at the bottom of the Blackhawk Formation which is of late Cretaceous age. Several thin, lenticular coal seams occur throughout the property, but none of them are of significant thickness or probable lateral extent to be of any economic interest. Only the Hiawatha seam is of sufficient thickness to be economically recoverable.

PART 6.4 Geology of Project Vicinity

The geology of the surface lands within the proposed mine permit area consists entirely of outcrop exposure of the Blackhawk Formation which consists of sandstone, mudstone, shale and coal and the Star Point Sandstone, refer to Plate 6-1 and Figure 7-1. The Hiawatha coal seam has been mined and is exposed at an approximate elevation of 7900 feet, refer to Item 6-1. Overburden for mining this seam in the permit area would consist entirely of the Blackhawk Formation rising from the portals to approximately 8800 feet in the northwest corner of the permit area. This would result in a maximum overburden of approximately 1000 feet with an average overburden of approximately 400 to 500 feet. The entire permit area is underlain by the Star Point Sandstone. During our geologic inspection of the property, all indications were that prior mining in the Hiawatha Seam did not encounter any subsurface water. The maps submitted as Items 6-3 and 6-4 and Figure 7-1 are included to show the relative location of the geologic formations to the mine permit area and are not intended to clearly define the geologic formations in the area as the Hiawatha seam is entirely covered

by the Blackhawk Formation within the mine permit area. No other geologic formations occur within the mine permit area above the Blackhawk Formation due to erosion.

Coal analysis of samples taken from the Hiawatha Seam indicate that it is a high volatile bituminous coal with a BTU content ranging from 12,500 to 13,000 BTUs, ash content of 6% to 8%, moisture of 3% to 7%, volatile matter from 40% to 44%, fixed carbon from 43% to 46% and sulfur from 0.3% to 0.8%. Sulfur forms averaged 0.20% pyritic sulfur, 0.09% sulfate sulfur and 0.50% organic sulfur.

Additional technical information has been submitted to determine the nature, depth and thickness of the coal seams, rider seams, overburden and interburden strata for the mine permit area based upon the recently completed drilling in 1985, refer to Item 6-1 and 6-5 and Plates 3-2 and 3-3. In the UGMS Coal Monograph Series Number 3 by Doelling on page 189, it is stated that there is insufficient evidence to support the presence of the Blind Canyon Seam in Crandall Canyon, but further to the south it thickens again until south of Mill Fork where it again is of little value. The old workings can provide information on the lower seam (Hiawatha) and some ground water information but nothing about the other seams. Additional geologic information was submitted by Mr. Wollen containing specific lithologic characterizations of the interburden, and the strata immediately above and below the coal seams, refer to Items 6-1, Items 6-3 and 6-4 were obtained from Doelling, 1972 for additional regional information. Continuity characteristics indicate the absence of faults and perched aquifers and/or other groundwater shows.

6.4.1 Stratigraphy

The Blackhawk Formation is comprised of approximately 1000 feet of gray, carbonaceous shales, siltstones, coals and thin interbedded sandstones. The coal beds to be mined, near the bottom of this formation, are anywhere from 6 to 14 feet in height and are generally classified as a high volatile bituminous coal with a sulfur content anywhere from 0.30% to 1.00%. The Blackhawk Formation is underlain by the massive, cliff forming Star Point Sandstone which is 200 to 400 feet thick.

Applicant has provided an accurate stratigraphic section based on the work of Doelling which has been confirmed by field analysis of distances between the mineable coal seams and the thickness of overburden throughout the mine area. Item 6-1 includes two geologic cross sections which were obtained by walking across the stratigraphic column from Cran-

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dall Creek to the Castle Gate Sandstone. The entire stratigraphic column is shown in Item 6-1 for the permit area as only the Blackhawk Formation exists in the overburden on Tract 1. The stratigraphic section accompanies this chapter as part of Item 6-4.

A coal isopach and overburden isopach map showing the depth to the mineable Hiawatha Seam is included as Plate 6-2 to support extrapolation of ground water hydrology projections from nearby mines to the Crandall Canyon Mine and to support projections of subsidence.

See Section 6.5.2.

6.4.2 Structure

The formations in the Wasatch Plateau of this general area gently dip 1-3 degrees westward off the west flank of the San Rafael swell. The regional structure altitude is broken by several north-south trending, high angle normal faults which offset the rocks from less than 10 feet to approximately 250 feet or more. The major faults as mapped indicate that there are no major faults occurring in the permit area we propose to mine in Crandall Canyon. Springs surface in the upper reaches of the canyon near the Castlegate Sandstone-Blackhawk Formation contact while several seeps of water have been noted in the Crandall Canyon area issuing from the Star Point Sandstone. A complete discussion of the springs and seeps encountered within the permit area is in Chapter 7.

Applicant has provided a structure map as Item 6-3.

PART 6.5 Geology of Coal Bed and Adjacent Units

6.5.1 Exploration and Drilling

Applicant's permit area being only 87.22 acres lends itself quite well to field reconnaissance exploration. With no structural disturbances and information from previous mining, we feel we can qualify the reserves on the 87.22 acres. Economics eliminates drilling of such a small parcel for exploratory reasons. See map included as Item 6-4 within this chapter for outcrop information.

6.5.2 Stratigraphy

The stratigraphy in the permit area and vicinity of the Crandall Canyon Mine consists of the Mesaverde group forma-

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tions. The stratigraphy of the permit area is included within Section 7.1.2.1. Additional information is contained in the Mining and Reclamation Plan, Huntington Canyon No. 4, Mine Permit Application submitted by Beaver Creek Coal Company -- Part 6.4.1 Stratigraphy, pages 6-4 through 6-10.

Applicant has included two lithologic, depth correlated sections to show thicknesses of interburden and coal from the Star Point sandstone to the surface. These geologic sections are attached to this document following this chapter as Item 6-1. The lithofacies of the Blackhawk Formation in the vicinity of the mine area is shown as a geologic cross section within Item 6-1. These cross sections should provide sufficient technical information to determine the nature, depth and thickness of the coal seams, rider seams, overburden and interburden strata for the permit area. The thickness and extent of all formations in and adjacent to the mine area is shown on Figure 7-1 with related discussion in Section 7.1.2.1.

The drilling results obtained during 1985 indicate the presence of the Blind Canyon seam, but of unmineable thickness, refer to Items 6-1 and 6-5. The upper seam will be called the Blind Canyon Seam at the request of DOGM to simplify discussion. The same seam has been referred to as the "upper Hiawatha Seam" and the "lower Bear Canyon Seam" at various other locations. USGS is satisfied that the upper seams are of uneconomic importance. Refer to Item 6-2.

The applicant feels that the cross sections submitted with this document will also satisfy the questions of coal recoverability, and roof and subsidence stability factors involving strata type and thickness.

See 6.4.1 above.

6.5.3 Structure

Plates 3-2, 3-3 and 6-1 previously provided show strike and dip providing an average strike over the entire area where the coal outcrop data has been obtained. An average strike designation was necessary due to the severe erosional and geographic conditions of the area, which would make anything but an average or mean direction highly inaccurate. The determination of the dip was at several points and averaged for a mean determination.

The ground water hydrology and aquiferous potential of the formations present in Crandall Canyon permit area are discussed in detail in Chapter 7, Section 7.1.2.

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Based on the above information concerning the formations and coal seams found in the Mesaverde group, and that the Mesaverde group formations in Crandall Canyon, as described by Doelling, and as described by applicant's field work, are as typical as found elsewhere, we believe the following information should be acceptable to DOGM as it relates to the hydrologic conditions of Genwal's permit area.

(1) Information presented in Chapter 7 indicates that the water table in the Star Point Sandstone is below the coal seams of the lower Blackhawk Formation. The flow of ground water in the formation is toward Huntington Creek.

(2) The Star point Sandstone (Ksp), which underlies the Hiawatha seam, is predominantly a light gray massive sandstone with minor interbedded layers of shale and siltstone near its base (Doelling, 1972). In the vicinity of the mine, the Star Point Sandstone is 200-400 feet thick. The Star Point Sandstone serves as an important regional aquifer (Danielson et al., 1981), yielding water to several minor and some major springs where fractured and jointed.

(3) The Blackhawk Formation, at the base of which the Hiawatha seam is located, could contain perched aquifers in the lenticular sandstones interbedded with the shales. The shales of the Blackhawk Formation are only slightly permeable; consequently, ground water within the formation is perched. The shales of the Blackhawk Formation are bentonitic and swell when wet; therefore, faults and fractures in the Blackhawk tend to seal, limiting secondary permeability, refer to the exceptions itemized in Section 7.1.2.2 (SP-53 through SP-58).

If perched water is encountered from the Blackhawk Formation, due to drilling or from the strains associated with subsidence, its vertical flow to deeper strata would be altered. Some perched aquifers releasing water under topographic conditions as springs, may be affected.

See 6.4.2 above.

6.5.4 Detailed Columns of Interest and Cross Sections

See Item 6-1 included with this Chapter. Cross section A was taken at the portal area and cross section B was taken 500 feet east of the portal area, refer to Plate 3-2 for locations on A and B.

6.5.5 Coal Reserves

Based on in seam mine data which indicates approximately

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840,000 tons remain in place, of which 420,000 tons recoverable. The Hiawatha seam is the only seam in the mine plan area that is of mineable thickness. The Hiawatha seam averages 6' thickness over the Tract 1 permit area.

The information obtained from both drill holes 1 and 2 show the Blind Canyon being approximately 59" and 40" respectively which makes this seam unmineable and of no economic value. The Blind Canyon is located approximately 40'-60' above the Hiawatha seam. Refer to Plate 3-2 for location. The Blind Canyon exists on approximately 60 acres of the property with an average height of 4', this translates into approximately 418,000 tons of coal in place. This seam remains fairly continuous across the property.

Coal deposit and reserve information is required by 30 CFR 211.10(c)(6)(i) which must conform with the information submitted with the mining and reclamation plan. Revisions to the General Mining Order No.1 has been submitted to the USGS as required.

6.5.5.1 Reserve Classifications

From USGS figures. A map is provided delineating coal outcrop lines for the Hiawatha and Blind Canyon seams with the strike and dip indicated at one point, refer to Plate 6-1.

6.5.5.2 Coal Quality and Characteristics, Sulfur Forms, Clay and Alkalinity

The pyrite, alkalinity and clay content information is from samples taken by applicant and submitted to Standard Laboratories, Huntington, Utah for chemical analysis. The lab reports are included with this document as Item 6-2.

The pyrite content and alkalinity content of the stratum immediately above the coal seam is as follows:

	Hiawatha	Blind Canyon
Pyrite	0.03%	0.09%
Alkalinity	7.6 - 63.3 mg/l	7.25 - 87.4 mg/l

The pyrite content, alkalinity and clay content of the stratum immediately below the coal seam is as follows:

	Hiawatha	Blind Canyon
Pyrite	0.06%	0.07%
Alkalinity	3.95 - 4.0 mg/l	3.90 - 0.0 mg/l
Clay Content	9.5%	10.5%

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The sulfur and iron sulfide content of the coal seams are as follows:

	Hiawatha	Blind Canyon
Sulfate	0.01	0.03
Organic	0.46	0.45
Pyritic	0.07	0.03

See 6.4 above.

6.5.6 Adjacent Units

See 6.4 above.

6.5.6.1 Rock Characteristics, Acid-Toxic, Pyrite, Clay and Alkalinity

See 6.3, 6.4, 6.4.1 and 6.4.2 above

PART 6.6 Geologic Effects of Mining

6.6.1 Mining Hazards

Applicant determines there will be no mining hazards other than would be normally encountered. Will be mining with MSHA approved roof and rib control plan which will detail procedure in normal and adverse geologic conditions, (see map included as Plate 3-2 and 3-3 for extent of underground workings).

6.6.2 Surface Hazards

Applicant determines there will be no surface hazards other than would normally encountered (negligible with underground operation).

6.6.3 Impacts of Mining

Applicant determines there will be no geologic impacts as a result of proposed mining operation.

PART 6.7 Bibliography

None included.

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PART 6.7 Bibliography

None included.