UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

TEXT TO ACCOMPANY:

COAL RESOURCE OCCURRENCE

AND

COAL DEVELOPMENT POTENTIAL

MAPS

OF THE

GLENROCK NORTHWEST QUADRANGLE

CONVERSE COUNTY, WYOMING

BY

INTRASEARCH INC.

DENVER, COLORADO

OPEN FILE REPORT 79-470

1979

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CONVERSION TABLE

TO CONVERT	MULTIPLY BY	TO OBTAIN
inches	2.54	centimeters (cm)
feet	0.3048	meters (m)
miles	1.609	kilometers (km)
acres	0.40469	hectares (ha)
tons (short)	0.9072	metric tons (t)
cubic yards/ton	0.8428	cubic meters per metric tons
acre feet	0.12335	hectare-meters
Btu/lb	2.326	kilojoules/kilogram (kJ/kg)
Btu/lb	0.55556	kilocalories/kilogram (kcal/kg)
Fahrenheit	5/9 (F-32)	Celsius

I. Introduction

This report and accompanying maps set forth the Coal Resource Occurrence (CRO) and Coal Development Potential (CDP) of coal beds within the Glenrock Northwest Quadrangle, Converse County, Wyoming. This CRO and CDP map series (U. S. Geological Survey Open-File Report 79-470) includes 8 plates. The project is compiled by IntraSearch Inc., 5351 South Roslyn Street, Englewood, Colorado, under KRCRA Eastern Powder River Basin, Wyoming Contract Number 14-08-0001-17180. This contract is part of a program to provide an inventory of unleased federal coal in Known Recoverable Coal Resource Areas (KRCRAs) in the western United States.

The Glenrock Northwest Quadrangle is located in Converse County, in northeastern Wyoming. It encompasses parts of Townships 34 and 35 North, Ranges 75 and 76 West, and covers the area: 42°52'30" to 43°00' north latitude; 105°52'30" to 106°00' west longitude.

Main access to the Glenrock Northwest Quadrangle is provided by Cole Creek road, a maintained gravel road which extends north-south along the western edge of the quadrangle. Minor roads and trails branching from the Cole Creek road provide access to the more remote regions of the quadrangle. The closest railroads are the Burlington Northern and the Chicago and Northwestern Railroads approximately 3 miles (5 km) to the south.

The drainage pattern of the Glenrock Northwest Quadrangle is characterized by sparse intermittent streams. Sand Creek, a tributary of the North Platte River, flows across the extreme northeastern corner of the quadrangle. Lone Tree Gulch drains the northwestern quadrant and flows into the North Platte River system. Topographic elevations within the quadrangle vary from less than 5100 feet (1554 m) in the southeastern quadrant to more than 5800 feet (1772 m) in the northeastern quadrant.

The 10 to 12 inches (25 to 30 cm) of annual precipitation falling in this semi-arid region accrue principally in the springtime. Summer and fall precipitation usually originates from thunderstorms, and infrequent snowfalls of 6 inches (15 cm) or less generally characterize winter precipitation. Although temperatures ranging from less than -25°F (-32°C) to more than 100°F (38°C) have been recorded near Douglas, Wyoming, average wintertime minimums and summertime maximums range from +5° to +°15F (-15° to -9°C) and 75° to 90°F (24° to 32°C), respectively.

Surface ownership is divided among fee, state, and federal categories with the state and federal surface generally leased to ranchers for grazing purposes. Details of surface ownership are available at the Converse County Courthouse in Douglas, Wyoming. Details of mineral ownership on federal lands are available from the U. S. Bureau of Land Management in Cheyenne, Wyoming. Federal coal ownership is shown on Plate 2 of the Coal Resource Occurrence maps. The non-federal coal ownership comprises both fee and state coal resources.

The Coal Resource Occurrence and Coal Development Potential program pertains to unleased federal coal and focuses upon the delineation of lignite, subbituminous coal, bituminous coal, and anthracite at the surface, and in the subsurface. In addition, the program identifies total tons of coal in place, as well as recoverable tons. These coal tonnages are then categorized into units of measured, indicated, and inferred reserves and resources, and hypothetical resources. Finally, recommendations are made regarding the potential for surface mining, underground mining, and in-situ gasification of the coal beds. This report evaluates the coal resources of all unleased federal coal beds in the quadrangle which are 5 feet (1.5 m) or greater in thickness and

occur at depths down to 3000 feet (914 m). No resources or reserves are computed for leased federal coal, state coal, fee coal, or lands encompassed by coal prospecting permits and preference-right lease applications.

Surface and subsurface geological and engineering extrapolations drawn from the current data base suggest the occurrence of approximately 19 million tons (17 million metric tons) of unleased federal coal resources in the Glenrock Northwest Quadrangle.

The suite of maps that accompany this report sets forth and portrays the coal resource and reserve occurrence in considerable detail. For the most part, this report supplements the cartographically displayed information with minimum verbal duplication of the CRO-CDP map data.

II. Geology

Regional. The thick, economic coal deposits of the Powder River Basin in northeastern Wyoming occur mostly in the Tongue River Member of the Fort Union Formation, and in the lower part of the Wasatch Formation. Approximately 3000 feet (914 m) of the Fort Union Formation, including the Tongue River, Lebo, and Tullock Members of Paleocene age, are unconformably overlain by approximately 700 feet (213 m) of the Wasatch Formation of Eocene age. These Tertiary formations lie in a structural basin flanked on the east by the Black Hills uplift, on the south by the Hartville and Casper Mountain uplifts, and on the west by the Casper Arch and the Big Horn Mountain uplift. The structural configuration of the Powder River Basin originated in Late Cretaceous time, with episodic uplift thereafter. The Cretaceous Cordillera was the dominant positive land form throughout the Rocky Mountain area at the close of Mesozoic time.

Outcrops of the Wasatch Formation and the Tongue River Member of the Fort Union Formation cover most of the areas of major coal resource occurrence in the Powder River Basin. The Tongue River Member is composed of very fine-grained sandstones, siltstones, claystones, shales, carbonaceous shales, and numerous coal beds. The Lebo Member of the Fort Union Formation consists of light- to dark-gray very fine-grained to conglomeratic sandstone with interbedded siltstone, claystone, carbonaceous shale and thin coal beds. Thin bedded calcareous ironstone concretions interbedded with massive white sandstone and slightly bentonitic shale occur throughout the unit (Denson and Horn, 1975). The Lebo Member is mapped at the surface northeast of Recluse, Wyoming. Here, the Lebo Member is east of the principal coal outcrops and associated clinkers (McKay, 1974), and it presumably projects into the subsurface beneath much of the basin. One of the principal characteristics for separating the Lebo and Tullock Members (collectively referred to as the Ludlow Member east of Miles City, Montana) from the overlying Tongue River Member is the color differential between the lighter-colored upper portion and the somewhat darker lower portion (Brown, 1958). Although geologists are trying to develop criteria for subsurface recognition of the Lebo-Tullock and Tongue River-Lebo contacts through the use of subsurface data from geophysical logs, no definitive guidelines are known to have been published. Hence, for subsurface mapping purposes, the Fort Union Formation is not divided into its members for this study.

During the Paleocene epoch, the Powder River Basin tropical to subtropical depositional environment included broad, inland flood basins with extensive swamps, marshes, freshwater lakes, and a sluggish, but active, northeastward-discharging drainage system. These features were

superimposed on an emerging sea floor, near base level. Much of the vast area where organic debris collected was within a reducing depositional environment. Localized uplifts began to disturb the near sea-level terrain of northeastern Wyoming following retreat of the Cretaceous seas. However, the extremely fine-grained characteristics of the Tongue River Member clastics suggest that areas of recurring uplift peripheral to the Powder River Basin were subdued during major coal deposit formation.

The uplift of areas surrounding the Powder River Basin created a structural basin of asymmetric character, with the steep west flank located on the eastern edge of the Big Horn Mountains. The axis of the Powder River Basin is difficult to specifically define, but it is thought to be located in the western part of the Basin and to display a north-south configuration some 15 to 20 miles (24 to 32 km) east of Sheridan, Wyoming. Thus, the sedimentary section described in this report lies on the east flank of the Powder River Basin, with gentle dips of two degrees or less disrupted by surface structure thought to relate to tectonic adjustment and differential compaction.

The youngest Cretaceous strata in the Powder River Basin are classified into the Lance Formation. The Lance Formation consist of white, gray, and brown sandstones, black and gray carbonaceous shales, coal beds, and bentonite beds. The continental sediments were deposited following the withdrawal of the Cretaceous sea. In areas where subsidence was greater than aggradation, lakes and swamps developed. The lenticular coal beds at the base of the Lance Formation formed in the bogs and swamps. Volcanism supplied ash layers that were transformed into the Lance Formation bentonite beds. The Lance Formation ranges in thickness from approximately 650 feet (198 m) along the flanks of the Powder River Basin to approximately 3000 feet (914 m) in the center of the basin (Dunlap, 1958).

The Glenrock Northwest Quadrangle is located in an area where surface rocks are classified into the Fort Union Formation and the Lance Formation. The Fort Union Formation is comprised of very fine-grained sandstones, siltstones, claystones, shales, carbonaceous shales, and coal beds, and it crops out in the northeastern portion of the quadrangle. Approximately 300 to 400 feet (91 to 122 m) of the Fort Union Formation are exposed in the study area. The Lance Formation, which crops out in the southwestern portion of the quadrangle, is composed of sandstones, carbonaceous shales, coal beds, and bentonite beds. Approximately 200 to 300 feet (61 to 91 m) of the Lance Formation are exposed in the Glenrock Northwest Quadrangle.

III. Data Sources

Geophysical logs from oil and gas test bores and producing wells comprise the source of subsurface control. Some geophysical logs are not applicable to this study, for the logs relate only to the deep, potentially productive oil and gas zones. More than 80 percent of the logs include resistivity, conductivity, and self-potential curves. Occasionally the suite of geophysical logs includes gamma, density, and sonic curves. These logs are available from several commercial sources.

All geophysical logs available in the quadrangle are scanned to select those with data applicable to Coal Resource Occurrence mapping. Paper copies of the logs are obtained and interpreted, and coal intervals are annotated. Maximum accuracy of coal bed indentification is accomplished where gamma, density, and resistivity curves are available. Coal bed tops and bottoms are picked on the logs at the midpoint between the minimum and maximum curve deflections. The correlation of coal beds within and between quadrangles is achieved utilizing a fence diagram to associate local correlations with regional coal occurrences.

The reliability of correlations, set forth by IntraSearch in this report, varies depending on: the density and quality of lithologic and geophysical logs; the detail, thoroughness, and accuracy of published and unpublished surface geological maps; and interpretative proficiency. There is no intent on the part of IntraSearch to refute nomenclature established in the literature or used locally by workers in the area. IntraSearch's nomenclature focuses upon the suggestion of regional coal bed names applicable throughout the eastern Powder River Basin. It is expected, and entirely reasonable, that some differences of opinion regarding correlations, as suggested by IntraSearch, exist. Additional drilling for coal, oil, gas, water, and uranium, coupled with expanded mapping of coal bed outcrops and associated clinkers will broaden the data base for coal bed correlations and allow continued improvement in the understanding of coal bed occurrences in the eastern Powder River Basin.

The topographic map of the Glenrock Northwest Quadrangle is published by the U. S. Geological Survey. It was compiled in 1949, and photoinspected in 1973. Land network and mineral ownership data are compiled from land plats available from the U. S. Bureau of Land Management in Cheyenne, Wyoming. This information is current to October 13, 1977.

IV. Coal Bed Occurrence

Lance Formation coal beds present in part of the Glenrock Northwest Quadrangle include two unnamed local coal beds. A complete suite of maps (coal isopach, structure, overburden isopach, identified resources, and areal distribution of identified resources) is prepared for a composite coal zone consisting of the Local $_2$ and Local $_3$ coal beds.

No physical and chemical analyses are known to have been published regarding the coal beds in the Glenrock Northwest Quadrangle. Proximate analysis performed on a general "as received" basis of the Lance Formation coal beds present in the Glenrock, Wyoming area is as follows:*

COAL BED NAME	ASH %	FIXED CARBON %	MOISTURE %	VOLATILES %	SULFUR %	BTU/LB
	6.8	34.0	23.4	35.9	0.66	8742

* - Glass, G. B., 1976

The Coal Data Sheet, Plate 3, shows the downhole identification of coal beds within the quadrangle as interpreted from geophysical logs, and from oil and gas test bores and producing sites. A datum coal bed is utilized to position columnar sections on Plate 3. This portrayal is schematic by design; hence, no structural or coal thickness implications are suggested by the dashed correlation lines projected through no record (NR) intervals. Inasmuch as the Local $_3$ coal bed underlies the largest area of the quadrangle, it is designated as datum for the correlation diagram.

Pinched out over approximately 60 percent of the Glenrock Northwest Quadrangle, the Local 2-3 coal zone occurs in the west-central and southeastern portions of the study area. The Local $_2$ and the Local $_3$ coal beds are two lenticular coal beds which were mapped together as a coal zone. The combined thickness of this coal zone attains a maximum value of over 15 feet (5 m) near the western boundary of the quadrangle. A non-coal interval of approximately 180 feet (55 m) separates the Local $_2$ coal bed and the Local $_3$ coal bed. The structure contour map is drawn on top of the Local $_2$ coal bed in the southeastern and west-central portions of the quadrangle, and on top of the Local $_3$ coal bed in the west-central portion of the quadrangle where the Local $_2$ coal bed is absent.

The structure contours indicate a northwest-southeast trending anticline in the southwestern quadrant. The northeastern and soutwestern flanks of the anticline dip approximately five to seven degrees. The $Local_{2-3}$ coal zone occurs approximately 715 to 3275 feet (218 to 998 m) beneath the surface throughout the Glenrock Northwest Quadrangle.

V. Geological and Engineering Mapping Parameters

The correct horizontal location and elevation of drill holes utilized in subsurface mapping are critical to map accuracy. IntraSearch Inc., plots the horizontal location of the drill hole as described on the geophysical log heading. Occasionally this location is superimposed on or near to a drillsite shown on the topographic map, and the topographic map, horizontal location is utilized. If the ground elevation on the geophysical log does not agree with the topographic elevation of the drillsite, the geophysical log ground elevation is adjusted to conformance. If there is no indication of a drillsite on the topographic map, the "quarter, quarter, quarter" heading location is shifted within a small area until the ground elevation on the heading agrees with the topographic map elevation. If no elevation agreement can be reached, the well heading or data sheet is rechecked for footage measurements and ground elevation accuracy. Inquiries to the companies who provided the oil and gas geophysical logs frequently reveal that corrections have been made in the original survey. If all horizontal location data sources have been checked and the information accepted as the best available data, the drillsite elevation on the geophysical log is modified to agree with the topographic map elevation. IntraSearch Inc., considers this agreement mandatory for the proper construction of most subsurface maps, but in particular, the overburden isopach, the mining ratio, and Coal Development Potential maps.

Subsurface mapping is based on geologic data within, and adjacent, to the Glenrock Northwest Quadrangle area. Data from geophysical logs are used to correlate coal beds and control contour lines for the coal thickness, structure, and overburden maps. Structure contour maps are constructed on the tops of the main coal beds. Where subsurface data are scarce, supplemental structural control points are selected from the topographic map along coal outcrops.

In preparing overburden isopach maps, no attempt is made to identify coal beds that occur in the overburden to a particular coal bed under study. Mining ratio maps for this quadrangle are constructed utilizing a 95 percent recovery factor. Contours of these maps identify the ratio of cubic yards of overburden to tons of recoverable coal. Where ratio control points are sparse, interpolated points are computed at the intersections of coal bed and overburden isopach contours using coal structure, coal isopach, and topographic control. On the Areal Distribution of Identified Resources Map (ADIR), coal bed reserves are not calculated where the coal is less than 5 feet (1.5 m) thick, where the coal occurs at a depth greater than 500 feet (152 m), where non-federal coal exists, or where federal coal leases, preference-right lease applications, and coal prospecting permits exist.

Coal tonnage calculations involve the planimetering of areas of measured, indicated, inferred reserves and resources, and hypothetical resources to determine their areal extent in acres. An Insufficient Data Line is drawn to delineate areas where surface and subsurface data are too sparse for CRO map construction. Various categories of resources are calculated in the unmapped areas by utilizing coal bed thicknesses mapped in the geologically controlled area adjacent to the insufficient data line. Acres are multiplied by the average coal bed

thickness and 1750, or 1770--the number of tons of lignite A or subbituminous C coal per acre-foot, respectively (12,874 or 13,018 metric tons per hectare-meter, respectively), to determine total tons in place. Recoverable tonnage is calculated at 95 percent of the total tons in place. Where tonnages are computed for the CRO-CDP map series, resources and reserves are expressed in millions of tons. Frequently the planimetering of coal resources on a sectionized basis involves complexly curvilinear lines (coal bed outcrop and 500-foot stripping limit designations) in relationship with linear section boundaries and circular resource category boundaries. Where these relationships occur, generalizations of complexly curvilinear lines are discretely utilized, and resources and/or reserves are calculated within an estimated 2 to 3 percent, plus or minus, accuracy.

VI. Coal Development Potential

Strippable Coal Development Potential. The U. S. Geological Survey has established 500 feet (152 m) as the stripping limit for surface mining methods in this area. Because the coal beds in the Glenrock Northwest Quadrangle occur more than 500 feet (152 m) beneath the surface, the quadrangle is considered to have no development potential for surface mining methods. Therefore, no surface mining potential map is prepared.

Underground Mining Coal Development Potential. Subsurface coal mining potential throughout the Glenrock Northwest Quadrangle is considered low. Inasmuch as recovery factors have not been established for the underground development of coal beds in this quadrangle, reserves are not calculated for coal beds that occur more than 500 feet (152 m) beneath the surface. Table 1 sets forth the estimated coal resources in tons per coal bed.

In-Situ Gasification Coal Development Potential. The evaluation of subsurface coal deposits for in-situ gasification potential relates to the occurrence of coal beds more than 5 feet (1.5 m) thick buried from 500 to 3000 feet (152 to 914 m) beneath the surface. This categorization is as follows:

1. Low development potential relates to: 1) a total coal section less than 100 feet (30 m) thick that lies 1000 feet (305 m) to 3000 feet (914 m) beneath the surface, or 2) a coal bed or coal zone 5 feet (1.5 m) or more in thickness which lies 500 feet (152 m) to 1000 feet (305 m) beneath the surface.
2. Moderate development potential is assigned to a total coal section from 100 to 200 feet (30 to 61 m) thick, and buried from 1000 to 3000 feet (305 to 914 m) beneath the surface.
3. High development potential involves 200 feet (61 m) or more of total coal thickness buried from 1000 to 3000 feet (305 to 914 m).

The coal development potential for in-situ gasification within the Glenrock Northwest Quadrangle is low, hence no CDP map is generated for this map series. The coal resource tonnage for in-situ gasification with low development potential totals approximately 19 million tons (17 million metric tons) (Table 2). None of the coal beds in the Glenrock Northwest Quadrangle qualify for a moderate or high development potential rating.

Table 1.--Coal Resource Base Data (in short tons) for Underground Mining Methods for Federal Coal Lands in the Glenrock Northwest Quadrangle, Converse County, Wyoming.

Coal Zone Name	High Development Potential	Moderate Development Potential	Low Development Potential	Total
Local 2 - 3	-----	-----	19,370,000	19,370,000
TOTAL	-----	-----	19,370,000	19,370,000

Table 2.--Coal Resource Base Data (in short tons) for In-Situ Gasification for Federal Coal Lands in the Glenrock Northwest Quadrangle, Converse County, Wyoming.

Coal Zone Name	High Development Potential	Moderate Development Potential	Low Development Potential	Total
Local $_{2-3}$	-----	-----	19,370,000	19,370,000
TOTAL	-----	-----	19,370,000	19,370,000

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