UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

TEXT TO ACCOMPANY:

COAL RESOURCE OCCURRENCE

AND

COAL DEVELOPMENT POTENTIAL

MAPS

OF THE

DOUBLE TANKS QUADRANGLE,

CAMPBELL COUNTY, WYOMING

BY

INTRASEARCH INC.

DENVER, COLORADO

OPEN FILE REPORT 79-051

1979

This report is preliminary, and has not been edited or reviewed for conformity with United States Geological Survey standards or stratigraphic nomenclature.

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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 Double Tanks Quadrangle, Campbell County, Wyoming. This CRO and CDP map series (U. S. Geological Survey Open-File Report 79-051) includes 35 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 Double Tanks Quadrangle is located in Campbell County, in northeastern Wyoming. It encompasses parts of Townships 47 and 48 North, Ranges 74 and 75 West, and covers the area: 44°00' to 44°07'30" north latitude; 105°45' to 105°52'30" west longitude.

Main access to the Double Tanks Quadrangle is provided by the Napier Road, a maintained gravel road which extends east-west across the central portion of the quadrangle. Minor roads and trails provide additional access to the more remote areas. The closest railroad is the Burlington Northern trackage, approximately 15 miles (24 km) to the northeast, west of Gillette, Wyoming.

The most significant drainage of the Double Tanks Quadrangle is provided by Dead Horse Creek and Beaver Creek, which flow westward into the Powder River. Topographic elevations within the quadrangle attain heights of approximately 5200 feet (1585 m), some 550 to 650 feet (168 to 198 m) above the valley floors to the west.

The 13 to 14 inches (33 to 36 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 Gillette, 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 Campbell County Courthouse in Gillette, 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 insitu 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 11.4 billion tons (10.3 billion metric tons) of unleased federal coal resources in the Double Tanks 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.

Some coal beds in the Powder River Basin exceed 200 feet (61 m) in thickness. Deposition of these thick, in-situ coal beds requires a delicate balance between subsidence of the earth's crust and in-filling by tremendous volumes of organic debris. These conditions in concert with a favorable ground water table, non-oxidizing clear water, and a climate amenable to the luxuriant growth of vegetation produce a stabilized swamp critical to the deposition of coal beds.

Deposition of the unusually thick coal beds of the Powder River Basin may be partially attributable to short-distance water transportation of organic detritus into areas of crustal subsidence.

Variations in coal bed thickness throughout the basin relate to changes in the depositional environment. Drill hole data that indicate either the complete absence or extreme attenuation of a thick coal bed probably relate to location of the drill holes within the ancient stream channel system draining this lowland area in Early Cenozoic time. Where thick coal beds thin rapidly from the depocenter of a favorable depositional environment, it is not unusual to encounter a synclinal structure over the maximum coal thickness due to the differential compaction between organic debris in the coal depocenter and fine-grained clastics in the adjacent areas.

The Wasatch Formation of Eocene age crops out over most of the central part of the Powder River Basin and exhibits a disconformable contact with the underlying Fort Union Formation. The contact has been placed at various horizons by different workers; however, for the purpose of this report, the contact is positioned near the top of the Roland coal bed as mapped by Olive (1957) in northwestern Campbell County, Wyoming, and it is considered to descend disconformably in the stratigraphic column to the top of the Wyodak-Anderson coal bed (Roland coal bed of Taff, 1909) along the eastern boundary of the coal measures. No attempt was made to differentiate the Wasatch and Fort Union Formations on geophysical logs or in the subsurface mapping program for this project.

Although Wasatch and Fort Union lithologies are too similar to allow differentiation in some areas, most of the thicker coal beds occur in the Fort Union section on the east flank of the Powder River Basin. Furthermore, orogenic movements peripheral to the basin apparently increased in magnitude during Wasatch time causing the deposition of friable, coarse-grained to gritty, arkosic sandstones, fine- to very

fine-grained sandstones, siltstones, mudstones, claystones, brown-to-black carbonaceous shales, and coal beds. These sediments are noticeably to imperceptibly coarser than the underlying Fort Union clastics.

The Double Tanks Quadrangle is located in an area where surface rocks are classified within the Wasatch Formation. Olive (1957) correlated coal beds in the Spotted Horse coal field with coal beds in the Sheridan coal field (Baker, 1929) and Gillette coal field (Dobbin and Barnett, 1927), Wyoming, and with coal beds in the Ashland coal field (Bass, 1932) in southeastern Montana. This report utilizes, where possible, the coal bed nomenclature used in previous reports. The Felix coal bed was named by Stone and Lupton (1910). The Ulm and Smith coal beds were named by Taff (1909). Baker (1929) assigned names to the Anderson, Canyon, and Wall coal beds.

IntraSearch's correlation of thick coal beds from the Spotted Horse coal field to Gillette points out that the Wyodak coal bed, named the "D" coal bed by Dobbin and Barnett (1927), is equivalent to the Anderson, Canyon and all or part of the Cook coal beds to the north and west of Gillette, Wyoming. Correlation of this suite of coal beds with the Wyodak coal bed south and southwest of Gillette suggest that the Anderson and Canyon coal beds equate with the upper 10 to 25 percent of the thick Wyodak coal bed, and the Cook and Wall or Upper Wall coal beds are equivalent to the major part of the Wyodak coal bed. Due to problematic correlations outside of the Gillette area, the name Wyodak has been informally used by many previous authors to represent the coal beds in the area surrounding the Wyodak coal mine.

IntraSearch uses the Anderson-Canyon-Cook nomenclature in the Double Tanks Quadrangle, in the Scott Dam Quadrangle directly north of the Double Tanks Quadrangle, and in the Bogie Draw Quadrangle directly

west of the Double Tanks Quadrangle. The name Wyodak is used adjacent to the Double Tanks Quadrangle to the east and south in the Pleasantdale Quadrangle and in the Northeast Quarter of Savageton Quadrangle.

The Cook coal bed was named by Bass (1932), and the Pawnee coal bed was named by Warren (1959). The Wildcat, Moyer, and Oedekoven coal beds were informally named by IntraSearch (1978b, 1979, and 1978a).

Local. The Double Tanks Quadrangle lies on the eastern flank of the Powder River Basin, where the strata dip gently westward. The Wasatch Formation crops out over the entire quadrangle and is comprised of friable, coarse-grained to gritty, arkosic sandstones, fine- to very fine-grained sandstones, siltstones, mudstones, claystones, brown-to-black carbonaceous shales, and coal beds.

III. Data Sources

Areal geology of the coal outcrops and associated clinker is derived and enlarged from Wegemann (1928). The outcrops are adjusted to conformance with the current U. S. Geological Survey topographic map of the area. The Ulm coal bed of this report is stratigraphically equivalent to the "B" coal bed of Wegemann (1928).

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, interpreted, and coal intervals

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 Double Tanks Quadrangle is published by the U. S. Geological Survey, compilation date 1971. 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

Wasatch and Fort Union Formation coal beds that are present in all or part of the Double Tanks Quadrangle include, in descending strati-

graphic order: the Ulm, the Felix, the Smith, two unnamed locals, the Anderson-Canyon-Cook, the Upper Wall, the Lower Wall, the Pawnee, the Wildcat, the Moyer, and the Oedekoven. A complete suite of maps (structure, coal isopach, overburden isopach, identified resources, and areal distribution of identified resources) is prepared for the Ulm coal bed, the Felix coal zone, the Smith coal zone, the Anderson-Canyon-Cook coal bed, the Upper Wall coal bed, the Lower Wall-Pawnee coal zone, and Wildcat-Moyer-Oedekoven coal zone. Mining ratio contours are presented on the Felix coal zone isopach map, and interburden contours are presented on the Felix overburden isopach map. Insufficient thickness and areal extent preclude detailed mapping of the local coal beds.

No physical and chemical analyses are known to have been published regarding the coal beds in the Double Tanks Quadrangle. However, the proximate analyses performed on an "as received" basis for central and southern Campbell County coal beds are as follows:

COAL BED NAME		ASH %	FIXED CARBON %	MOISTURE %	VOLATILES %	SULFUR %	BTU/LB
Ulm (U)	Hole 7323	7.288	33.626	30.070	29.016	1.309	7730
Felix (U)	Hole 7324	6.993	35.200	25.010	32.798	0.629	8544
Upper Smith (U)	Hole 7311	16.323	29.797	25.376	28.503	2.598	7273
Lower Smith (U)	Hole 7311	6.167	33.340	29.610	30.883	1.068	8215
Anderson-Canyon-Cook (U)	Hole 7310	5.852	33.938	29.060	31.150	0.435	8172
Wall (U)	Hole 7426	9.542	29.322	32.150	28.985	0.500	7279
Pawnee (U)	Hole 7424C	7.880	31.029	31.910	29.183	0.386	7344
(*)	Hole 11447	4.3	38.5	27.8	29.4	0.27	8410

(*) - Winchester 1912
(U) - U. S. Geological Survey and Montana Bureau of Mines and Geology - 1974 & 1976

The Coal Data Sheet, Plate 3, shows the downhole identification of coal beds within the quadrangle as interpreted from geophysical logs from oil and gas test bores and from producing sites. A datum coal bed is utili-

zed 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 Anderson-Canyon-Cook coal bed underlies the entire quadrangle, it is designated as datum for the correlation diagram. The Anderson-Canyon-Cook and the Upper Wall coal beds show the thickest single coal bed occurrences within the quadrangle. The Felix, Smith, Lower Wall-Pawnee, and Wildcat-Moyer-Oedekoven coal zones show a moderate coal thickness within the quadrangle.

The Ulm coal bed crops out in a small portion of the southeastern quadrant. Due to the limited areal extent of the Ulm coal bed, coal bed data are cartographically shown as 8½ x 11 inch (22 x 28 cm) (Figures 1-3) rather than quadrangle-sized maps. Surface measured sections of the coal bed (Wegemann, 1928) indicate a coal bed thickness averaging approximately 10 feet (3 m). Structure contours drawn on top of the Ulm coal bed indicate a northward dip and possibly a small anticlinal feature present in the southeastern quarter of the study area. The Ulm coal bed lies less than 100 feet (30 m) beneath the surface.

The Felix coal zone occurs approximately 600 feet (183 m) beneath the Ulm coal bed. The coal zone is comprised of one to three thin coal beds. The combined thickness of the coal beds in the Felix coal zone varies from less than 5 feet (1.5 m) in the southwestern corner to more than 30 feet (9 m) in the northeastern quadrant. The noncoal interburden within the Felix coal zone ranges from 0 to 166 feet (0 to 51 m) thick. The structure contour map is drawn on top of the Upper Felix coal bed except in the southwestern quadrant where the Upper Felix coal bed is absent. In this area the structure contour

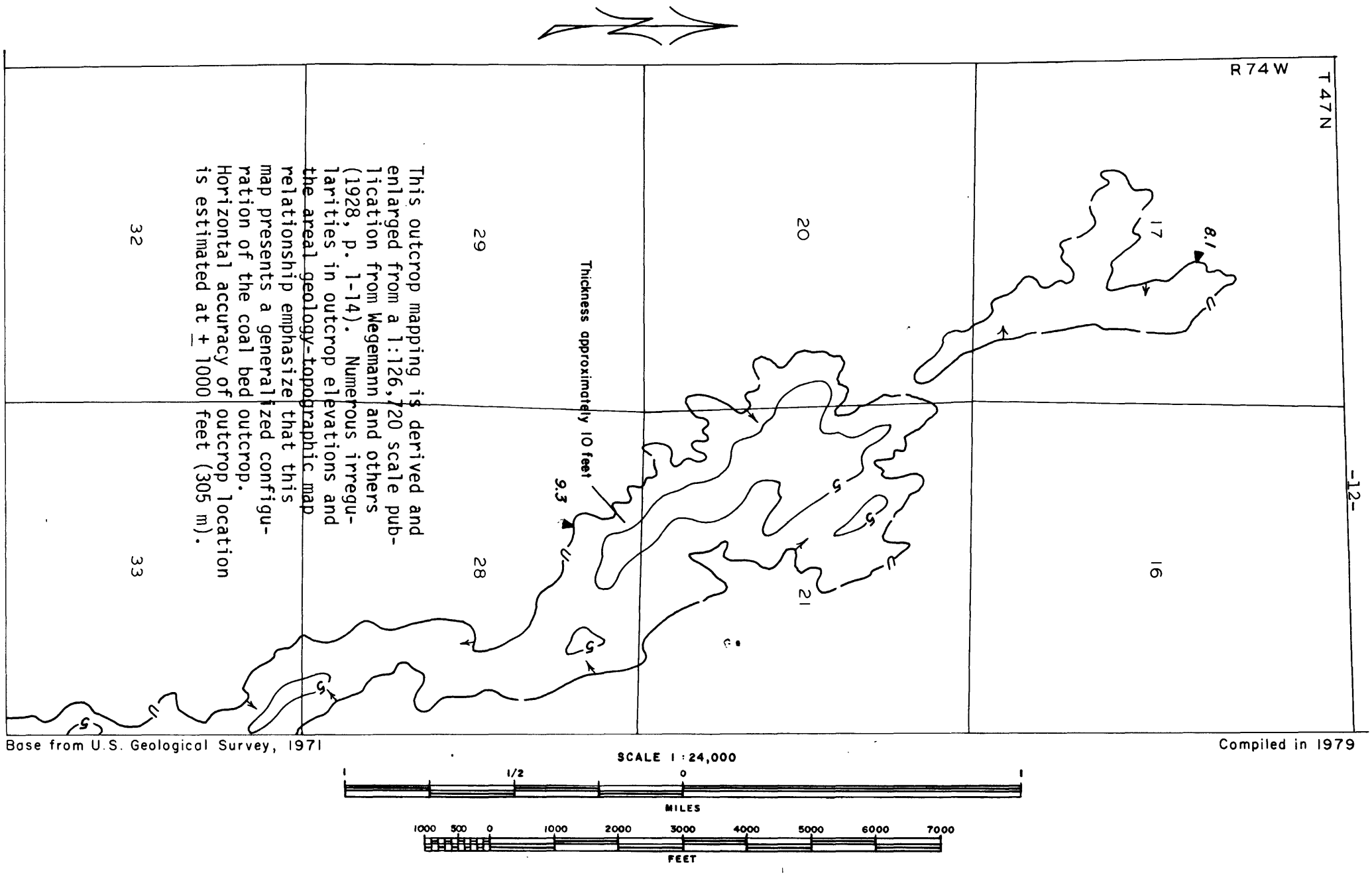
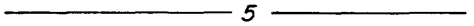
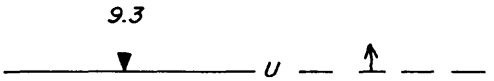


FIGURE 1
ISOPACH AND MINING RATIO MAP
OF ULM COAL BED IN
DOUBLE TANKS QUADRANGLE
CAMPBELL COUNTY, WYOMING
(See following page for Explanation)

EXPLANATION FOR FIGURE 1



MINING RATIO CONTOUR-Number indicates cubic yards of overburden per ton of recoverable coal by surface mining methods. Contours shown only in area suitable for surface mining within the stripping limit.



TRACE OF COAL BED OUTCROP-Showing coal thickness in feet, measured at triangle. Arrow points toward the coal-bearing area. Coal bed dashed where inferred.

To convert feet to meters multiply feet by 0.3048.

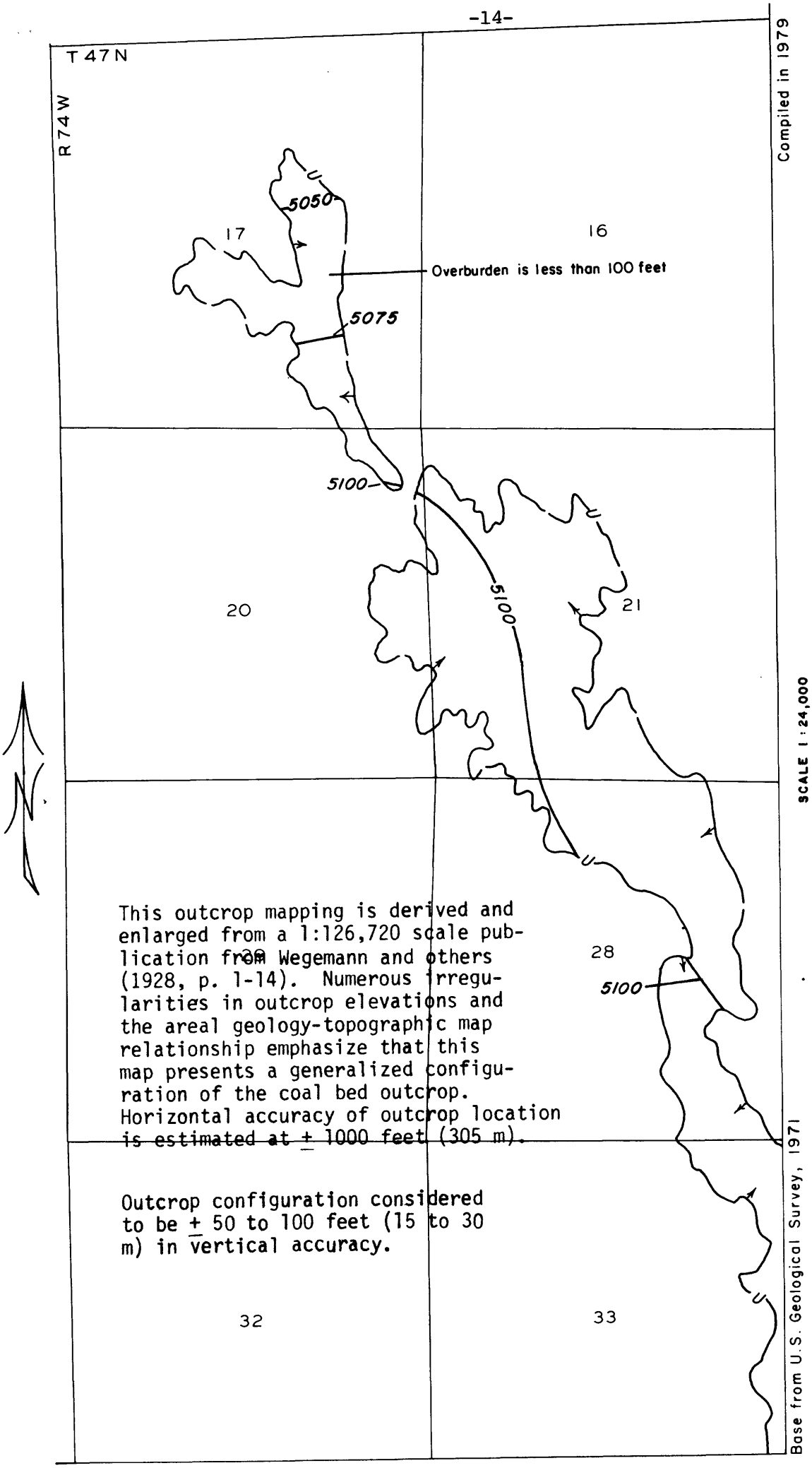
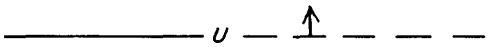


FIGURE 2
STRUCTURE CONTOUR AND ISOPACH OF OVERBURDEN MAP
OF ULM COAL BED IN
DOUBLE TANKS QUADRANGLE
CAMPBELL COUNTY, WYOMING

(See following page for Explanation)

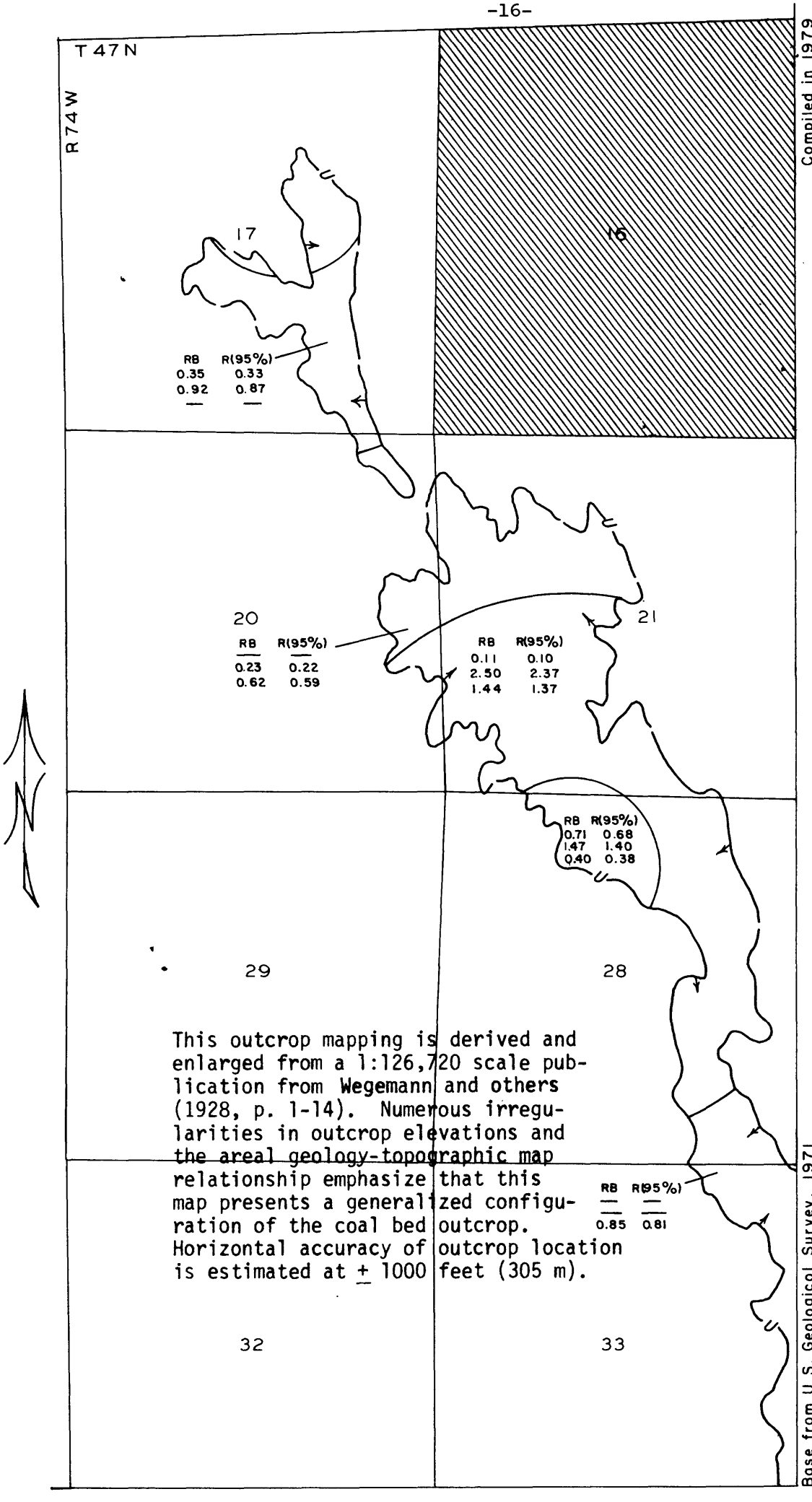
EXPLANATION FOR FIGURE 2

STRUCTURE CONTOURS-Drawn on top of coal bed. Contour interval 25 feet. Datum is mean sea level.



TRACE OF COAL BED OUTCROP-Arrow points toward the coal-bearing area. Coal bed dashed where inferred.

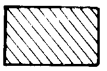
To convert feet to meters, multiply feet by 0.3048.



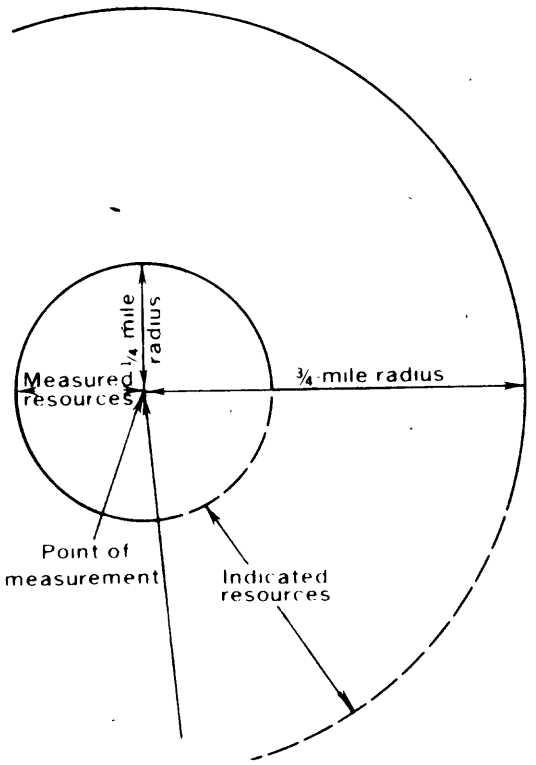
This outcrop mapping is derived and enlarged from a 1:126,720 scale publication from Wegemann and others (1928, p. 1-14). Numerous irregularities in outcrop elevations and the areal geology-topographic map relationship emphasize that this map presents a generalized configuration of the coal bed outcrop. Horizontal accuracy of outcrop location is estimated at ± 1000 feet (305 m).

FIGURE 3
AREAL DISTRIBUTION OF IDENTIFIED RESOURCES
AND IDENTIFIED RESOURCES MAP
OF ULM COAL BED IN
DOUBLE TANKS QUADRANGLE
CAMPBELL COUNTY, WYOMING

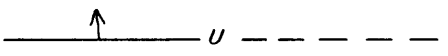
EXPLANATION FOR FIGURE 3



NON-FEDERAL COAL LAND-Coal tonnages not evaluated.



BOUNDARY LINES-Enclosing areas of measured, indicated, and inferred coal resources of the coal bed.



TRACE OF COAL BED OUTCROP-Arrow points toward the coal-bearing area. Coal bed dashed where inferred.

RB	R(95%)	
0.35	0.33	(Measured)
0.92	0.87	(Indicated)
—	—	(Inferred)

IDENTIFIED RESOURCES OF COAL BED-In millions of short tons. Dash indicates no resources in that category. Reserve Base (RB) x the recovery factor (95%) = Reserves (R).

To convert miles to kilometers multiply miles by 1.609.

To convert short tons to metric tons, multiply short tons by 0.9072.

map is drawn on top of the Lower Felix coal bed. The Felix coal zone dips less than two degrees to the west. The overburden above the Felix coal bed ranges in thickness from less than 200 feet (61 m) to more than 500 feet (152 m).

Composed of one to four thin coal beds, the Smith coal zone lies approximately 305 to 416 feet (93 to 127 m) below the Felix coal zone. The total coal thickness of the Smith coal zone ranges from less than 5 feet (1.5 m) in the southeastern quadrant and along the eastern quadrangle boundary to more than 25 feet (8 m) in the southwestern quadrant. The non-coal interburden varies in thickness from 0 to 114 feet (0 to 35 m). Structure contours drawn on top of the highest Smith coal bed indicate minor anticlinal and synclinal features superimposed on a regional dip to the west. The Smith coal zone occurs from less than 750 feet (229 m) to more than 1000 feet (305 m) beneath the surface.

The Anderson-Canyon-Cook coal bed is located approximately 126 to 386 feet (38 to 118 m) below the Smith coal zone. A minimum of 30 feet (9 m) thick in the east-central portion of the quadrangle, the Anderson-Canyon-Cook coal bed attains a maximum thickness of more than 90 feet (27 m) in the west-central portion of the quadrangle. A small, localized, non-coal separation within the Anderson-Canyon-Cook coal bed in the northeastern quadrant varies in thickness from 20 to 22 feet (6 to 7 m). Generally, the Anderson-Canyon-Cook coal bed dips to the west. The overburden above the Anderson-Canyon-Cook coal bed varies in thickness from less than 1000 feet (305 m) to more than 1250 feet (381 m).

A non-coal interval of approximately 65 to 390 feet (20 to 119 m) separates the Upper Wall coal bed from the overlying Anderson-Canyon-Cook coal bed. Pinched out in the southeastern quadrant, the Upper Wall coal bed attains a maximum thickness of over 90 feet (27 m) in the

east-central region of the study area. The non-coal interburden within the Upper Wall coal bed varies in thickness from 0 to 13 feet (0 to 4 m). The structure contour map of the Upper Wall coal bed is characterized by minor flexures superimposed on a dip of less than two degrees to the west. The Upper Wall coal bed occurs at depths ranging from less than 1250 feet (381 m) to more than 1500 feet (457 m) below the surface.

The Lower Wall-Pawnee coal zone lies approximately 52 to 248 feet (16 to 76 m) below the Upper Wall coal bed. The coal zone is composed of two rather uniformly thin coal beds separated by approximately 57 to 180 feet (17 to 55 m) of interburden. The combined thickness of the coal beds in the Lower Wall-Pawnee coal zone ranges from less than 5 feet (1.5 m) in the southwestern corner to more than 50 feet (15 m) in the northeastern corner. Structure contours drawn on top of the Lower Wall coal bed indicate a westward to northwestward dip and several minor anticlinal and synclinal features. The overburden above the Lower Wall-Pawnee coal zone varies from less than 1500 feet (457 m) to more than 1750 feet (533 m).

The Wildcat-Moyer-Oedekoven coal zone occurs 224 to 469 feet (68 to 143 m) beneath the Lower Wall-Pawnee coal zone, and it is comprised of one to four thin coal beds. The composite thickness of the coal beds varies from less than 10 feet (3 m) in the northeastern quadrant to more than 50 feet (15 m) in the extreme northwestern corner. The Wildcat-Moyer-Oedekoven coal zone dips one to two degrees to the west and lies at depths varying from less than 2000 feet (610 m) to more than 2250 feet (686 m).

V. Geological and Engineering Mapping Parameters

The correct horizontal location and elevation of drill holes utilized in subsurface mapping are critical to map accuracy. Intra-Search 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 Double Tanks Quadrangle area. Data from geophysical logs are used to correlate coal beds and control contour lines for the coal thickness, structure, and overburden maps. Isopach lines are also drawn to honor selected surface measured sections where there is sparse subsurface control. Where isopach contours do not honor surface measured sections, the surface thicknesses are thought to be attenuated by oxidation and/or erosion; hence they are not reflective of total coal thickness. Isopach lines extend to the coal bed outcrops, the projections of coal bed outcrops, and the contact between porcellanite (clinker) and unoxi-

dized coal in place. Attenuation of total coal bed thickness is known to take place near these lines of definition; however, the overestimation of coal bed tonnages that results from this projection of total coal thickness is insignificant to the Coal Development Potential 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. Areas where coal beds are 5 feet (1.5 m) or more in thickness and are overlain by 500 feet (152 m) or less of overburden are considered to have potential for surface mining and are assigned a high, moderate, or low development potential based on the mining ratio (cubic yards of overburden per ton of recoverable coal). The formula used to calculate mining ratios for subbituminous coal is as follows:

$$MR = \frac{to\ (0.911)^*}{tc\ (rf)}$$

where MR = mining ratio
to = thickness of overburden
tc = thickness of coal
rf = recovery factor
0.911*= conversion factor (cu. yds./ton)

*A conversion factor of 0.922 is used for lignite.

A surface mining development potential map (Plate 34) was prepared utilizing the following mining ratio criteria for coal beds 5 to 40 feet (1.5 to 12 m) thick:

1. Low development potential = 15:1 and greater ratio.

2. Moderate development potential = 10:1 to 15:1 ratio.

3. High development potential = 0 to 10:1 ratio.

The following mining ratio criteria is utilized for coal beds greater than 40 feet (12 m) thick:

1. Low development potential = 7:1 and greater ratio.

2. Moderate development potential = 5:1 to 7:1 ratio.

3. High development potential = 0 to 5:1 ratio.

The surface mining development potential is high for only 1 to 2 percent of the Double Tanks Quadrangle. A moderate development potential rating covers approximately 20 percent of the study area. The high and moderate development potential ratings result from low overburden-to-coal ratios for the Felix coal zone in the northern half of the quadrangle. High overburden-to-coal ratios for the Felix coal zone account for classification of approximately 55 percent of the quadrangle as having low surface mining development potential. The remainder of the quadrangle is considered either to have no development potential for surface mining methods, or is non-federal coal land. Table 1 sets forth the estimated strippable reserve base tonnages per coal bed for the quadrangle.

Underground Mining Coal Development Potential. Subsurface coal mining potential throughout the Double Tanks 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 2 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 Double Tanks Quadrangle is moderate for approximately 85 percent of the area. The coal resource tonnage for in-situ gasification with moderate development potential totals approximately 8.6 billion tons (7.8 billion metric tons) (Table 3). The remaining 15 percent of the quadrangle is classified as high or low development potential area, or as non-federal coal land.

Table 1.--Strippable Coal Reserve Base Data (in short tons) for Federal Coal Lands in the Double Tanks Quadrangle, Campbell County, Wyoming.

Development potentials are based on mining ratios (cubic yards of overburden/ton of recoverable coal).

Coal Bed	High Development Potential (0-10:1 Mining Ratio)	Moderate Development Potential (10:1-15:1 Mining Ratio)	Low Development Potential (> 15:1 Mining Ratio)	Total
RESERVE BASE TONNAGE				
Ulm	9,120,000	-----	-----	9,120,000
Felix	4,150,000	258,750,000	613,900,000	876,800,000
TOTAL	13,270,000	258,750,000	613,900,000	885,920,000

Table 2.--Coal Resource Base Data (in short tons) for Underground Mining Methods for Federal Coal Lands in the Double Tanks Quadrangle, Campbell County, Wyoming.

Coal Bed Name	High Development Potential	Moderate Development Potential	Low Development Potential	Total
Felix	-----	-----	150,240,000	150,240,000
Smith	-----	-----	608,390,000	608,390,000
Anderson-Canyon-Cook	-----	-----	3,680,850,000	3,680,850,000
Upper Wall	-----	-----	3,389,210,000	3,389,210,000
Lower Wall-Pawnee	-----	-----	1,446,140,000	1,446,140,000
Wildcat-Moyer-Oedekoven	-----	-----	1,261,090,000	1,261,090,000
TOTAL	-----	-----	10,535,920,000	10,535,920,000

Table 3.--Coal Resource Base Data (in short tons) for In-Situ Gasification for Federal Coal Lands in the Double Tanks Quadrangle, Campbell County, Wyoming.

Coal Bed Name	High Development Potential	Moderate Development Potential	Low Development Potential	Total
	495,280,000	8,637,190,000	1,403,450,000	10,535,920,000
TOTAL	495,280,000	8,637,190,000	1,403,405,000	10,535,920,000

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