

THE GEOLOGICAL SURVEY OF WYOMING

DANIEL N. MILLER, JR., STATE GEOLOGIST

REPORT OF INVESTIGATIONS NO. 11

ANALYSES AND MEASURED SECTIONS OF 54 WYOMING COAL SAMPLES

(Collected in 1974)

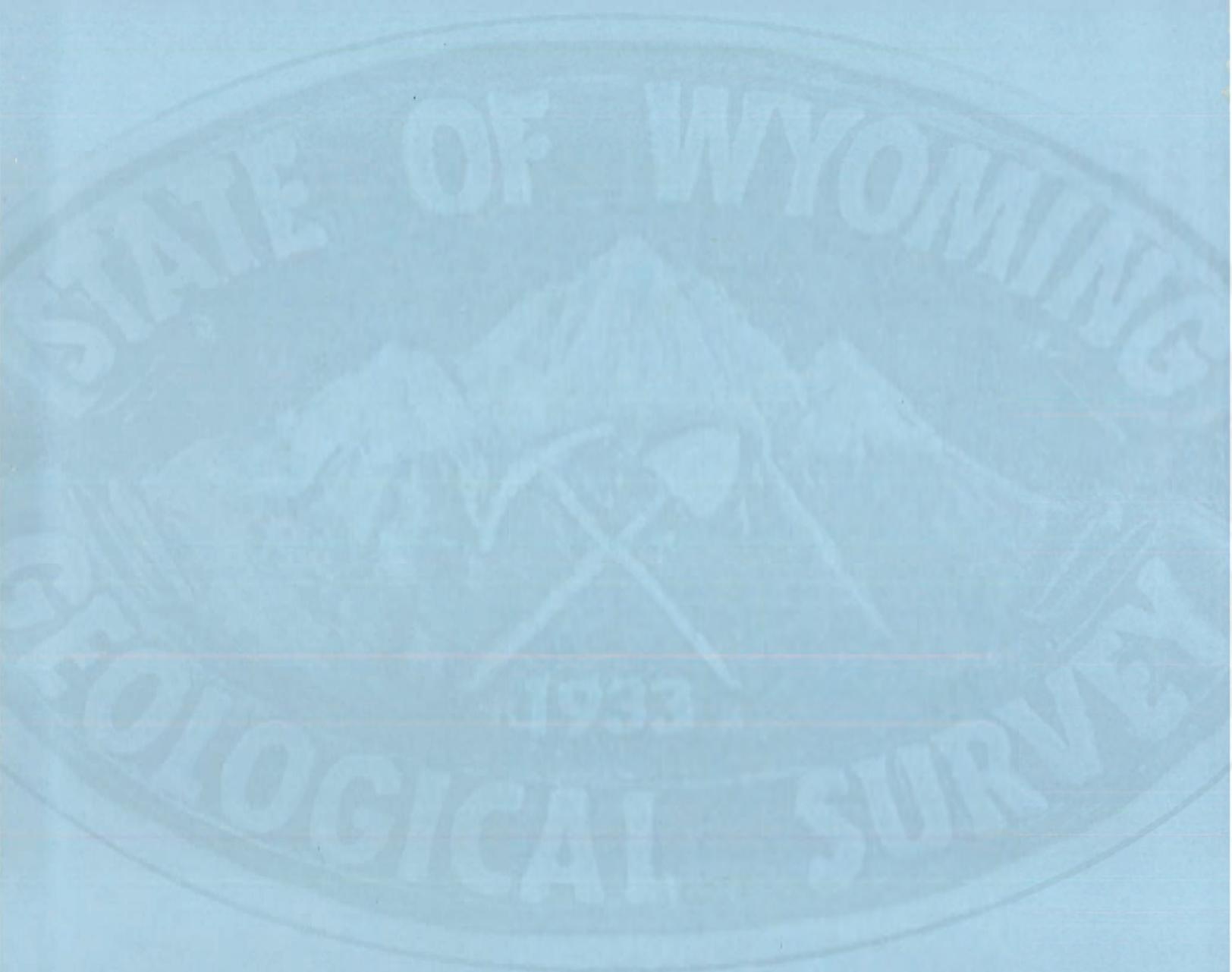
BY GARY B. GLASS

BOX 3008, UNIVERSITY STATION
LARAMIE, WYOMING 82071

NOVEMBER 1975



In cooperation with the U. S. Bureau of Mines; U. S. Geological Survey; Department of Geology, University of Wyoming; and Minerals Division, Wyoming Department of Economic Planning and Development.



STATE OF WYOMING

GEOLOGICAL SURVEY

1933

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ABOUT THE COVER: Two University of Wyoming students
transfer a portion of a face-channel
sample into a sample can, using the
collection techniques of the author.

ANALYSES AND MEASURED SECTIONS OF 54 WYOMING COAL SAMPLES
(COLLECTED IN 1974)

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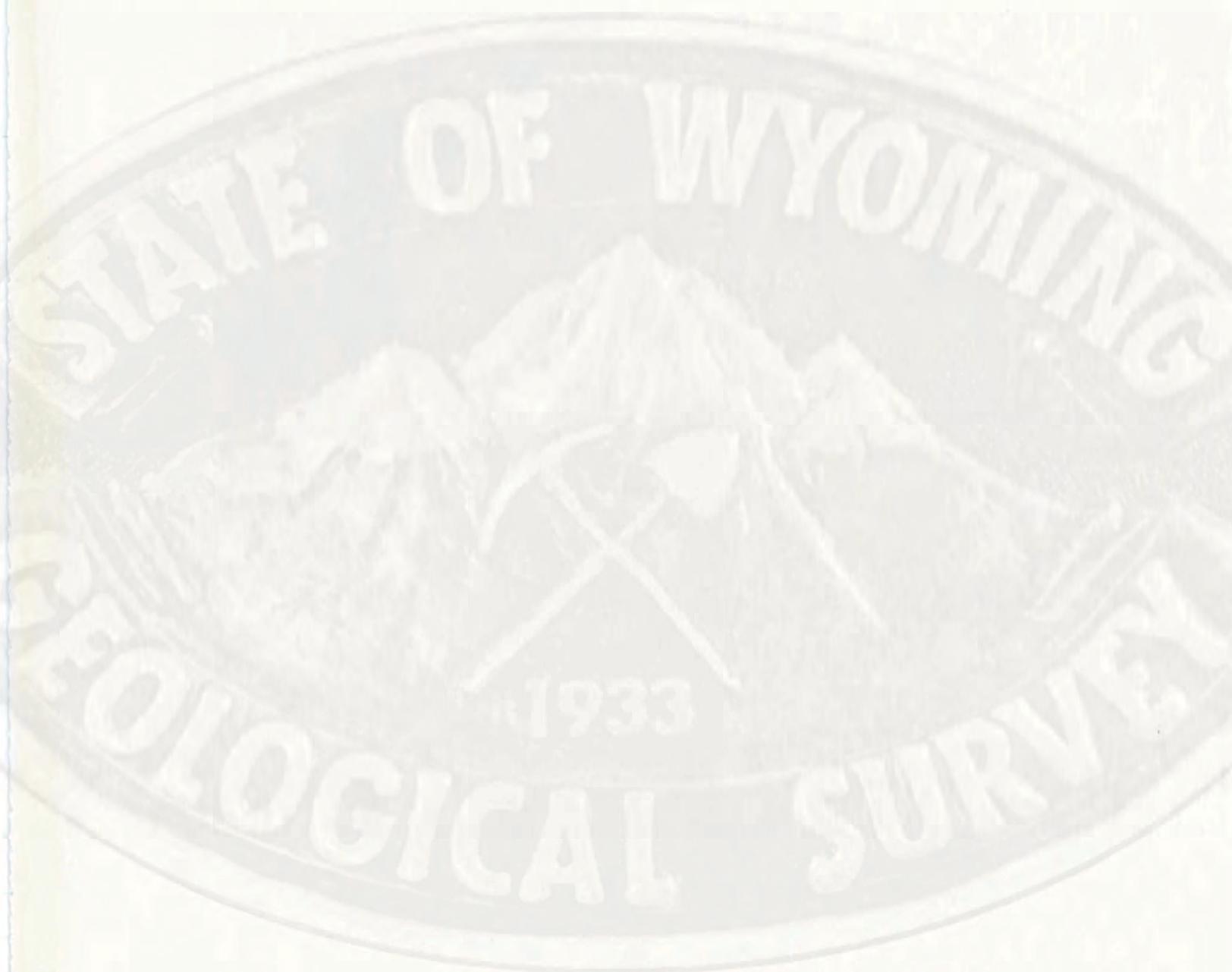
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ANALYSES AND MEASURED SECTIONS OF 54 WYOMING COAL SAMPLES
COLLECTED IN 1974

by

Gary B. Glass¹

INTRODUCTION

In the summer and fall of 1974, Wyoming Geological Survey personnel collected 54 face-channel coal samples from active mines or unweathered outcrops located in four of the ten major coal-bearing areas of Wyoming. These samples were split in the field and representative portions sent to the U. S. Bureau of Mines in Pittsburgh, Pennsylvania, to the U. S. Geological Survey in Denver, Colorado, and to the joint Department of Geology and Wyoming Geological Survey laboratory in Laramie, Wyoming for analysis. Routine analysis, ash composition, and trace element concentrations were determined by various of these labs. To compliment each of the analyses, a detailed measured section was made at each sampling site.

It's stressed at the onset that there are not enough analyses in this report to characterize any individual coals or mines. The chemical and physical characterization of Wyoming's coals by either individual coal bed or coals in specific mines, coal fields, or geologic formations is deferred until other published and unpublished analyses are integrated with these. Such characterization is part of an ongoing study at the Geological Survey of Wyoming and a preliminary report is already in progress.

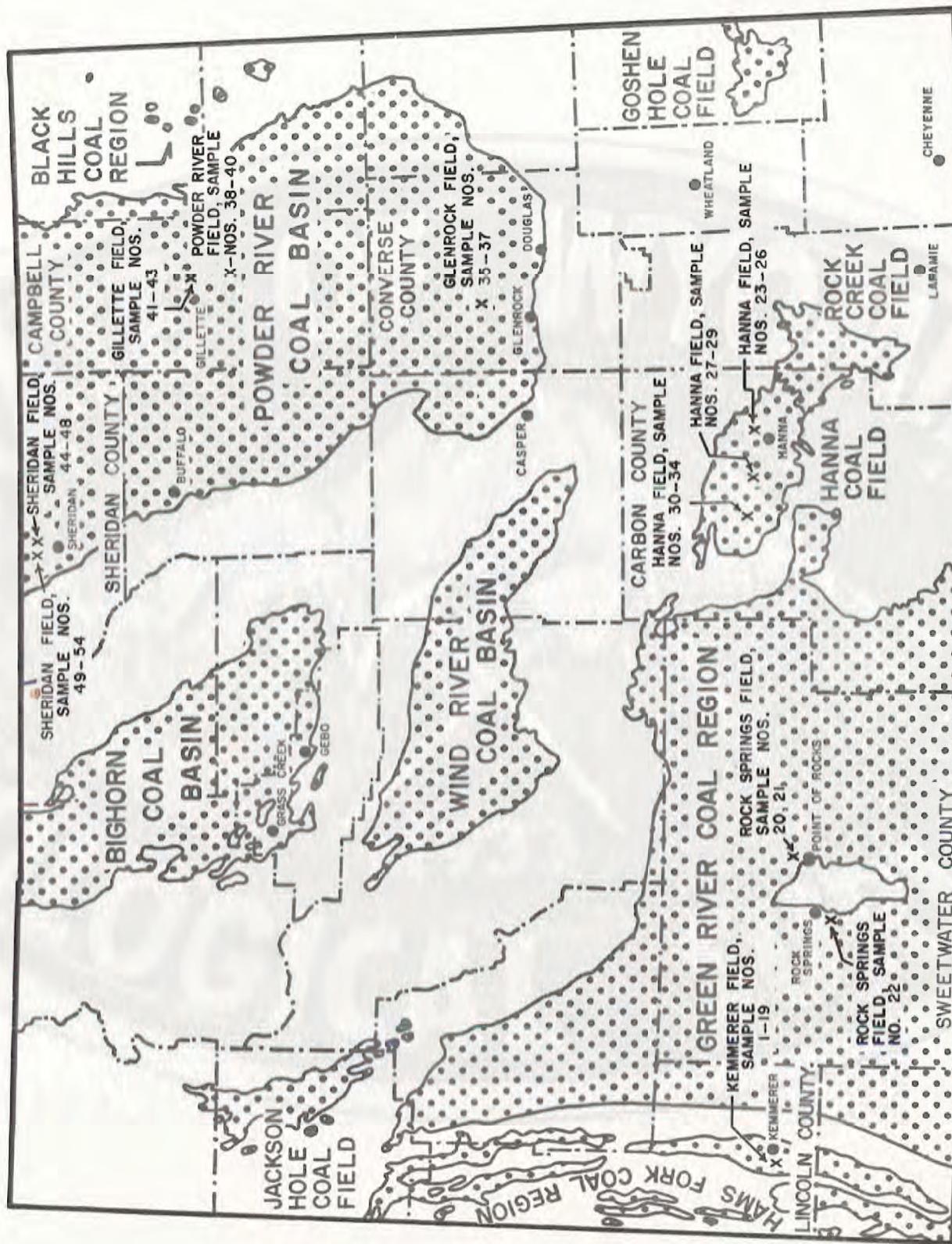
ACKNOWLEDGEMENTS

Grant Number G0244004 from the U. S. Department of Interior, Bureau of Mines, Intermountain Field Operation Center, Denver, Colorado, partially funded the sampling, routine analysis, and publication of this report. This financial assistance is gratefully acknowledged. Additional financial assistance from the Minerals Division of the Wyoming Department of Economic Planning and Development provided a furnace for ashing samples in our laboratory in Laramie, Wyoming.

We would also like to acknowledge the fine analytical work provided by Forrest E. Walker's Coal Analysis Section of the Bureau of Mines in Pittsburgh, Pennsylvania; by analysts J. W. Baker, G. T. Burrow, A. F. Drenick, J. A. England, E. J. Fennelly, J. Gardner, P. Guest, C. Huffman, Jr., J. O. Johnson, R. E. McGregor, V. M. Merritt, H. T. Millard, H. G. Neiman, G. D. Shipley, J. A. Thomas, R. E. Van Loenen, J. S. Wahlberg, and R. J. Young of the U. S. Geological Survey's Branch of Analytical Laboratories in Denver, Colorado; by chemist, J. W. Murphy, of the Department of Geology's

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FIGURE 1: INDEX MAP OF SAMPLE SITES



laboratory in Laramie, Wyoming; and by chemist, J. V. Thomas, of the Department of Minerals Engineering's laboratory in Laramie, Wyoming.

The help of V. E. Swanson and J. R. Hatch of the U. S. Geological Survey's Branch of Coal Resources and D. H. White, Jr. of the Bureau of Mines is also appreciated. Student and part-time assistants E. A. Baldwin, B. A. Bose, C. J. Crossland, J. McPherson C. G. Oviatt, C. R. Tucker, K. H. Westervelt, and G. P. Wilkes are to be complimented for their aid. Special mention is also given to the Survey's draftsman, E. S. Groutage, his assistant, Phyllis Wenger, and to Linda Coffin, who typed the manuscript and tables.

Last but not least, the Survey thanks all the coal mining companies that permitted sampling in or around their mines.

SAMPLING SITES

The samples analyzed in this report were collected from sites in only four of the ten major coal-bearing regions of the State (Figure 1). Nineteen samples came from the Hams Fork Coal Region, 3 from the Green River Coal Region, 12 from the Hanna Coal Field, and 20 from the Powder River Coal Basin. Additionally, these samples were from only seven of the 23 coal fields that occur in those four coal-bearing areas. In order of abundance, nineteen samples were collected from the Kemmerer Coal Field, 12 from the Hanna Coal Field, 11 from the Sheridan Coal Field, and 3 from each of the Gillette, Glenrock, Powder River, and Rock Springs coal fields.

These particular sites were chosen because they are active mines or because they are in the immediate vicinity of an active mine. Although all the coals mined in 1974 were to be sampled, the Mayfield and Gebo coals in the Bighorn Coal Basin were omitted. In both cases, the coals were only exposed in small, seasonally operational mines. Arrangements to collect samples from those mines failed because the mine owners could not be contacted before bad weather set in.

The detailed location of each sample site is given in Appendix A.

SAMPLED COALS

These 54 samples represent an estimated 32 different coals ranging in age from Upper Cretaceous to Eocene. In all, 13 coals were sampled in the Hams Fork Coal Region, 2 coals in the Green River Coal Region, 8 coals in the Hanna Coal Field, and 9 coals in the Powder River Coal Basin. Table 1 shows what geologic formations and coals were sampled in each coal-bearing region.

Since no individual coal beds have ever been correlated from one coal-bearing region to another, regional correlation of coals beyond the formational equivalencies shown in Table 1 are unlikely. In fact correlation of individual beds across any coal-bearing region or even a coal field is seldom possible. For this reason, most coals

TABLE 1: SAMPLED FORMATIONS AND COAL BEDS
BY COAL-BEARING REGIONS

INCREASING AGE →			
	EOCENE	PALEOCENE	UPPER CRETACEOUS
HAMS FORK COAL REGION			Adaville Formation Adaville No. 11 coal Adaville No. 10 coal Adaville No. 6 through No. 1 coals Includes 5 rider coals
GREEN RIVER COAL REGION		Fort Union Formation Deadman coal	Rock Springs Formation Rock Springs No. 7 coal
HANNA COAL FIELD	Hanna Formation Bed No. 82	Hanna Formation Bed No. 80 Hanna No. 2 coal Brooks coal Ferris Formation Bed No. 65 Bed No. 50 Bed No. 25 Bed No. 24	
POWDER RIVER COAL BASIN		Fort Union Formation Badger coal School coal Anderson coal Canyon coal Dietz No. 2 coal Unnamed coal Dietz No. 3 coal Monarch rider coal Monarch coal	

Note: The coal beds are listed from youngest to oldest under each formation except the Fort Union Formation of the Powder River Coal Basin where confusion in correlation makes any sequence questionable.

are treated as separate seams if their names are different. Even this poses problems since coal names alone are not positive evidence for or against bed equivalencies. As examples, it is not certain that the Monarch coal as defined in the Big Horn strip mine (Sample No. 74-48) is equivalent to the Monarch coal in the Welch strip mine (Sample No. 74-54) some 6 miles to the west. Conversely, recent geologic mapping shows that the coals variously called "Roland", Anderson, Wyodak, or D are all probably the same coal at least in Campbell County (Breckenridge, and others, 1975).

FIELD SAMPLING TECHNIQUE

All the analyses in this report were of face-channel samples. In this sampling method, a hand pick was used to cut a vertical channel from the top to the bottom of the exposed coal face. With few exceptions these samples represent the entire height (thickness) of each sampled coal, excluding all unmined portions of the bed. Usually these

unmined portions were noncoaly partings of shale or other rock. Conversely, all noncoaly partings that were mined along with the coal were left in the samples. This deviates from more conventional procedures that require a sampler to pick out and discard all partings of shale, pyrite, or other noncoaly material greater than 3/8 inches thick -- in essence cleaning the coal. This more conventional practice was avoided because Wyoming's coals are not cleaned after mining. Since the analyses of "as-used" coals are as important to the prediction of plant emissions as they are to the prediction of its combustion behavior in those plants, the removal of mined impurities could lessen the value of the analyses for both these purposes.

Exceptions to this sampling procedure were necessitated by (1) poor or incomplete exposures, (2) by benched mining techniques, (3) by complex splitting of single coal beds into two or more thinner coals, or (4) for reasons of comparison. The first case was necessitated when it was physically impossible to expose an entire bed or when it was too dangerous to sample poorly accessible portions of the coal.

The second case was a consequence of a mining technique used in Wyoming. Wyoming strip mines often extract thick (greater than 40 feet) coals in two benches or lifts. Sometimes the break between the benches is picked at a rock parting as in the Big Horn strip mine in Sheridan County (Figure 2). In this case, the upper and lower benches were actually two different coals (Dietz No. 3 and Monarch) which were sampled separately. Although there is no parting in the Anderson-Canyon (Wyodak) coal in the Belle Ayr strip mine in Campbell County, it is also mined in two benches. Since each 35 foot thick bench may be shipped separately, a separate channel sample was taken for each mined bench as well as another down the full 70 foot thickness of the coal.

FIGURE 2: BENCHED MINING TECHNIQUE IN THE BIG HORN NO. 1 STRIP MINE



The third case was necessitated when coals split into two or more individual benches with thick unminable rock partings between them. As an example, the Adaville No. 10 coal (Sample Nos. 74-2 & 74-3) in the Sorensen strip mine in Lincoln County splits into two benches. Where it split into these separate benches, the parting between them exceeded 20 feet in thickness. In such cases, each bench was sampled as an individual bed because it was mined and often shipped as a separate coal. The alternative was to sample both benches as if they were a single coal bed with partings removed.

The last reason for modifying sampling procedures was for comparison. In a few cases, a second sample was collected from a site to see the effects of excluding or not excluding partings. This was only done when it appeared that a mining company might choose either way to mine it.

An unnamed coal in the Big Horn strip mine was also sampled even though it was not being mined. This was done to ascertain why it was not mined. On an as-received basis, the coal (Sample No. 74-45) turned out to be rather high in ash (14%) and sulfur (2.2%). Each sample is described in Appendix A to avoid misunderstandings about what was and was not sampled. This sampling procedure is described in Appendix B.

FIELD PREPARATION OF SAMPLES

After completion of the channeling, the sample was crushed with a rock hammer to fragments less than 1 inch in diameter. It was then quartered, bagged, and put in air-tight ammunition cans for shipment to the U. S. Bureau of Mines or delivery to Laramie for storage and later splitting. Complete details on this phase of the sampling is also described in Appendix B.

Sample splits for the U. S. Bureau of Mines were each shipped within a week after their collection. Two to three months after sampling, splits of 12 samples were shipped to the U. S. Geological Survey. An additional 36 sample splits were sent to the U. S. Geological Survey in March of 1975 -- four to eight months after the various samples were collected. Because samples for the Wyoming Geological Survey's laboratory were split out 2 1/2 months after the last sample was collected in October of 1974, all those sample splits were less than 3 1/2 months old when analyzed.

COAL ANALYSES AND PHYSICAL TESTS

Proximate and ultimate analyses as well as determinations of heat values, fusibilities of coal ash, free swelling indices, forms of sulfur, Hardgrove grindability indices, and real specific gravities are reported for all 54 samples. This report also contains the results of analyses for major, minor, and trace elements. Major and minor elements determined were silicon (Si), aluminum (Al), calcium (Ca), magnesium (Mg), sodium (Na), potassium (K), iron (Fe), manganese (Mn), titanium (Ti), phosphorous (P), sulfur (S), and chlorine (Cl). Trace elements reported for various samples are arsenic (As), boron (B), barium (Ba), beryllium (Be), cadmium (Cd), cerium (Ce), cobalt (Co), chromium (Cr),

copper (Cu), fluorine (F), gallium (Ga), germanium (Ge), mercury (Hg), lanthanum (La), lithium (Li), molybdenum (Mo), niobium (Nb), neodymium (Nd), nickel (Ni), lead (Pb), antimony (Sb), scandium (Sc), selenium (Se), strontium (Sr), thorium (Th), uranium (U), vanadium (V), yttrium (Y), ytterbium (Yb), zinc (Zn), and zirconium (Zr).

These analyses and tests were performed by either the U. S. Bureau of Mines' Coal Analysis Section in Pittsburgh, Pennsylvania, the U. S. Geological Survey's Branch of Analytical Laboratories in Denver, Colorado, the joint Wyoming Geological Survey/Department of Geology's laboratory in Laramie, Wyoming, or the Department of Minerals Engineering's laboratory in Laramie, Wyoming. Table 2 shows which analyses or tests were done by each of the laboratories. The only directly comparable analytical results are the 13 trace elements determined by both the Wyoming Geological Survey and the U. S. Geological Survey. Even these determinations differ somewhat because of dissimilar analytical techniques. Although the major and minor oxides determined by the Wyoming Geological Survey and the U. S. Geological Survey are similar, they were performed on coals ashed at 750°C and 525°C, respectively. The results are therefore not directly comparable.

Routine coal analyses and physical tests

The U. S. Bureau of Mines' Coal Analysis Section did the routine proximate and ultimate analyses as well as the determinations of heat values and the forms of sulfur. The results of these analyses are given in Table 3 on an as received, dry, and dry, ash-free basis. The Bureau also determined the fusibility of ash, Hardgrove grindability index, real specific gravity, and free-swelling index of each sample. The results of these tests are shown in Table 4. Tables 5 and 6 give the mean values of the routine coal analyses and both mean values and standard deviations of the physical tests by coal-bearing region and geologic formation. Since these means are only for the 54 samples analyzed for this report, they do not necessarily characterize the coal-bearing areas or the formations from which they were sampled.

The analytical methods used by the U. S. Bureau of Mines are described in U. S. Bureau of Mines' Bulletin 638 (Office of Coal Research, 1967), and are not included in this report.

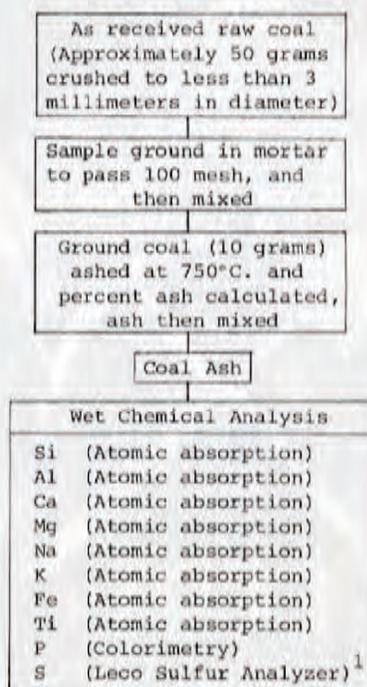
Major and minor elements in coal

Both the Wyoming Geological Survey and the U. S. Geological Survey analyzed up to 12 major and minor elements in these coal samples. All these elements were determined on laboratory ashed samples and consisted of the following elements: silicon (Si), aluminum (Al), calcium (Ca), magnesium (Mg), sodium (Na), potassium (K), iron (Fe), manganese (Mn), titanium (Ti), phosphorous (P), sulfur (S), and chlorine (Cl). Because the two laboratories ashed their samples at different temperatures, each set of data is presented separately.

The Wyoming Geological Survey determined all the major and minor elements listed above except manganese and chlorine for all 54 samples. All these analyses were performed on coals ashed at 750°C. Silicon, aluminum, calcium, magnesium, sodium, potassium, iron, and titanium were done by atomic absorption spectroscopy. The methodology was

modified from Bernas (1968). Phosphorous was determined by colorimetry using a Varian 635D UV-Vis spectrophotometer (modification of a procedure by Shapiro, 1967). Separate splits of the coal ash were given to the Minerals Engineering laboratory where sulfur was determined with a Leco Sulfur Analyzer. Figure 3 depicts this sequence of sample preparation and chemical analysis. The results of these analyses are reported in Table 7 only as percent oxides in the ash. Mean values and standard deviations of these analyses are tabulated in Table 8 for comparative purposes. Again, characterization of coal-bearing areas or geologic formations from this data alone is suspect at best.

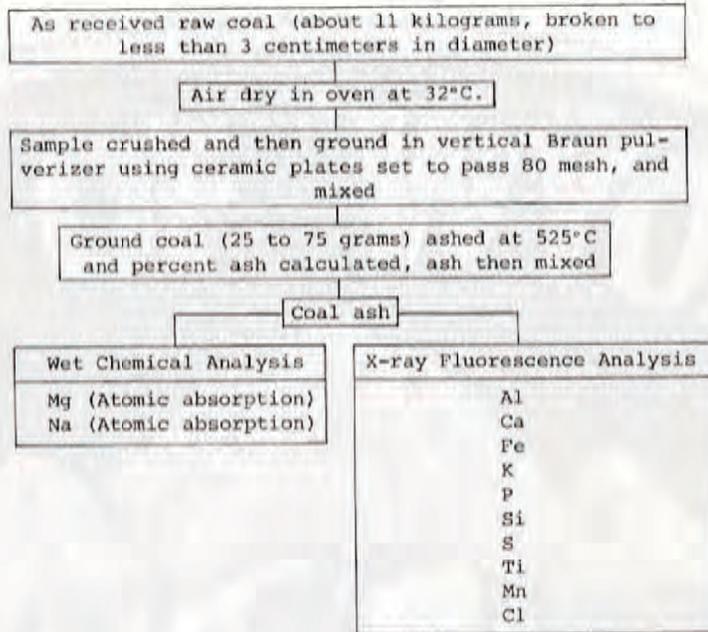
FIGURE 3: WYOMING GEOLOGICAL SURVEY/DEPARTMENT OF GEOLOGY'S LABORATORY SEQUENCE OF SAMPLE PREPARATION AND CHEMICAL ANALYSIS FOR MAJOR AND MINOR ELEMENTS IN COAL



¹ Performed by the Department of Minerals Engineering laboratory

Forty-eight of the samples were also analyzed by the U. S. Geological Survey's Branch of Analytical Laboratories for all 12 major and minor elements. In these analyses the coal was ashed at only 525°C. Silicon, aluminum, calcium, potassium, iron, manganese, phosphorous, titanium, sulfur, and chlorine were analyzed by X-ray fluorescence. Magnesium and sodium were done by atomic absorption spectroscopy. The sequence of sample preparation and chemical analysis is shown in Figure 4. Tables 9 and 10, respectively, give the results of these analyses as percent oxides in the ash (exception chlorine) and as percent elements calculated back to whole-coal. Table 11 lists the means and standard deviations of the oxides of the ash, and Table 12 does the same on the whole-coal basis.

FIGURE 4: THE U. S. GEOLOGICAL SURVEY'S LABORATORY SEQUENCE OF SAMPLE PREPARATION AND CHEMICAL ANALYSIS FOR MAJOR AND MINOR ELEMENTS IN COAL



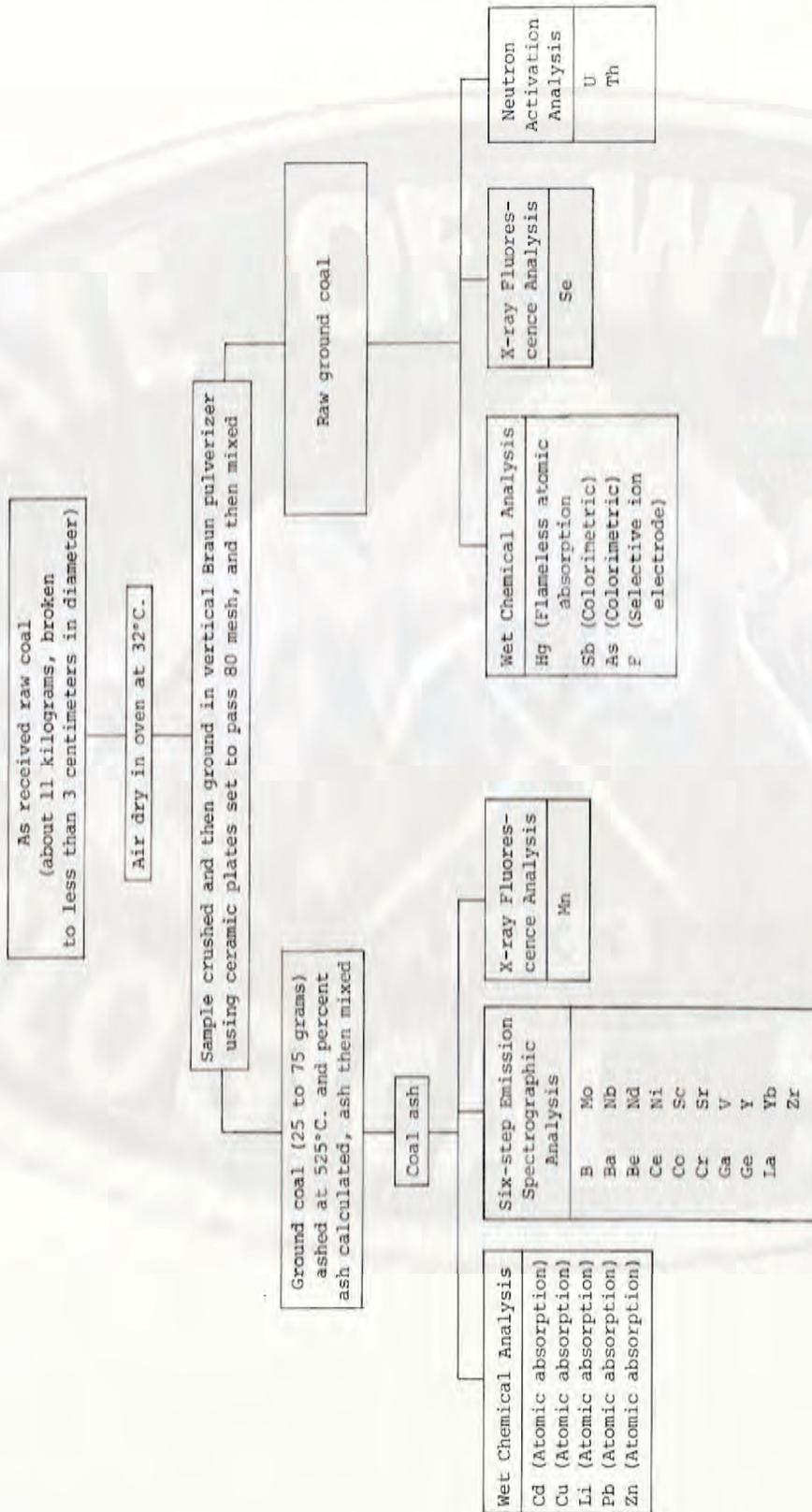
Trace elements in coal

The U. S. Geological Survey and/or the Wyoming Geological Survey determined concentrations of up to 32 different trace elements in these coal samples. Depending on which laboratory performed the analysis, 25 of these elements were identified in 500°C. or 525°C. laboratory ash. Elements determined in the ash were boron (B), barium (Ba), beryllium (Be), cadmium (Cd), cerium (Ce), cobalt (Co), chromium (Cr), copper (Cu), gallium (Ga), germanium (Ge), lanthanum (La), lithium (Li), manganese (Mn), molybdenum (Mo), niobium (Nb), neodymium (Nd), nickel (Ni), lead (Pb), scandium (Sc), strontium (Sr), vanadium (V), yttrium (Y), ytterbium (Yb), zinc (Zn), and zirconium (Zr). Because the ashing temperatures are so close, the analyses performed by the two laboratories are considered comparable, and both sets of data are reported in Table 13. The remaining 7 elements were determined on whole or raw coal, not on the ash. These elements were arsenic (As), fluorine (F), mercury (Hg), antimony (Sb), selenium (Se), thorium (Th), and uranium (U).

The tabulated results of the trace element analyses are contained in Tables 13 and 14. Tables 15 and 16 are statistical summaries of these data compiled for comparison purposes.

The U. S. Geological Survey's Branch of Analytical Laboratories in Denver, Colorado, determined the concentration of all 32 trace elements listed above for 48 of the coal samples. With the exceptions of the arsenic (As), fluorine (F), mercury (Hg), antimony (Sb), selenium (Se), thorium (Th), and uranium (U) analyses, which were performed on raw

FIGURE 5: THE U. S. GEOLOGICAL SURVEY'S LABORATORY SEQUENCE OF SAMPLE PREPARATION AND CHEMICAL ANALYSIS FOR TRACE ELEMENTS IN COAL



coal, the concentrations of all 25 other trace elements were determined on 525°C. laboratory ash (Swanson and Huffman, 1975). Figure 5 shows the U. S. Geological Survey's sequence of sample preparation and chemical analysis for all 32 elements.

Analyses of only 12 of the elements were quantitative determinations: arsenic (As), cadmium (Cd), copper (Cu), fluorine (F), mercury (Hg), lithium (Li), lead (Pb), selenium (Se), antimony (Sb), thorium (Th), uranium (U), and zinc (Zn). The other 20 elements were determined semiquantitatively by spectrographic analysis. The results of the semiquantitative spectrographic analyses are to be identified with geometric brackets whose boundaries are 1.2, 0.83, 0.56, 0.38, 0.26, 0.18, 0.12, etc., but are reported arbitrarily as mid-points of those brackets. The mid-points are 1.0, 0.7, 0.5, 0.3, 0.2, 0.15, and 0.12, etc. The precision of the semiquantitative data is approximately one bracket at 68 percent, or two brackets at 95 percent confidence.

The results of the U. S. Geological Survey's analyses are given in Table 13 as parts per million (ppm) of the laboratory ash, and in Table 14 as parts per million (ppm) on a whole-coal basis. Statistical summaries follow in Tables 15 and 16.

The Wyoming Geological Survey/Department of Geology's laboratory in Laramie, Wyoming, also determined 13 of the same elements for all 54 of the samples, including the 6 samples not analyzed by the U. S. Geological Survey. Beryllium (Be), cadmium (Cd), cobalt (Co), chromium (Cr), copper (Cu), lithium (Li), manganese (Mn), molybdenum (Mo), nickel (Ni), lead (Pb), vanadium (V), and zinc (Zn) were identified from 500°C. laboratory ash; mercury (Hg) was determined on raw coal. All the results are quantitative determinations. The Wyoming Geological Survey's sequence and methods of analysis are shown on Figure 6.

Results are reported as parts per million (ppm) in the ash (Table 13) and as parts per million (ppm) in whole-coal (Table 14). Again the mean values and standard deviations of the data are found in Tables 15 and 16.

A comparison of the analytical results of the 13 elements analyzed by both the Wyoming Geological Survey and the U. S. Geological Survey laboratories is given in Table 17. Some differences are expected simply because (1) the analyses were done by two different laboratories, (2) different analytical methods were often used, and (3) different splits of each sample were analyzed.

There is excellent agreement in the mean values of cadmium (Cd), cobalt (Co), chromium (Cr), copper (Cu), mercury (Hg), lithium (Li), nickel (Ni), and zinc (Zn). Agreement between means for beryllium (Be), molybdenum (Mo), manganese (Mn), lead (Pb), and vanadium (V) are generally fair although the Wyoming Geological Survey's values tend to be the higher of the two laboratories.

FIGURE 6: THE WYOMING GEOLOGICAL SURVEY/DEPARTMENT OF GEOLOGY'S LABORATORY SEQUENCE OF SAMPLE PREPARATION AND CHEMICAL ANALYSIS FOR TRACE ELEMENTS IN COAL

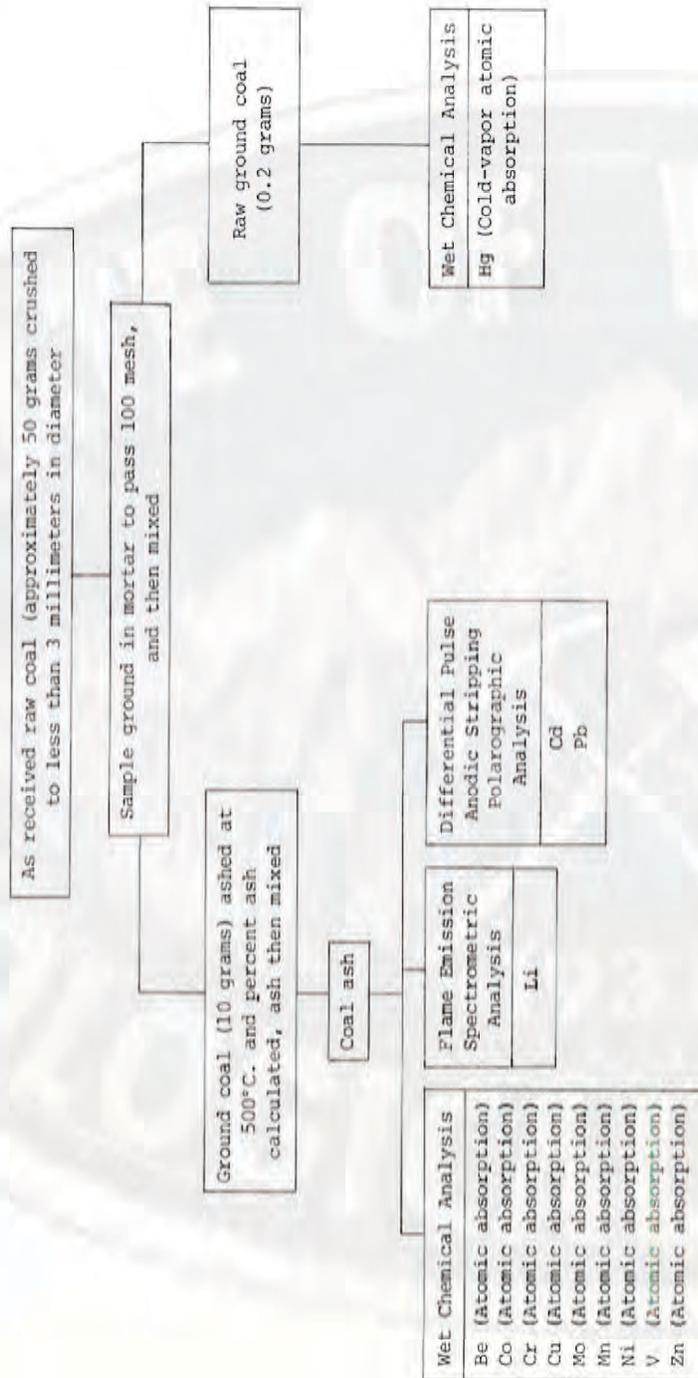


TABLE 2: ANALYSES AND PHYSICAL TESTS PERFORMED BY THE VARIOUS LABORATORIES

U. S. BUREAU OF MINES	WYOMING GEOLOGICAL SURVEY/ DEPARTMENT OF GEOLOGY	MINERALS ENGINEERING	U. S. GEOLOGICAL SURVEY
Proximate analysis (percent)	Major and minor oxides (percent) ¹	Major oxide (percent) ¹	Major and minor elements (percent) ³
Moisture	Silicon dioxide (SiO ₂)	Sulfur trioxide (SO ₃)	Silicon (Si)
Volatile matter	Aluminum oxide (Al ₂ O ₃)		Aluminum (Al)
Fixed carbon	Calcium oxide (CaO)		Calcium (Ca)
Ash	Magnesium oxide (MgO)		Magnesium (Mg)
Ultimate analysis (percent)	Sodium monoxide (Na ₂ O)		Sodium (Na)
Hydrogen (H)	Potassium monoxide (K ₂ O)		Potassium (K)
Carbon (C)	Ferric oxide (Fe ₂ O ₃)		Iron (Fe)
Nitrogen (N)	Titanium dioxide (TiO ₂)		Manganese (Mn)
Oxygen (O)	Phosphorous pentoxide (P ₂ O ₅)		Titanium (Ti)
Sulfur (S)			Phosphorous (P)
Ash			Sulfur (S)
Heat value (Btu/pound)			Chlorine (Cl)
Forms of Sulfur (percent)			Trace elements (ppm) ⁴
Sulfate	Trace elements (ppm) ²		Arsenic (As)
Pyritic	Beryllium (Be)		Beryllium (Be)
Organic	Cadmium (Cd)		Boron (B)
Fusibility of ash (Temp. °F)	Cobalt (Co)		Barium (Ba)
Initial deformation	Chromium (Cr)		Cadmium (Cd)
Softening temperature	Copper (Cu)		Cerium (Ce)
Fluid temperature	Mercury (Hg)		Cobalt (Co)
Hardgrove grindability index	Lithium (Li)		Chromium (Cr)
Real specific gravity	Manganese (Mn)		Copper (Cu)
Free-swelling index	Molybdenum (Mo)		Fluorine (F)
	Nickel (Ni)		Gallium (Ga)
	Lead (Pb)		Germanium (Ge)
	Vanadium (V)		Mercury (Hg)
	Zinc (Zn)		Lanthanum (La)
			Lithium (Li)
			Molybdenum (Mo)
			Niobium (Nb)
			Neodymium (Nd)
			Nickel (Ni)
			Lead (Pb)
			Antimony (Sb)
			Scandium (Sc)
			Selenium (Se)
			Strontium (Sr)
			Thorium (Th)
			Uranium (U)
			Vanadium (V)
			Yttrium (Y)
			Ytterbium (Yb)
			Zinc (Zn)
			Zirconium (Zr)

¹ Reported only as oxides in 750°C laboratory ash.

² Reported as ppm on a whole-coal basis and/or in 500°C laboratory ash

³ Reported as oxides in 525°C laboratory ash (chlorine excepted) as well as on a whole-coal basis

⁴ Reported as ppm on a whole-coal basis and/or in 525°C laboratory ash

TABLE 3: PROXIMATE, ULTIMATE, HEAT VALUE, AND

SAMPLE NUMBER	COUNTY, SEC. TWP. RGE.	COAL FIELD, MINE NAME, MINE TYPE	FORMATION, AGE	COAL NAME, BED THICKNESS, SAMPLE THICKNESS	LAB NUMBER
HAMS FORK COAL REGION					
74-1	Lincoln, 10 20N 117W	Kemmerer Field, Sorensen mine, strip	Adaville, Cretaceous	Adaville No. 11, 13 feet, 13 feet	K-46567
74-2	Lincoln 3 20N 117W	Kemmerer Field, Sorensen mine, strip	Adaville, Cretaceous	Adaville No. 10 (upper bench), 4.8 feet, 4.8 feet	K-46569
74-3	Lincoln, 3 20N 117W	Kemmerer Field, Sorensen mine, strip	Adaville, Cretaceous	Adaville No. 10 (lower bench), 7.95+ feet, 7.05 feet	K-46570
74-4	Lincoln, 10 20N 117W	Kemmerer Field, Sorensen mine, strip	Adaville, Cretaceous	Adaville No. 6 (upper bench), 8.8 feet, 8.8 feet	K-46568
74-5	Lincoln, 10 20N 117W	Kemmerer Field, Sorensen mine, strip	Adaville, Cretaceous	Adaville No. 6 (lower bench), 8 feet, 8 feet	K-46429
74-6	Lincoln, 19 21N 116W	Kemmerer Field, Sorensen mine, strip	Adaville, Cretaceous	Adaville No. 5, 8.5 feet, 8.5 feet	K-47332
74-7	Lincoln, 3 20N 117W	Kemmerer Field, Sorensen mine, strip	Adaville, Cretaceous	Adaville No. 4 rider, 11.5 feet, 11.5 feet	K-46428
74-8	Lincoln, 3 20N 117W	Kemmerer Field, Sorensen mine, strip	Adaville, Cretaceous	Adaville No. 4 (upper bench), 5 feet, 5 feet	K-46427
74-9	Lincoln, 3 20N 117W	Kemmerer Field, Sorensen mine, strip	Adaville, Cretaceous	Adaville No. 4 (lower bench), 12.2 feet, 12 feet	K-46426
74-10	Lincoln, 19 21N 116W	Kemmerer Field, Sorensen mine, strip	Adaville, Cretaceous	Adaville No. 4 rider 5 feet, 5 feet	K-47331
74-11	Lincoln, 19 21N 116W	Kemmerer Field, Sorensen mine, strip	Adaville, Cretaceous	Adaville No. 4 (upper bench) 7 feet, 6 feet	K-47195
74-12	Lincoln, 20 21N 116W	Kemmerer Field, Sorensen mine, strip	Adaville Cretaceous	Adaville No. 4 (lower bench) 6.95 feet, 6.55 feet	K-47199
74-13	Lincoln, 20 21N 116W	Kemmerer Field, Sorensen mine strip	Adaville, Cretaceous	Adaville No. 3 middle rider 10.6 feet, 10 feet	K-47198
74-14	Lincoln, 20 21N 116W	Kemmerer Field, Sorensen mine, strip	Adaville, Cretaceous	Adaville No. 3 lower rider 8.5 feet, 6.5 feet	K-47197
74-15	Lincoln, 20 21N 116W	Kemmerer Field, Sorensen mine, strip	Adaville, Cretaceous	Adaville No. 3 33.6 feet 33.6 feet	K-47333

FORMS OF SULFUR OF 54 FACE-CHANNEL SAMPLES OF COAL¹

LAB NUMBER	PROXIMATE ANALYSIS (PERCENT)				ULTIMATE ANALYSIS (PERCENT)					SULFUR FORMS (PERCENT)			BTU/ POUND	BASIS ²
	MOISTURE	VOLATILE MATTER	FIXED CARBON	ASH	H	C	N	O	S	SULFATE	PYRITIC	ORGANIC		
HAMS FORK COAL REGION														
K-46567	27.5	31.7	36.1	4.7	6.2	47.2	1.4	39.4	1.1	0.03	0.75	0.33	7,920	1
		43.7	49.8	6.5	4.4	65.2	2.0	20.4	1.5	0.04	1.03	0.45	10,930	2
		46.8	53.2		4.7	69.7	2.1	21.9	1.6	0.04	1.11	0.48	11,690	3
K-46569	20.5	33.0	39.6	6.9	6.0	53.8	1.5	30.9	0.9	0.02	0.61	0.31	9,410	1
		41.5	49.8	8.7	4.7	67.7	1.9	15.8	1.2	0.02	0.76	0.39	11,840	2
		45.4	54.6		5.1	74.1	2.1	17.4	1.3	0.03	0.84	0.43	12,960	3
K-46570	22.1	31.1	37.9	8.9	6.1	50.8	1.4	31.0	1.8	0.01	1.25	0.51	8,980	1
		40.0	48.6	11.4	4.7	65.2	1.8	14.6	2.3	0.01	1.61	0.66	11,530	2
		45.1	54.9		5.3	73.6	2.1	16.4	2.6	0.01	1.81	0.75	13,010	3
K-46568	23.8	33.1	37.8	5.3	6.1	50.7	1.4	35.9	0.6	0.28	0.03	0.34	8,560	1
		43.5	49.5	7.0	4.6	66.6	1.8	19.1	0.9	0.36	0.04	0.45	11,230	2
		46.7	53.3		4.9	71.5	2.0	20.7	0.9	0.39	0.04	0.48	12,070	3
K-46429	26.1	34.0	33.5	6.4	6.5	48.8	0.8	36.9	0.6	0.06	0.12	0.39	8,340	1
		46.0	45.3	8.7	4.8	65.9	1.0	18.8	0.8	0.08	0.16	0.53	11,280	2
		50.3	49.7		5.3	72.2	1.1	20.6	0.8	0.09	0.17	0.58	12,350	3
K-47332	17.5	35.1	43.7	3.7	6.1	58.5	1.5	29.8	0.4	0.03	0.09	0.23	10,180	1
		42.5	53.0	4.5	5.0	70.8	1.8	17.5	0.4	0.04	0.11	0.28	12,330	2
		44.5	55.5		5.2	74.2	1.9	18.3	0.4	0.04	0.11	0.29	12,910	3
K-46428	23.0	32.3	40.5	4.2	6.4	54.1	1.3	33.0	1.0	0.01	0.75	0.22	9,490	1
		41.9	52.7	5.4	5.0	70.3	1.7	16.3	1.3	0.01	0.98	0.29	12,320	2
		44.3	55.7		5.3	74.4	1.8	17.1	1.4	0.01	1.04	0.31	13,030	3
K-46427	22.1	33.4	40.1	4.4	6.3	54.3	1.3	32.4	1.3	0.01	1.11	0.18	9,540	1
		42.9	51.5	5.6	5.0	69.6	1.7	16.4	1.7	0.01	1.42	0.23	12,240	2
		45.4	54.6		5.3	73.8	1.8	17.3	1.8	0.01	1.51	0.24	12,970	3
K-46426	20.9	34.7	41.2	3.2	6.3	56.2	1.4	32.2	0.7	0.03	0.44	0.27	9,860	1
		43.9	52.1	4.0	5.1	71.0	1.7	17.3	0.9	0.04	0.55	0.34	12,470	2
		45.7	54.3		5.3	74.0	1.8	17.9	1.0	0.04	0.57	0.35	12,990	3
K-47331	20.0	34.3	40.0	5.7	5.9	54.8	1.4	31.9	0.3	0.03	0.12	0.14	9,350	1
		42.9	50.0	7.1	4.6	68.5	1.7	17.7	0.4	0.04	0.15	0.18	11,690	2
		46.1	53.9		4.9	73.8	1.9	19.0	0.4	0.04	0.16	0.19	12,590	3
K-47195	20.6	33.9	42.2	3.3	6.3	57.2	1.4	31.5	0.3	0.01	0.03	0.28	9,910	1
		42.7	53.2	4.1	5.1	72.1	1.7	16.6	0.4	0.01	0.04	0.35	12,480	2
		44.5	55.5		5.3	75.2	1.8	17.3	0.4	0.01	0.04	0.37	13,020	3
K-47199	20.9	34.0	41.2	3.9	6.1	55.9	1.5	32.2	0.4	0.01	0.11	0.28	9,750	1
		42.9	52.2	4.9	4.8	70.7	1.8	17.3	0.5	0.01	0.15	0.35	12,320	2
		45.1	54.9		5.1	74.3	1.9	18.2	0.5	0.01	0.15	0.37	12,960	3
K-47198	15.4	36.1	44.7	3.8	5.9	60.0	1.5	28.5	0.3	0.04	0.05	0.25	10,330	1
		42.7	52.8	4.5	4.9	71.0	1.8	17.4	0.4	0.05	0.06	0.30	12,220	2
		44.7	55.3		5.1	74.3	1.9	18.3	0.4	0.05	0.06	0.32	12,790	3
K-47197	20.3	37.1	37.8	4.8	6.1	56.3	1.4	31.1	0.3	0.01	0.08	0.20	9,780	1
		46.6	47.4	6.0	4.8	70.6	1.8	16.4	0.4	0.01	0.10	0.25	12,270	2
		49.5	50.5		5.2	75.1	1.9	17.4	0.4	0.01	0.10	0.27	13,050	3
K-47333	15.6	35.6	44.4	4.4	6.0	59.8	1.3	28.2	0.3	0.00	0.04	0.22	10,400	1
		42.2	52.5	5.3	5.0	70.8	1.6	17.0	0.3	0.00	0.05	0.26	12,320	2
		44.5	55.5		5.3	74.8	1.7	17.9	0.3	0.00	0.05	0.28	13,010	3

TABLE 3: PROXIMATE, ULTIMATE, HEAT VALUE, AND

SAMPLE NUMBER	COUNTY, SEC. TWP. RGE.	COAL FIELD, MINE NAME, MINE TYPE	FORMATION, AGE	COAL NAME, BED THICKNESS, SAMPLE THICKNESS	LAB NUMBER
HAMS FORK COAL REGION - continued					
74-16	Lincoln, 20 21N 116W	Kemmerer Field, Sorensen mine, strip	Adaville, Cretaceous	Adaville No. 2 upper rider, 4.25 feet, 3.85 feet	K-47374
74-17	Lincoln, 20 21N 116W	Kemmerer Field, Sorensen mine, strip	Adaville, Cretaceous	Adaville No. 2 lower rider, 3.7 feet, 3.7 feet	K-47196
74-18	Lincoln, 20 21N 116W	Kemmerer Field, Sorensen mine, strip	Adaville, Cretaceous	Adaville No. 2, 15.75 feet, 15 feet	K-47200
74-19	Lincoln, 20 21N 116W	Kemmerer Field, Elkol mine, strip	Adaville, Cretaceous	Adaville No. 1, 88.075 feet, 86.675 feet	K-47373
GREEN RIVER COAL REGION					
74-20	Sweetwater, 20 21N 100W	Rock Springs Field, Jim Bridger mine, strip	Fort Union, Paleocene	Deadman (upper bench), 31.4 feet, 15 feet	K-47372
74-21	Sweetwater, 20 21N 100W	Rock Springs Field, Jim Bridger mine, strip	Fort Union, Paleocene	Deadman (lower bench), 31.4 feet, 15.9 feet	K-47371
74-22	Sweetwater, 23 18N 105W	Rock Springs Field, Rainbow No. 8 mine, underground	Rock Springs, Cretaceous	Rock Springs No. 7, 4.95 feet, 4.95 feet	K-47201
HANNA COAL FIELD					
74-23	Carbon, 34 23N 81W	Hanna Field, Rosebud Pit No. 5, strip	Hanna, Eocene	Bed No. 82, 11.25 feet, 11.25 feet	K-47600
74-24	Carbon, 3 22N 81W	Hanna Field, Rosebud Pit No. 4, strip	Hanna, ? Paleocene	Bed No. 80, 16.65 feet, 13.95 feet	K-47599
74-25	Carbon, 28 23N 81W	Hanna Field, Rosebud Pit No. 8, strip	Hanna, ? Paleocene	Bed No. 80, 18.1 feet, 18.1 feet	K-47549
74-26	Carbon, 4 22N 81W	Hanna Field, Old Monolith mine, strip	Hanna, ? Paleocene	Hanna No. 2, 35.4 feet, 35.4 feet	K-47845
74-27	Carbon, 9 22N 82W	Hanna Field, Rimrock No. 3 Pit, strip	Hanna, ? Paleocene	Brooks, 7.5 feet, 7.5 feet	K-47847
74-28	Carbon, 8 22N 82W	Hanna Field, Vanguard No. 1 mine, underground	Ferris, Paleocene	Bed No. 65, 7.65 feet, 6.65 feet	K-48218
74-29	Carbon, 18 22N 82W	Hanna Field, Vanguard No. 2 mine, underground	Ferris, Paleocene	Bed No. 50, 18.25 feet, 9.4 feet	K-48217

FORMS OF SULFUR OF 54 FACE-CHANNEL SAMPLES OF COAL¹ - continued

LAB NUMBER	PROXIMATE ANALYSIS (PERCENT)				ULTIMATE ANALYSIS (PERCENT)					SULFUR FORMS (PERCENT)			BTU/ POUND	BASIS ²
	MOISTURE	VOLATILE MATTER	FIXED CARBON	ASH	H	C	N	O	S	SULFATE	PYRITIC	ORGANIC		
HAMS FORK COAL REGION - continued														
K-47374	16.5	34.5	43.3	5.7	5.9	58.1	1.3	28.5	0.5	0.02	0.09	0.36	10,090	1
		41.3	51.8	6.9	4.9	69.6	1.6	16.4	0.6	0.02	0.11	0.43	12,190	2
		44.3	55.7		5.2	74.7	1.7	17.8	0.6	0.03	0.12	0.46	13,080	3
K-47196	18.9	33.5	42.4	5.2	6.1	57.4	1.4	29.4	0.5	0.00	0.04	0.43	9,960	1
		41.3	52.3	6.4	4.9	70.8	1.7	15.6	0.6	0.00	0.05	0.53	12,280	2
		44.1	55.9		5.2	75.6	1.8	16.8	0.6	0.00	0.05	0.57	13,120	3
K-47200	17.5	34.4	44.1	4.0	5.9	58.3	1.4	30.1	0.3	0.05	0.09	0.17	10,100	1
		41.7	53.4	4.9	4.8	70.6	1.7	17.6	0.4	0.06	0.11	0.21	12,240	2
		43.8	56.2		5.1	74.3	1.8	18.4	0.4	0.06	0.11	0.22	12,870	3
K-47373	16.7	36.5	42.8	4.0	6.2	60.1	0.9	27.5	1.3	0.02	0.16	1.11	10,530	1
		43.8	51.4	4.8	5.2	72.1	1.1	15.3	1.5	0.02	0.19	1.33	12,640	2
		46.0	54.0		5.5	75.8	1.2	15.9	1.6	0.02	0.20	1.40	13,270	3
GREEN RIVER COAL REGION														
K-47372	19.5	32.6	42.0	5.9	5.6	55.6	1.1	31.3	0.5	0.15	0.08	0.26	9,270	1
		40.5	52.1	7.4	4.3	69.1	1.4	17.2	0.6	0.18	0.10	0.32	11,520	2
		43.8	56.2		4.6	74.6	1.5	18.7	0.6	0.20	0.11	0.34	12,440	3
K-47371	23.0	30.1	36.5	10.4	5.6	48.1	1.1	34.3	0.5	0.07	0.05	0.41	7,940	1
		39.1	47.4	13.5	3.9	62.5	1.4	18.0	0.7	0.10	0.06	0.53	10,310	2
		45.2	54.8		4.5	72.2	1.7	20.8	0.8	0.11	0.07	0.61	11,920	3
K-47201	10.4	38.1	46.1	5.4	5.8	66.1	1.6	20.2	0.9	0.04	0.40	0.49	11,720	1
		42.5	51.5	6.0	5.2	73.8	1.8	12.2	1.0	0.04	0.45	0.55	13,080	2
		45.2	54.8		5.5	78.5	1.9	13.0	1.1	0.05	0.48	0.58	13,910	3
HANNA COAL FIELD														
K-47600	11.2	40.9	40.6	7.3	5.8	61.3	1.6	23.0	1.0	0.03	0.44	0.50	10,830	1
		46.1	45.6	8.3	5.1	69.0	1.8	14.7	1.1	0.03	0.49	0.57	12,200	2
		50.2	49.8		5.6	75.2	2.0	16.0	1.2	0.04	0.53	0.62	13,300	3
K-47599	12.4	39.2	39.6	8.8	5.7	59.7	1.3	23.3	1.2	0.02	0.44	0.69	10,450	1
		44.7	45.3	10.0	5.0	68.1	1.5	14.1	1.3	0.02	0.50	0.79	11,930	2
		49.7	50.3		5.5	75.7	1.7	15.6	1.5	0.02	0.56	0.88	13,260	3
K-47549	10.6	37.4	47.6	4.4	5.9	65.6	1.5	21.9	0.7	0.01	0.22	0.42	11,510	1
		41.8	53.2	5.0	5.3	73.4	1.7	13.8	0.8	0.01	0.25	0.53	12,880	2
		44.0	56.0		5.6	77.2	1.8	14.6	0.8	0.01	0.26	0.55	13,560	3
K-47845	11.3	40.1	43.2	5.4	6.1	65.1	1.3	21.7	0.4	0.01	0.15	0.24	11,350	1
		45.2	48.7	6.1	5.5	73.3	1.4	13.2	0.5	0.01	0.17	0.28	12,790	2
		48.1	51.9		5.9	78.1	1.5	14.0	0.5	0.01	0.18	0.29	13,620	3
K-47847	12.3	33.5	47.2	7.0	5.6	62.5	1.1	23.3	0.5	0.03	0.27	0.21	10,820	1
		38.2	53.8	8.0	4.8	71.3	1.3	14.0	0.6	0.03	0.31	0.23	12,340	2
		41.5	58.5		5.3	77.4	1.4	15.3	0.6	0.04	0.34	0.26	13,410	3
K-48218	10.1	37.2	46.4	6.3	5.6	64.4	1.6	21.5	0.6	0.01	0.34	0.25	11,150	1
		41.4	51.6	7.0	5.0	71.6	1.8	13.9	0.7	0.01	0.38	0.28	12,400	2
		44.5	55.5		5.4	77.1	1.9	14.9	0.7	0.01	0.40	0.30	13,340	3
K-48217	11.3	34.1	43.7	10.9	5.3	58.9	1.4	23.1	0.4	0.02	0.09	0.28	10,070	1
		38.4	49.3	12.3	4.6	66.4	1.6	14.7	0.4	0.02	0.10	0.32	11,360	2
		43.8	56.2		5.2	75.7	1.8	16.8	0.5	0.03	0.11	0.36	12,940	3

TABLE 3: PROXIMATE, ULTIMATE, HEAT VALUE, AND

SAMPLE NUMBER	COUNTY, SEC. TWP. RGE.	COAL FIELD, MINE NAME, MINE TYPE	FORMATION, AGE	COAL NAME, BED THICKNESS, SAMPLE THICKNESS	LAB NUMBER
HANNA COAL FIELD - continued					
74-30	Carbon, 7 22N 83W	Hanna Field, outcrop	Ferris, Paleocene	Bed No. 25 (upper bench), 4 feet, 4 feet	K-47850
74-31	Carbon, 7 22N 83W	Hanna Field, outcrop	Ferris, Paleocene	Bed No. 25 (middle bench), 5.5 feet, 5.5 feet	K-47851
74-32	Carbon, 7 22N 83W	Hanna Field, outcrop	Ferris, Paleocene	Bed No. 25 (lower bench), 8.3 feet, 8.3 feet	K-47846
74-33	Carbon, 12 22N 84W	Hanna Field, outcrop	Ferris, Paleocene	Bed No. 25 (lower bench), 7.2 feet, 7.2 feet	K-47848
74-34	Carbon, 7 22N 83W	Hanna Field, outcrop	Ferris, Paleocene	Bed No. 24, 19 feet, 19 feet	K-47849
POWDER RIVER COAL BASIN					
74-35	Converse, 34 36N 75W	Glenrock Field, Dave Johnston mine, strip	Fort Union, Paleocene	Badger, 16.8 feet, 16.2 feet	K-45927
74-36	Converse, 2 35N 75W	Glenrock Field, Dave Johnston mine, strip	Fort Union, Paleocene	School, 38.1 feet, 38.1 feet	K-45926
74-37	Converse, 34 36N 75W	Glenrock Field, Dave Johnston mine, strip	Fort Union, Paleocene	School, 37 feet, 36.2 feet	K-45928
74-38	Campbell, 34 48N 71W	Powder River Field, Belle Ayr mine, strip	Fort Union, Paleocene	Anderson-Canyon (Wyodak) upper lift, 74.4 feet, 35 feet	K-46217
74-39	Campbell, 34 48N 71W	Powder River Field, Belle Ayr mine, strip	Fort Union, Paleocene	Anderson-Canyon (Wyodak) lower lift, 74.4 feet, 39.4 feet	K-46216
74-40	Campbell, 34 48N 71W	Powder River Field, Belle Ayr mine, strip	Fort Union, Paleocene	Anderson-Canyon (Wyodak), 74.4 feet, 74.4 feet	K-46218
74-41	Campbell, 28 50N 71W	Gillette Field, Wyodak North Pit, strip	Fort Union, Paleocene	Anderson, 91.8 feet, 41.7 feet	K-46430
74-42	Campbell, 28 50N 71W	Gillette Field, Wyodak South Pit, strip	Fort Union, Paleocene	Anderson, 109.05 feet, 58.45 feet	K-46566
74-43	Campbell, 28 50N 71W	Gillette Field, Wyodak South Pit, strip	Fort Union, Paleocene	Canyon, 109.05 feet, 42 feet	K-46565

FORMS OF SULFUR OF 54 FACE-CHANNEL SAMPLES OF COAL¹ - continued

LAB NUMBER	PROXIMATE ANALYSIS (PERCENT)				ULTIMATE ANALYSIS (PERCENT)					SULFUR FORMS (PERCENT)			BTU/ POUND	BASIS ²
	MOISTURE	VOLATILE MATTER	FIXED CARBON	ASH	H	C	N	O	S	SULFATE	PYRITIC	ORGANIC		
HANNA COAL FIELD - continued														
K-47850	14.3	34.0	44.3	7.4	5.4	58.8	1.0	26.7	0.7	0.01	0.35	0.31	9,940	1
		39.6	51.7	8.7	4.5	68.6	1.1	16.3	0.8	0.01	0.41	0.36	11,600	2
		43.4	56.6		4.9	75.1	1.3	17.8	0.9	0.01	0.44	0.39	12,690	3
K-47851	11.5	32.5	39.3	16.7	5.1	52.9	0.9	24.1	0.3	0.01	0.07	0.21	9,080	1
		36.8	44.3	18.9	4.3	59.7	1.0	15.8	0.3	0.01	0.08	0.23	10,260	2
		45.3	54.7		5.3	73.6	1.2	19.5	0.4	0.01	0.10	0.29	12,650	3
K-47846	13.8	33.3	44.3	8.6	5.4	58.0	0.8	26.8	0.4	0.03	0.17	0.18	9,950	1
		38.6	51.5	9.9	4.5	67.3	1.0	16.9	0.4	0.03	0.19	0.20	11,540	2
		42.8	57.2		5.0	74.7	1.1	18.7	0.5	0.04	0.21	0.23	12,810	3
K-47848	18.9	34.5	40.0	6.6	5.2	52.2	0.9	34.6	0.5	0.21	0.09	0.17	8,340	1
		42.5	49.4	8.1	3.8	64.3	1.1	22.1	0.6	0.26	0.11	0.21	10,280	2
		46.2	53.8		4.1	70.0	1.2	24.1	0.6	0.29	0.12	0.23	11,190	3
K-47849	16.0	34.3	45.8	3.9	5.8	60.0	0.8	29.1	0.4	0.01	0.19	0.16	10,180	1
		40.8	54.5	4.7	4.8	71.4	0.9	17.8	0.4	0.01	0.23	0.19	12,120	2
		42.8	57.2		5.1	74.9	0.9	18.6	0.5	0.01	0.24	0.20	12,710	3
POWDER RIVER COAL BASIN														
K-45927	22.7	34.9	32.6	9.8	6.2	48.3	0.6	34.6	0.5	0.01	0.01	0.49	8,290	1
		45.2	42.2	12.6	4.7	62.5	0.8	18.7	0.7	0.01	0.01	0.63	10,720	2
		51.7	48.3		5.4	71.6	0.9	21.3	0.8	0.01	0.01	0.72	12,280	3
K-45926	20.7	35.3	28.3	15.7	5.8	45.9	0.6	31.5	0.5	0.01	0.07	0.46	7,850	1
		44.5	35.7	19.8	4.5	57.8	0.8	16.4	0.7	0.01	0.09	0.58	9,900	2
		55.4	44.6		5.6	72.1	1.0	20.5	0.8	0.02	0.11	0.72	12,340	3
K-45928	19.5	38.1	33.6	8.8	6.1	51.8	1.4	31.2	0.7	0.01	0.05	0.61	8,870	1
		47.3	41.8	10.9	4.9	64.4	1.8	17.2	0.8	0.01	0.06	0.76	11,030	2
		53.1	46.9		5.5	72.3	2.0	19.3	0.9	0.01	0.07	0.85	12,380	3
K-46217	21.4	35.5	36.9	6.2	6.6	54.0	0.9	31.7	0.6	0.01	0.16	0.44	9,390	1
		45.1	47.0	7.9	5.4	68.7	1.1	16.1	0.8	0.01	0.21	0.55	11,940	2
		48.9	51.1		5.9	74.5	1.2	17.6	0.8	0.01	0.23	0.60	12,960	3
K-46216	22.6	32.9	39.6	4.9	6.5	54.1	0.9	33.2	0.4	0.01	0.12	0.24	9,310	1
		42.6	51.1	6.3	5.1	69.9	1.1	17.1	0.5	0.01	0.15	0.31	12,020	2
		45.4	54.6		5.5	74.6	1.2	18.2	0.5	0.01	0.16	0.33	12,840	3
K-46218	21.1	35.0	38.4	5.5	5.9	54.9	0.9	32.3	0.5	0.01	0.15	0.32	9,480	1
		44.4	48.6	7.0	4.5	69.5	1.1	17.3	0.6	0.01	0.19	0.41	12,010	2
		47.7	52.3		4.9	74.8	1.2	18.4	0.7	0.01	0.20	0.44	12,920	3
K-46430	21.9	33.6	40.3	4.2	6.4	55.0	1.4	32.4	0.6	0.08	0.24	0.26	9,600	1
		43.0	51.7	5.3	5.1	70.4	1.8	16.7	0.7	0.10	0.31	0.34	12,280	2
		45.5	54.5		5.3	74.4	1.9	17.6	0.8	0.11	0.33	0.36	12,970	3
K-46566	27.2	33.9	31.2	7.7	6.5	47.7	0.7	36.6	0.8	0.08	0.34	0.34	8,280	1
		46.5	42.9	10.6	4.8	65.5	1.0	17.1	1.0	0.10	0.47	0.47	11,380	2
		52.1	47.9		5.4	73.2	1.1	19.1	1.2	0.12	0.53	0.53	12,730	3
K-46565	29.9	32.1	32.6	5.4	6.5	48.2	0.8	38.8	0.3	0.01	0.16	0.14	8,180	1
		45.7	46.6	7.7	4.6	68.8	1.1	17.3	0.5	0.01	0.23	0.21	11,660	2
		49.5	50.5		5.0	74.5	1.2	18.8	0.5	0.01	0.25	0.22	12,630	3

TABLE 3: PROXIMATE, ULTIMATE, HEAT VALUE, AND

SAMPLE NUMBER	COUNTY, SEC. TWP. RGE.	COAL FIELD, MINE NAME, MINE TYPE	FORMATION, AGE	COAL NAME, BED THICKNESS, SAMPLE THICKNESS	LAB NUMBER
POWDER RIVER COAL BASIN - continued					
74-44	Sheridan, 22 57N 84W	Sheridan Field, Big Horn mine, strip	Fort Union, Paleocene	Dietz No. 2, 11.1 feet, 11.1 feet	K-45925
74-45	Sheridan, 22 57N 84W	Sheridan Field, Big Horn mine, strip	Fort Union, Paleocene	Unnamed, 5.1 feet, 5.1 feet	K-45924
74-46	Sheridan, 22 57N 84W	Sheridan Field, Big Horn mine, strip	Fort Union, Paleocene	Four-Foot Bed, 25.2 feet, 4.1 feet	K-46219
74-47	Sheridan, 22 57N 84W	Sheridan Field, Big Horn mine, strip	Fort Union, Paleocene	Dietz No. 3, 25.2 feet, 24.9 feet	K-45923
74-48	Sheridan, 22 57N 84W	Sheridan Field, Big Horn mine, strip	Fort Union, Paleocene	Monarch, 26.1 feet, 25.8 feet	K-45922
74-49	Sheridan, 22 57N 85W	Sheridan Field, Welch mine, strip	Fort Union, Paleocene	Monarch rider, 3.9 feet, 3.9 feet	K-45921
74-50	Sheridan, 22 57N 85W	Sheridan Field, Welch mine, strip	Fort Union, Paleocene	Monarch (upper bench), 12.05 feet, 2.9 feet	K-46223
74-51	Sheridan 22 57N 85W	Sheridan Field, Welch mine, strip	Fort Union, Paleocene	Monarch (upper middle bench), 12.05 feet, 1.7 feet	K-46222
74-52	Sheridan, 22 57N 85W	Sheridan Field, Welch mine, strip	Fort Union, Paleocene	Monarch (lower middle bench), 12.05 feet, 2.75 feet	K-46221
74-53	Sheridan, 22 57N 85W	Sheridan Field, Welch mine, strip	Fort Union, Paleocene	Monarch (lower bench), 12.05 feet, 2.7 feet	K-46220
74-54	Sheridan, 22 57N 85W	Sheridan Field, Welch mine, strip	Fort Union, Paleocene	Monarch, 12.05 feet, 10.05 feet	K-45920

FORMS OF SULFUR OF 54 FACE-CHANNEL SAMPLES OF COAL¹ - continued

LAB NUMBER	PROXIMATE ANALYSIS (PERCENT)				ULTIMATE ANALYSIS (PERCENT)					SULFUR FORMS (PERCENT)			BTU/ POUND	BASIS ²
	MOISTURE	VOLATILE MATTER	FIXED CARBON	ASH	H	C	N	O	S	SULFATE	PYRITIC	ORGANIC		
POWDER RIVER COAL BASIN - continued														
K-45925	21.7	33.6	38.5	6.2	6.4	53.6	1.2	31.7	0.9	0.10	0.19	0.65	9,370	1
		42.9	49.1	8.0	5.0	68.5	1.6	15.7	1.2	0.13	0.24	0.83	11,960	2
		46.6	53.4		5.5	74.4	1.7	17.1	1.3	0.14	0.26	0.91	13,000	3
K-45924	19.5	32.9	32.8	14.8	5.9	48.0	1.1	28.0	2.2	0.07	1.27	0.89	8,560	1
		40.8	40.8	18.4	4.7	59.6	1.3	13.2	2.8	0.09	1.58	1.10	10,640	2
		50.0	50.0		5.7	73.1	1.6	16.2	3.4	0.11	1.94	1.35	13,040	3
K-46219	18.3	35.4	41.4	4.9	6.2	56.8	1.1	30.5	0.5	0.01	0.09	0.41	9,900	1
		43.3	50.7	6.0	5.1	69.5	1.4	17.4	0.6	0.01	0.11	0.50	12,110	2
		46.1	53.9		5.4	73.9	1.5	18.5	0.7	0.01	0.12	0.53	12,890	3
K-45923	19.1	34.8	41.7	4.4	6.1	56.6	1.1	31.3	0.5	0.02	0.11	0.36	9,710	1
		43.0	51.6	5.4	4.9	70.0	1.3	17.8	0.6	0.02	0.13	0.45	12,010	2
		45.4	54.6		5.2	74.0	1.4	18.8	0.6	0.03	0.14	0.47	12,700	3
K-45922	21.1	33.1	40.0	5.8	6.2	55.0	1.0	31.4	0.6	0.02	0.19	0.43	9,560	1
		42.0	50.6	7.4	4.9	69.7	1.3	15.9	0.8	0.02	0.24	0.55	12,110	2
		45.3	54.7		5.3	75.2	1.4	17.2	0.9	0.03	0.26	0.59	13,080	3
K-45921	20.5	32.8	38.7	8.0	6.0	52.6	1.2	31.4	0.8	0.02	0.20	0.58	9,190	1
		41.2	48.8	10.0	4.7	66.2	1.5	16.6	1.0	0.02	0.25	0.73	11,570	2
		45.8	54.2		5.3	73.6	1.7	18.3	1.1	0.03	0.28	0.82	12,860	3
K-46223	18.0	36.8	37.4	7.8	6.3	53.6	1.3	29.8	1.2	0.04	0.57	0.55	9,450	1
		44.9	45.5	9.6	5.2	65.4	1.5	16.9	1.4	0.05	0.70	0.67	11,530	2
		49.6	50.4		5.8	72.3	1.7	18.6	1.6	0.05	0.77	0.74	12,750	3
K-46222	17.8	38.9	34.7	8.6	6.0	52.9	1.3	29.8	1.4	0.04	0.79	0.54	9,490	1
		47.3	42.2	10.5	4.9	64.3	1.6	17.0	1.7	0.05	0.96	0.66	11,540	2
		52.9	47.1		5.5	71.8	1.8	19.0	1.9	0.05	1.07	0.73	12,890	3
K-46221	18.3	37.5	36.1	8.1	6.1	53.7	1.2	28.9	2.0	0.01	1.24	0.79	9,600	1
		45.9	44.2	9.9	5.0	65.7	1.4	15.5	2.5	0.01	1.52	0.97	11,740	2
		51.0	49.0		5.5	72.9	1.6	17.2	2.8	0.01	1.68	1.07	13,030	3
K-46220	19.1	28.3	30.7	21.9	5.4	42.1	1.0	27.7	1.9	0.02	1.15	0.68	7,380	1
		35.0	37.9	27.1	4.0	52.0	1.2	13.4	2.3	0.02	1.43	0.84	9,130	2
		48.0	52.0		5.5	71.4	1.7	18.3	3.1	0.03	1.96	1.15	12,520	3
K-45920	21.1	33.7	34.0	11.2	5.8	49.2	1.1	31.5	1.2	0.02	0.63	0.57	8,720	1
		42.7	43.1	14.2	4.4	62.4	1.4	16.1	1.5	0.02	0.80	0.72	11,050	2
		49.8	50.2		5.1	72.7	1.7	18.7	1.8	0.03	0.93	0.84	12,880	3

¹All these analyses were done by the U. S. Bureau of Mines' Coal Analysis Section in Pittsburgh, Pennsylvania.

²The analyses are reported as 1, sample as received; 2, sample moisture-free (dry); and 3, sample moisture and ash-free (dry, ash-free).

TABLE 4: FUSIBILITY OF ASHES, HARDGROVE GRINDABILITY INDICES, REAL SPECIFIC GRAVITIES, AND FREE-SWELLING INDICES OF 54 FACE-CHANNEL SAMPLES OF COAL¹

SAMPLE NUMBER	LABORATORY NUMBER	FUSIBILITY OF ASH (TEMPERATURE, °F.)			HARDGROVE GRINDABILITY INDEX	REAL SPECIFIC GRAVITY	FREE-SWELLING INDEX
		INITIAL DEFORMATION	SOFTENING TEMPERATURE	FLUID TEMPERATURE			
HAMS FORK COAL REGION							
74-1	K-46567	2,030	2,080	2,180	87	1.50	Non-caking
74-2	K-46569	1,930	1,980	2,030	53	1.48	Non-caking
74-3	K-46570	1,980	2,030	2,080	55	1.50	Non-caking
74-4	K-46568	2,050	2,100	2,150	41	1.49	Non-caking
74-5	K-46429	2,050	2,100	2,150	52	1.47	Non-caking
74-6	K-47332	2,080	2,130	2,180	45	1.46	Non-caking
74-7	K-46428	1,960	2,010	2,060	47	1.44	Non-caking
74-8	K-46427	1,960	2,010	2,060	46	1.45	Non-caking
74-9	K-46426	2,010	2,060	2,180	47	1.43	Non-caking
74-10	K-47331	1,980	2,030	2,130	45	1.49	Non-caking
74-11	K-47195	2,040	2,090	2,280	45	1.44	Non-caking
74-12	K-47199	2,030	2,080	2,340	48	1.44	Non-caking
74-13	K-47198	2,220	2,340	2,460	48	1.45	Non-caking
74-14	K-47197	2,040	2,090	2,140	50	1.45	Non-caking
74-15	K-47333	2,140	2,190	2,240	51	1.44	Non-caking
74-16	K-47374	2,180	2,280	2,660	52	1.44	Non-caking
74-17	K-47196	2,030	2,080	2,130	51	1.46	Non-caking
74-18	K-47200	2,040	2,090	2,300	52	1.45	Non-caking
74-19	K-47373	2,160	2,210	2,260	57	1.42	Non-caking
GREEN RIVER COAL REGION							
74-20	K-47372	2,030	2,080	2,130	79	1.51	Non-caking
74-21	K-47371	2,460	2,520	2,620	82	1.57	Non-caking
74-22	K-47201	2,200	2,250	2,300	48	1.39	1 1/2
HANNA COAL FIELD							
74-23	K-47600	2,230	2,280	2,360	50	1.44	Non-caking
74-24	K-47599	2,080	2,130	2,230	47	1.47	Non-caking
74-25	K-47549	2,030	2,080	2,130	49	1.40	Non-caking
74-26	K-47845	2,090	2,120	2,150	48	1.41	Non-caking
74-27	K-47847	2,080	2,110	2,140	48	1.45	Non-caking
74-28	K-48218	2,080	2,130	2,180	50	1.44	Non-caking

TABLE 4: FUSIBILITY OF ASHES, HARDGROVE GRINDABILITY INDICES, REAL SPECIFIC GRAVITIES, AND FREE-SWELLING INDICES OF 54 FACE-CHANNEL SAMPLES OF COAL¹ - continued

SAMPLE NUMBER	LABORATORY NUMBER	FUSIBILITY OF ASH (TEMPERATURE °F.)			HARDGROVE GRINDABILITY INDEX	REAL SPECIFIC GRAVITY	FREE-SWELLING INDEX
		INITIAL DEFORMATION	SOFTENING TEMPERATURE	FLUID TEMPERATURE			
HANNA COAL FIELD - continued							
74-29	K-48217	2,100	2,150	2,210	45	1.51	Non-caking
74-30	K-47850	2,200	2,240	2,270	47	1.50	Non-caking
74-31	K-47851	2,110	2,140	2,170	41	1.57	Non-caking
74-32	K-47846	2,090	2,120	2,150	50	1.51	Non-caking
74-33	K-47848	2,360	2,390	2,420	66	1.59	Non-caking
74-34	K-47849	2,400	2,430	2,460	47	1.46	Non-caking
POWDER RIVER COAL BASIN							
74-35	K-45927	2,080	2,140	2,190	30	1.53	Non-caking
74-36	K-45926	2,100	2,150	2,200	35	1.57	Non-caking
74-37	K-45928	2,000	2,040	2,080	35	1.50	Non-caking
74-38	K-46217	2,040	2,080	2,120	51	1.47	Non-caking
74-39	K-46216	2,130	2,180	2,290	53	1.46	Non-caking
74-40	K-46218	2,040	2,080	2,120	55	1.45	Non-caking
74-41	K-46430	2,090	2,140	2,240	49	1.47	Non-caking
74-42	K-46566	2,140	2,190	2,250	55	1.48	Non-caking
74-43	K-46565	2,030	2,080	2,130	54	1.47	Non-caking
74-44	K-45925	2,080	2,130	2,180	40	1.46	Non-caking
74-45	K-45924	2,020	2,070	2,120	43	2.23	Non-caking
74-46	K-46219	2,050	2,080	2,110	46	1.46	Non-caking
74-47	K-45923	2,040	2,090	2,140	39	1.46	Non-caking
74-48	K-45922	2,040	2,090	2,140	43	1.46	Non-caking
74-49	K-45921	2,040	2,090	2,140	40	1.47	Non-caking
74-50	K-46223	1,980	2,030	2,080	43	1.47	Non-caking
74-51	K-46222	1,980	2,030	2,080	44	1.48	Non-caking
74-52	K-46221	1,950	2,000	2,050	45	1.49	Non-caking
74-53	K-46220	2,140	2,190	2,280	50	1.64	Non-caking
74-54	K-45920	2,090	2,140	2,200	44	1.51	Non-caking

¹All these analyses were done by the U. S. Bureau of Mines' Coal Analysis Section in Pittsburgh, Pennsylvania

TABLE 5: MEAN VALUES OF PROXIMATE, ULTIMATE, HEAT VALUES, AND FORMS OF SULFUR ANALYSES OF 54 FACE-CHANNEL SAMPLES OF COAL BY COAL-BEARING AREA AND GEOLOGIC FORMATION

NUMBER AVER- AGED	PROXIMATE ANALYSIS (PERCENT)				ULTIMATE ANALYSES (PERCENT)					SULFUR FORMS (PERCENT)			BTU/ POUND	BASIS ¹	
	MOISTURE	VOLATILE MATTER	FIXED CARBON	ASH	H	C	N	O	S	SULFATE	PYRITIC	ORGANIC			
HAMS FORK COAL REGION															
					Adaville Formation										
19	20.3	34.1	40.7	4.9	6.1	55.4	1.3	31.6	0.7	0.04	0.31	0.33	9,600	1	
		42.8	51.0	6.1	4.9	69.4	1.7	17.0	0.9	0.04	0.40	0.41	12,040	2	
		45.6	54.4		5.2	74.0	1.8	18.1	0.9	0.05	0.43	0.44	12,830	3	
GREEN RIVER COAL REGION															
					Fort Union Formation										
2	21.3	31.3	39.2	8.2	5.6	51.8	1.1	32.8	0.5	0.11	0.06	0.33	8,605	1	
		39.8	49.7	10.5	4.1	65.8	1.4	17.6	0.6	0.14	0.08	0.42	10,910	2	
		44.5	55.5		4.5	73.4	1.6	19.8	0.7	0.15	0.09	0.47	12,180	3	
					Rock Springs Formation										
1	10.4	38.1	46.1	5.4	5.8	66.1	1.6	20.2	0.9	0.04	0.40	0.49	11,720	1	
		42.5	51.5	6.0	5.2	73.8	1.8	12.2	1.0	0.04	0.45	0.55	13,080	2	
		45.2	54.8		5.5	78.5	1.9	13.0	1.1	0.05	0.48	0.58	13,910	3	
HANNA COAL FIELD															
					Hanna Formation										
5	11.6	38.2	43.6	6.6	5.8	62.8	1.4	22.6	0.7	0.02	0.30	0.41	10,990	1	
		43.2	49.3	7.5	5.1	71.0	1.5	14.0	0.8	0.02	0.34	0.48	12,430	2	
		46.7	53.3		5.6	76.7	1.7	15.1	0.9	0.02	0.37	0.52	13,430	3	
					Ferris Formation										
7	13.7	34.3	43.4	8.6	5.4	57.9	1.1	26.6	0.5	0.04	0.19	0.22	9,820	1	
		39.7	50.3	9.9	4.5	67.0	1.2	16.8	0.5	0.05	0.21	0.26	11,370	2	
		44.1	55.9		5.0	74.4	1.3	18.6	0.6	0.06	0.23	0.29	12,620	3	
POWDER RIVER COAL BASIN															
					Fort Union Formation										
20	21.1	34.5	36.0	8.5	6.1	51.7	1.1	31.7	0.9	0.03	0.39	0.49	9,010	1	
		43.7	45.6	10.7	4.8	65.5	1.3	16.5	1.1	0.04	0.48	0.61	11,420	2	
		49.0	51.0		5.4	73.4	1.5	18.4	1.3	0.04	0.57	0.70	12,780	3	

¹The analyses are reported as 1, sample as received; 2, sample moisture-free (dry); and 3, sample moisture and ash-free (dry, ash-free)

Note: These statistical summaries are not to be construed as absolutely characterizing any coal-bearing area or formation, but are presented as an aid to comparing these 54 analyses.

TABLE 6: MEAN VALUES AND STANDARD DEVIATIONS¹ OF THE FUSIBILITY OF ASHES, HARDGROVE GRINDABILITY INDICES, REAL SPECIFIC GRAVITIES, AND FREE-SWELLING INDICES OF 54 FACE-CHANNEL SAMPLES OF COAL BY COAL-BEARING AREA AND GEOLOGIC FORMATION

NUMBER AVERAGED	FUSIBILITY OF ASH (TEMPERATURE ° F.)			HARDGROVE GRINDABILITY INDEX	REAL SPECIFIC GRAVITY	FREE-SWELLING INDEX
	INITIAL DEFORMATION	SOFTENING TEMPERATURE	FLUID TEMPERATURE			
HAMS FORK COAL REGION						
	Adaville Formation					
19	2,050 (76)	2,100 (90)	2,210 (149)	51 (9)	1.46 (0.023)	Non-caking
GREEN RIVER COAL REGION						
	Fort Union Formation					
2	2,245 (215)	2,300 (220)	2,375 (245)	80 (1.5)	1.54 (0.03)	Non-caking
	Rock Springs Formation					
1	2,200	2,250	2,300	48	1.39	1 1/2
HANNA COAL FIELD						
	Hanna Formation					
5	2,100 (67)	2,140 (70)	2,200 (87)	48 (1)	1.43 (0.03)	Non-caking
	Ferris Formation					
7	2,190 (125)	2,230 (121)	2,270 (116)	49 (7)	1.51 (0.05)	Non-caking
POWDER RIVER COAL BASIN						
	Fort Union Formation					
20	2,050 (52)	2,100 (53)	2,160 (67)	45 (7)	1.53 (0.17)	Non-caking
GRAND MEAN AND STANDARD DEVIATION OF ALL 54 SAMPLES COMBINED						
54	2,050 (270)	2,130 (110)	2,200 (130)	49 (10)	1.49 (0.11)	---

¹Standard deviation is shown in parentheses below each mean.

Note: These statistical summaries are not to be construed as absolutely characterizing any coal-bearing area or formation, but are presented as an aid to comparing these 54 samples.

TABLE 7: MAJOR AND MINOR OXIDE COMPOSITION OF THE 750°C. LABORATORY ASH OF 54 COAL SAMPLES¹

MAJOR AND MINOR OXIDES AS PERCENT OF THE ASH											
SAMPLE NUMBER	SiO ₂	Al ₂ O ₃	CaO	MgO	Na ₂ O	K ₂ O	Fe ₂ O ₃	TiO ₂	P ₂ O ₅	SO ₃	TOTAL
HAMS FORK COAL REGION											
74-1	48.0	13.6	2.04	0.73	0.13	0.60	29.50	0.37	0.40	1.80	97.17
74-2	43.2	7.4	8.50	2.61	0.13	0.34	21.30	0.33	0.61	9.26	93.68
74-3	45.7	9.5	6.15	2.64	0.15	1.81	19.90	0.52	0.28	5.74	92.39
74-4	36.6	4.0	4.50	4.37	0.10	0.31	39.20	0.20	0.15	9.34	98.77
74-5	52.9	15.6	5.93	1.43	0.11	0.43	11.30	0.45	0.15	6.24	94.54
74-6	47.2	8.8	8.90	6.74	0.20	0.25	10.90	0.37	0.13	10.69	94.18
74-7	39.3	6.8	8.70	2.97	0.11	0.27	25.90	0.33	0.05	8.79	93.22
74-8	38.0	8.4	10.60	2.85	0.10	0.25	19.20	0.26	0.47	12.23	92.36
74-9	49.0	13.3	6.10	1.00	0.06	0.41	17.80	0.36	0.60	6.62	95.25
74-10	47.8	13.5	6.94	3.59	0.12	1.63	9.40	0.45	0.20	5.37	89.00
74-11	53.2	13.7	5.08	3.31	0.20	1.00	13.30	0.41	0.43	5.79	96.42
74-12	53.8	9.7	6.22	3.70	0.12	0.78	6.90	0.36	0.42	4.00	86.00
74-13	60.4	11.9	5.94	1.62	0.20	0.49	8.00	0.44	0.57	6.24	95.80
74-14	55.7	14.5	6.00	3.40	0.20	1.20	10.10	0.45	1.31	5.49	98.35
74-15	50.7	16.2	9.10	4.78	0.23	0.50	4.53	0.65	0.25	7.89	94.83
74-16	64.6	13.8	4.28	1.59	0.12	1.10	3.26	0.55	0.15	4.52	93.97
74-17	59.0	13.9	7.25	3.29	0.15	0.55	3.57	0.53	0.50	6.24	94.98
74-18	57.2	15.3	5.56	1.76	0.12	0.53	7.30	0.53	1.17	4.57	94.04
74-19	43.6	20.3	8.70	2.72	0.12	0.20	5.70	0.40	0.29	11.29	93.32
GREEN RIVER COAL REGION											
74-20	44.3	15.2	11.70	3.77	0.36	0.10	4.11	0.50	0.05L ²	11.81	91.90
74-21	60.1	14.6	5.70	1.77	0.32	0.37	3.08	0.89	0.25	8.56	95.64
74-22	55.1	23.5	3.50	0.91	0.25	2.45	7.40	0.73	1.56	1.42	96.82
HANNA COAL FIELD											
74-23	37.6	20.9	10.90	3.43	0.13	1.43	8.40	1.23	1.10	9.36	94.48
74-24	29.9	14.6	15.10	3.39	0.20	1.19	14.50	0.45	0.77	13.58	93.68
74-25	30.5	18.0	11.70	4.96	0.14	1.13	12.60	0.75	0.64	16.48	96.90
74-26	30.2	16.5	20.80	4.97	0.25	1.00	6.10	0.56	1.11	10.09	91.58
74-27	40.7	13.1	18.30	2.22	0.21	0.85	8.70	0.53	0.35	10.01	94.97
74-28	29.0	15.4	21.90	3.90	0.22	0.80	7.20	0.50	1.00	11.36	91.28

TABLE 7: MAJOR AND MINOR OXIDE COMPOSITION OF THE 750°C. LABORATORY ASH OF 54 COAL SAMPLES¹ - continued

MAJOR AND MINOR OXIDES AS PERCENT OF THE ASH											
SAMPLE NUMBER	SiO ₂	Al ₂ O ₃	CaO	MgO	Na ₂ O	K ₂ O	Fe ₂ O ₃	TiO ₂	P ₂ O ₅	SO ₃	TOTAL
HANNA COAL FIELD - continued											
74-29	40.2	16.6	22.80	3.30	0.45	1.49	3.64	0.38	0.61	5.27	94.74
74-30	24.7	9.1	30.20	5.12	0.48	0.56	11.60	0.31	0.63	12.98	95.68
74-31	--	--	--	--	--	--	--	--	--	4.00	--
74-32	46.6	17.5	16.00	3.16	0.27	2.40	4.25	0.46	0.68	6.09	97.41
74-33	29.3	11.8	28.90	4.89	0.39	0.60	4.69	0.45	1.60	12.34	94.96
74-34	14.0	8.3	45.50	3.09	0.16	0.15	7.50	0.30	0.05L	14.83	93.88
POWDER RIVER COAL BASIN											
74-35	50.4	15.9	14.70	2.10	0.13	0.80	2.30	0.65	0.23	9.19	96.40
74-36	46.8	18.1	13.60	2.34	0.13	1.67	2.18	0.89	0.34	5.34	91.39
74-37	31.2	15.8	26.00	3.34	0.13	0.42	3.00	0.88	1.14	12.24	94.15
74-38	27.4	14.0	22.20	3.48	1.28	0.36	5.20	1.01	0.54	16.80	92.27
74-39	27.6	14.2	26.70	4.21	1.45	0.24	4.02	1.09	0.63	15.08	95.22
74-40	28.0	16.0	23.40	3.80	1.45	0.33	4.00	1.12	0.90	16.98	95.98
74-41	26.8	19.8	20.80	4.96	0.43	0.55	3.77	0.94	0.57	16.68	95.30
74-42	30.7	17.7	15.60	3.58	0.79	0.50	6.70	0.89	0.67	17.55	94.68
74-43	29.9	13.2	23.20	5.31	1.82	0.37	3.54	0.68	1.13	12.08	91.23
74-44	30.6	20.4	11.00	5.50	1.49	1.10	6.80	0.88	1.45	15.91	95.13
74-45	40.8	20.0	4.69	2.12	1.19	2.15	16.70	0.63	0.60	6.17	95.05
74-46	20.0	20.0	19.00	4.95	0.13	0.62	6.00	0.72	2.83	15.08	89.33
74-47	20.7	14.6	18.00	5.50	4.25	0.66	12.90	0.69	0.58	17.43	95.31
74-48	34.6	16.3	13.30	3.75	3.40	1.00	6.60	0.93	0.52	17.18	96.48
74-49	35.1	20.7	9.60	4.71	1.29	1.83	9.20	0.59	0.40	11.09	94.51
74-50	32.8	18.3	12.00	4.82	1.68	1.09	10.30	0.57	0.34	10.94	92.84
74-51	25.3	16.6	18.70	4.11	1.42	0.80	10.80	0.38	0.45	15.33	93.89
74-52	26.5	17.3	9.50	4.13	1.14	0.74	19.90	0.43	1.39	13.26	94.29
74-53	52.9	21.8	2.87	2.24	0.53	2.92	9.20	0.71	0.10	3.37	96.64
74-54	42.6	20.4	6.50	3.29	1.09	2.23	9.30	0.55	0.38	8.81	95.15

¹All these analyses were done by either the Wyoming Geological Survey/Department of Geology Laboratory or the Department of Minerals Engineering laboratory.

²L means less than.

Notes

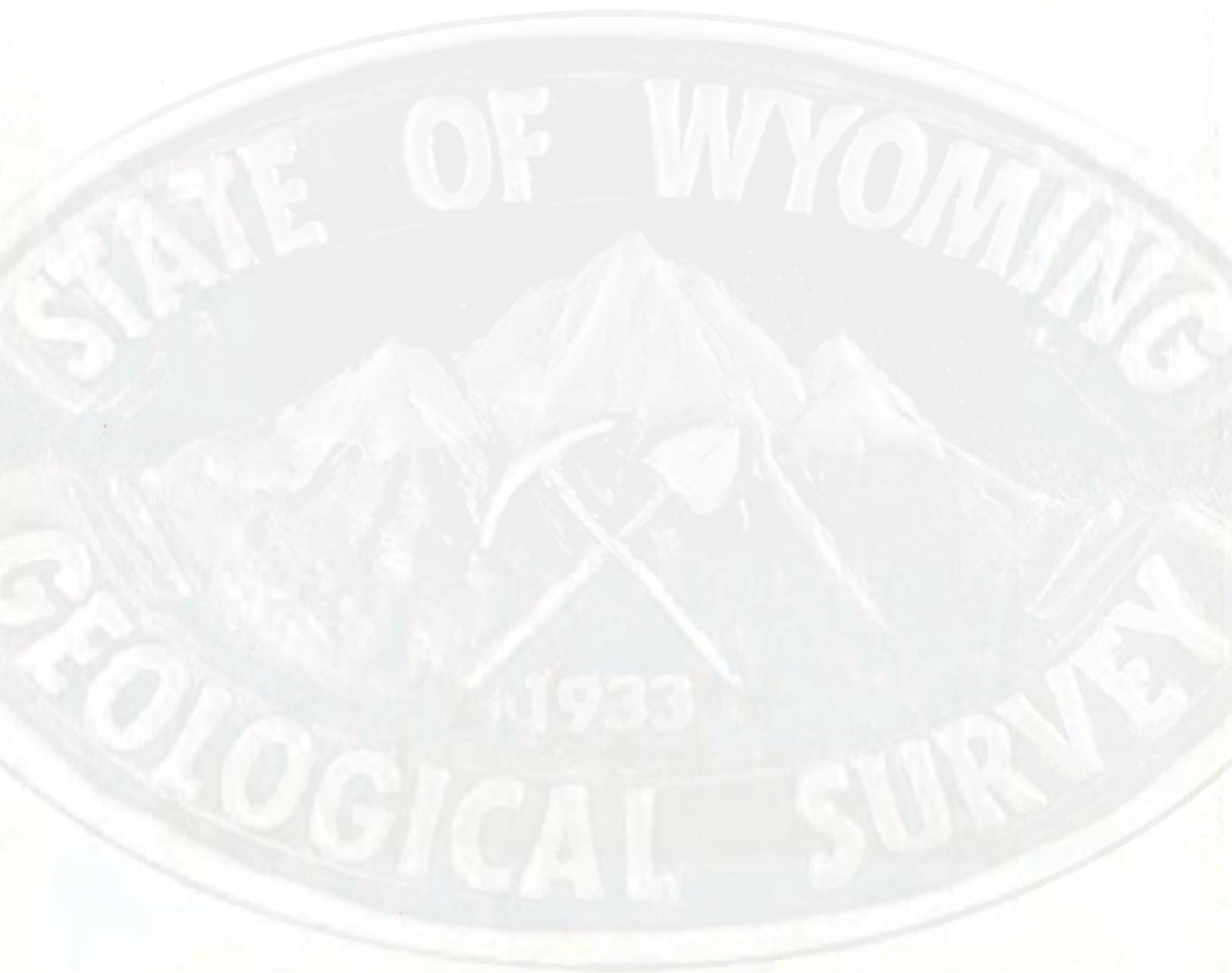


TABLE 8: MEAN VALUES AND STANDARD DEVIATIONS¹ OF THE MAJOR AND MINOR OXIDES IN THE 750°C, LABORATORY ASH OF 54 COAL SAMPLES BY COAL-BEARING AREA AND GEOLOGIC FORMATION

NUMBER AVER- AGED	MEAN VALUES AND STANDARD DEVIATIONS OF THE MAJOR AND MINOR OXIDES AS PERCENT OF THE ASH										
	SiO ₂	Al ₂ O ₃	CaO	MgO	Na ₂ O	K ₂ O	Fe ₂ O ₃	TiO ₂	P ₂ O ₅	SO ₃	TOTAL
HAMS FORK COAL REGION											
Adaville Formation											
19	49.8 (7.5)	12.1 (3.8)	6.7 (2.0)	2.9 (1.4)	0.14 (0.04)	0.67 (0.46)	14.1 (9.5)	0.42 (0.11)	0.43 (0.33)	6.95 (2.63)	94.12 (2.90)
GREEN RIVER COAL REGION											
Fort Union Formation											
2	52.2 (7.9)	14.9 (0.3)	8.7 (3.0)	2.77 (1.00)	0.34 (0.02)	0.23 (0.13)	3.59 (0.52)	0.69 (0.19)	0.15 (0.10)	10.19 (1.63)	93.77 (1.87)
Rock Springs Formation											
1	55.1	23.5	3.5	0.91	0.25	2.45	7.4	0.73	1.56	1.42	96.82
HANNA COAL FIELD											
Hanna Formation											
5	33.8 (4.5)	16.6 (2.7)	15.4 (3.8)	3.79 (1.05)	0.19 (0.04)	1.12 (0.19)	10.1 (3.05)	0.70 (0.28)	0.79 (0.29)	11.90 (2.72)	94.32 (1.73)
Ferris Formation											
6	30.6 (10.5)	13.1 (3.6)	27.6 (9.3)	3.91 (0.82)	0.33 (0.12)	1.00 (0.74)	6.5 (2.7)	0.40 (0.08)	0.76 (0.47)	9.55 ² (4.00)	94.66 (1.86)
POWDER RIVER COAL BASIN											
Fort Union Formation											
20	33.0 (9.0)	17.6 (2.5)	15.5 (6.8)	3.91 (1.09)	1.26 (1.02)	1.02 (0.73)	7.62 (4.66)	0.76 (0.20)	0.76 (0.60)	12.83 (4.26)	94.26 (1.89)
GRAND MEAN AND STANDARD DEVIATION OF ALL ANALYSES COMBINED											
53 ³	40.0 (12.0)	15.0 (4.2)	13.2 (8.6)	3.44 (1.32)	0.60 (0.81)	0.90 (0.66)	9.87 (7.30)	0.59 (0.24)	0.64 (0.51)	9.94 (4.47)	94.29 (2.31)

¹Standard deviation is shown in parentheses below each mean.

²SO₃ mean and standard deviation was computed for 7 analyses.

³Grand mean for SO₃ was computed for 54 analyses.

Note: These statistical summaries are not to be construed as absolutely characterizing any coal-bearing area or formation, but are presented as an aid to comparing these 54 analyses.

TABLE 9: MAJOR AND MINOR OXIDE AND CHLORINE COMPOSITION OF THE 525°C. LABORATORY ASH OF 48 COAL SAMPLES¹

SAMPLE NUMBER	LAB NUMBER	ASH	MAJOR AND MINOR OXIDES AND CHLORINE AS PERCENT OF THE ASH													TOTAL
			SiO ₂	Al ₂ O ₃	CaO	MgO	Na ₂ O	K ₂ O	Fe ₂ O ₃	MnO	TiO ₂	P ₂ O ₅	SO ₃	Cl		
HAMIS FORK COAL REGION																
74-2	D171859	8.8	47.0	10.0	4.9	2.34	0.09	1.30	16.0	0.05	0.62	0.19	9.0	0.1L ²	91.59	
74-3	D171860	11.6	48.0	7.1	2.37	0.12	0.35	19.0	0.55	0.38	0.31	11.0	0.1L	96.38		
74-4	D171861	7.7	51.0	4.3	3.67	0.10	0.32	26.0	0.25	0.24	0.14	15.0	0.1L	105.02		
74-6	D171855	4.9	49.0	11.0	4.6	0.15	0.42	6.7	0.02L	0.51	0.24	11.0	0.1L	88.89		
74-10	D171858	7.2	38.0	13.0	4.27	0.08	0.99	6.5	0.058	0.52	0.20	3.6	0.1L	74.42		
74-11	D171857	4.4	50.0	9.0	2.97	0.15	0.52	7.6	0.10	0.48	0.21	11.0	0.1L	88.13		
74-12	D171854	5.0	57.0	7.7	3.92	0.12	0.39	9.2	0.15	0.40	0.17	12.0	0.1L	97.65		
74-13	D171856	4.8	61.0	11.0	1.39	0.16	0.63	11.0	0.18	0.40	0.18	4.8	0.1L	95.04		
74-14	D171853	5.9	54.0	13.0	3.44	0.17	0.81	7.2	0.077	0.55	0.44	9.9	0.1L	95.09		
74-15	D170263	4.8	57.0	19.0	3.70	0.19	0.45	5.0	0.02L	0.63	0.10L	6.5	0.1L	100.09		
74-16	D171852	7.5	70.0	14.0	1.47	0.11	0.81	3.6	0.02L	0.67	0.13	6.4	0.1L	101.21		
74-17	D171851	6.5	59.0	13.0	2.79	0.13	0.56	3.2	0.02L	0.57	0.29	7.5	0.1L	93.46		
74-18	D170262	4.8	55.0	14.0	1.20	0.08	0.45	6.9	0.02L	0.52	0.50	1.3	0.1L	83.77		
74-19	D170261	5.1	48.0	19.0	2.59	0.09	0.14	4.8	0.02L	0.56	0.10L	9.1	0.1L	93.00		
GREEN RIVER COAL REGION																
74-20	D171834	6.9	45.0	15.0	3.41	0.28	0.10	4.4	0.051	0.77	0.22	15.0	0.1L	95.33		
74-21	D171833	13.5	57.0	13.0	1.80	0.25	0.20	3.4	0.022	1.20	0.16	11.0	0.1L	94.73		
74-22	D170264	5.8	51.0	25.0	0.73	0.22	1.20	11.0	0.02L	0.86	1.70	1.8	0.1L	98.33		
HANNA COAL FIELD																
74-23	D170258	8.5	34.0	20.0	2.84	0.11	0.93	9.5	0.11	1.20	0.10L	12.0	0.1L	91.79		
74-24	D170259	10.7	33.0	16.0	3.04	0.18	0.93	11.0	0.063	0.02L	0.10L	15.0	0.1L	94.33		
74-25	D171832	5.4	25.0	15.0	5.52	0.11	0.69	11.0	0.069	0.79	0.32	16.0	0.1L	86.50		
74-26	D170253	7.2	30.0	14.0	4.45	0.18	0.58	5.6	0.02L	0.71	0.10L	11.0	0.1L	88.64		
74-27	D170260	9.2	36.0	10.0	1.84	0.15	0.61	9.0	0.061	0.53	0.10L	8.4	0.1L	86.69		
74-28	D171835	8.3	26.0	13.0	3.02	0.16	0.70	6.5	0.037	0.50	0.55	14.0	0.1L	85.47		
74-29	D171836	14.1	34.0	15.0	3.19	0.45	0.92	3.3	0.02L	0.45	0.51	5.7	0.1L	84.54		
74-30	D170257	9.2	22.0	7.1	4.45	0.36	0.43	11.0	0.11	0.36	0.10L	11.0	0.1L	80.91		
74-31	D170256	17.1	52.0	16.0	2.34	0.45	2.10	3.6	0.02L	0.58	0.10L	4.0	0.1L	93.19		
74-32	D170255	10.8	45.0	17.0	3.14	0.22	1.50	4.9	0.02L	0.53	0.10L	7.9	0.1L	95.31		

TABLE 9: MAJOR AND MINOR OXIDE AND CHLORINE COMPOSITION OF THE 525°C. LABORATORY ASH OF 48 COAL SAMPLES¹ - continued

SAMPLE NUMBER	LAB NUMBER	ASH	MAJOR AND MINOR OXIDES AND CHLORINE AS PERCENT OF THE ASH											TOTAL	
			SiO ₂	Al ₂ O ₃	CaO	MgO	MgO	K ₂ O	Fe ₂ O ₃	MnO	TiO ₂	P ₂ O ₅	SO ₃		Cl
HANNA COAL FIELD - continued															
74-34	D170254	5.3	16.0	7.1	35.0	2.24	0.11	0.12	6.9	0.02L	0.46	0.10L	19.0	0.1L	87.05
POWDER RIVER COAL BASIN															
74-35	D171838	12.9	36.0	16.0	19.0	2.67	0.08	0.61	2.9	0.08	0.68	0.39	13.0	0.1L	91.51
74-36	D171837	21.7	50.0	19.0	11.0	1.94	0.15	1.40	2.7	0.05	0.98	0.25	7.6	0.1L	95.17
74-37	D171839	11.3	27.0	13.0	22.0	2.96	0.10	0.42	4.2	0.059	0.92	0.52	15.0	0.1L	86.18
74-38	D171827	7.6	27.0	13.0	19.0	3.15	1.20	0.30	5.2	0.049	1.30	0.41	23.0	0.1L	93.71
74-39	D171826	6.3	23.0	14.0	23.0	3.94	1.50	0.23	3.6	0.02L	1.40	0.58	20.0	0.1L	91.37
74-40	D171828	7.1	26.0	14.0	21.0	3.51	1.36	0.30	4.6	0.023	1.30	0.47	22.0	0.1L	94.56
74-41	D171831	8.7	26.0	17.0	18.0	4.27	0.34	0.46	3.7	0.02L	1.20	0.40	20.0	0.1L	91.39
74-42	D171830	10.4	30.0	16.0	14.0	3.33	0.64	0.40	5.8	0.04	1.00	0.36	17.0	0.1L	88.67
74-43	D171829	7.5	31.0	13.0	21.0	5.22	1.73	0.32	3.2	0.02L	1.00	0.63	15.0	0.1L	92.22
74-44	D171843	7.9	25.0	18.0	10.0	5.09	1.35	0.73	6.9	0.02L	0.86	0.58	18.0	0.1L	86.63
74-45	D171842	18.0	37.0	19.0	4.6	2.10	1.12	1.40	16.0	0.095	0.63	0.29	11.0	0.1L	93.33
74-46	D171844	6.0	20.0	18.0	15.0	4.39	4.16	0.53	5.7	0.02L	0.77	1.00	21.0	0.1L	90.57
74-47	D171841	5.4	20.0	14.0	16.0	5.15	4.23	0.53	11.0	0.11	0.69	0.40	24.0	0.1L	96.21
74-48	D171840	7.4	32.0	14.0	11.0	3.41	3.11	0.70	6.3	0.02L	0.95	0.30	11.0	0.1L	82.89
74-49	D171850	10.0	35.0	18.0	7.6	4.22	1.12	1.20	8.3	0.02L	0.63	0.24	15.0	0.1L	91.43
74-50	D171848	10.2	30.0	16.0	8.5	4.34	1.62	0.75	11.0	0.02L	0.59	0.24	19.0	0.1L	92.16
74-51	D171847	10.2	28.0	17.0	8.8	4.47	1.67	0.71	12.0	0.02L	0.48	0.32	20.0	0.1L	93.57
74-52	D171846	9.9	19.0	13.0	8.4	3.82	1.02	0.50	18.0	0.02	0.43	0.49	15.0	0.1L	79.78
74-53	D171845	26.2	45.0	18.0	2.6	2.14	0.45	1.70	8.4	0.02L	0.69	0.10L	4.6	0.1L	83.80
74-54	D171849	14.0	40.0	18.0	5.5	3.07	1.04	1.30	9.5	0.02L	0.63	0.19	14.0	0.1L	93.35

¹All these analyses were done by the U. S. Geological Survey's Branch of Analytical Laboratories in Denver, Colorado.

²L means less than.

TABLE 10: MAJOR AND MINOR ELEMENT COMPOSITION OF 48 COAL SAMPLES REPORTED ON A WHOLE-COAL BASIS CALCULATED FROM ANALYSES OF 525°C, LABORATORY ASH¹

SAMPLE NUMBER	LAB NUMBER	MAJOR AND MINOR ELEMENTS AS PERCENT ON A WHOLE-COAL BASIS										
		Si	Al	Ca	Mg	Na	K	Fe	Mn	Ti	P	Cl
HAMS FORK COAL REGION												
74-2	D171859	1.93	0.48	0.31	0.120	0.006	0.098	0.96	0.0034	0.033	0.0074	0.009L ²
74-3	D171860	2.60	0.44	0.59	0.170	0.010	0.034	1.50	0.0492	0.026	0.0157	0.012L
74-4	D171861	1.83	0.17	0.21	0.170	0.005	0.020	1.40	0.0151	0.011	0.0045	0.008L
74-6	D171855	1.12	0.28	0.16	0.150	0.005	0.017	0.23	0.0008L	0.015	0.0052	0.005L
74-10	D171858	1.28	0.50	0.37	0.190	0.004	0.059	0.33	0.0032	0.022	0.0064	0.007L
74-11	D171857	1.03	0.21	0.19	0.079	0.005	0.019	0.23	0.0034	0.013	0.0040	0.004L
74-12	D171854	1.33	0.20	0.23	0.120	0.004	0.016	0.32	0.0058	0.012	0.0036	0.005L
74-13	D171856	1.37	0.28	0.14	0.040	0.006	0.025	0.37	0.0067	0.012	0.0037	0.005L
74-14	D171853	1.49	0.42	0.23	0.120	0.008	0.040	0.30	0.0035	0.019	0.0113	0.006L
74-15	D170263	1.30	0.48	0.26	0.107	0.007	0.018	0.17	0.0007L	0.018	0.0021L	0.010L
74-16	D171852	2.45	0.55	0.21	0.067	0.006	0.050	0.19	0.0012L	0.030	0.0044	0.008L
74-17	D171851	1.79	0.45	0.29	0.110	0.007	0.030	0.15	0.0010L	0.022	0.0082	0.007L
74-18	D170262	1.20	0.37	0.13	0.035	0.003	0.018	0.23	0.0007L	0.015	0.0100	0.010L
74-19	D170261	1.20	0.52	0.31	0.080	0.004	0.006	0.17	0.0008L	0.017	0.0022L	0.010L
GREEN RIVER COAL REGION												
74-20	D171834	1.45	0.55	0.53	0.140	0.014	0.006	0.21	0.0027	0.032	0.0066	0.007L
74-21	D171833	3.59	0.95	0.63	0.150	0.026	0.023	0.32	0.0023	0.093	0.0093	0.013L
74-22	D170264	1.40	0.77	0.20	0.026	0.009	0.056	0.43	0.0009L	0.030	0.0440	0.010L
HANNA COAL FIELD												
74-23	D170258	1.30	0.89	0.70	0.145	0.007	0.066	0.56	0.0073	0.061	0.0037L	0.010L
74-24	D170259	1.70	0.92	1.10	0.196	0.014	0.083	0.86	0.0053	0.001L	0.0047L	0.010L
74-25	D171832	0.63	0.42	0.48	0.180	0.004	0.031	0.43	0.0029	0.025	0.0075	0.005L
74-26	D170253	1.00	0.54	1.10	0.193	0.009	0.035	0.28	0.0011L	0.031	0.0031L	0.010L
74-27	D170260	1.50	0.50	1.30	0.102	0.010	0.047	0.58	0.0043	0.029	0.0040L	0.010L
74-28	D171835	1.00	0.56	1.20	0.150	0.010	0.049	0.38	0.0024	0.025	0.0200	0.008L
74-29	D171836	2.20	1.10	2.10	0.270	0.047	0.110	0.32	0.0022L	0.038	0.0317	0.014L
74-30	D170257	0.95	0.35	1.60	0.247	0.025	0.033	0.72	0.0078	0.020	0.0040L	0.010L
74-31	D170256	4.20	1.50	1.40	0.241	0.056	0.293	0.43	0.0026L	0.059	0.0075L	0.020L
74-32	D170255	2.20	0.95	1.20	0.204	0.017	0.134	0.37	0.0017L	0.034	0.0047L	0.010L
74-34	D170254	0.41	0.20	1.30	0.072	0.004	0.005	0.26	0.0008L	0.015	0.0023L	0.010L

TABLE 10: MAJOR AND MINOR ELEMENT COMPOSITION OF 48 COAL SAMPLES REPORTED ON A WHOLE-COAL BASIS CALCULATED FROM ANALYSES OF 525°C. LABORATORY ASH¹ - continued

SAMPLE NUMBER	LAB NUMBER	MAJOR AND MINOR ELEMENTS AS PERCENT ON A WHOLE-COAL BASIS										
		Si	Al	Ca	Mg	Na	K	Fe	Mn	Ti	P	Cl
POWDER RIVER COAL BASIN												
74-35	D171838	2.17	1.10	1.70	0.210	0.008	0.066	0.26	0.0079	0.053	0.0220	0.013L
74-36	D171837	5.06	2.20	1.70	0.250	0.024	0.240	0.40	0.0084	0.130	0.0239	0.022L
74-37	D171839	1.40	0.79	1.70	0.200	0.008	0.040	0.33	0.0052	0.062	0.0257	0.011L
74-38	D171827	0.96	0.54	1.00	0.140	0.068	0.019	0.28	0.0029	0.058	0.0135	0.008L
74-39	D171826	0.68	0.48	1.00	0.150	0.070	0.012	0.16	0.0010L	0.051	0.0160	0.006L
74-40	D171828	0.86	0.53	1.00	0.150	0.072	0.017	0.23	0.0013	0.055	0.0146	0.007L
74-41	D171831	1.10	0.80	1.10	0.220	0.022	0.033	0.23	0.0013L	0.064	0.0151	0.009L
74-42	D171830	1.46	0.86	1.00	0.210	0.049	0.035	0.43	0.0033	0.063	0.0164	0.010L
74-43	D171829	1.08	0.51	1.10	0.240	0.096	0.020	0.17	0.0012L	0.047	0.0207	0.008L
74-44	D171843	0.92	0.74	0.58	0.240	0.079	0.048	0.38	0.0012L	0.041	0.0202	0.008L
74-45	D171842	3.11	1.80	0.60	0.230	0.150	0.200	2.10	0.0133	0.068	0.0228	0.018L
74-46	D171844	0.57	0.58	0.66	0.160	0.190	0.027	0.24	0.0009L	0.028	0.0269	0.006L
74-47	D171841	0.50	0.39	0.60	0.170	0.170	0.024	0.41	0.0048	0.022	0.0095	0.005L
74-48	D171840	1.11	0.55	0.56	0.150	0.170	0.043	0.33	0.0011L	0.042	0.0098	0.007L
74-49	D171850	1.63	0.95	0.54	0.260	0.083	0.097	0.58	0.0015L	0.038	0.0104	0.010L
74-50	D171848	1.43	0.85	0.62	0.270	0.120	0.063	0.77	0.0016L	0.036	0.0106	0.010L
74-51	D171847	1.33	0.91	0.64	0.280	0.130	0.060	0.88	0.0016L	0.029	0.0142	0.010L
74-52	D171846	0.88	0.69	0.59	0.230	0.075	0.041	1.20	0.0015L	0.026	0.0214	0.010L
74-53	D171845	5.50	2.50	0.49	0.340	0.086	0.370	1.50	0.0041L	0.110	0.0114L	0.026L
74-54	D171849	2.61	1.40	0.55	0.260	0.110	0.150	0.93	0.0022L	0.053	0.0118	0.014L

¹All these figures were calculated from analyses of ash done by the U. S. Geological Survey's Branch of Analytical Laboratories in Denver, Colorado.

²L means less than.

TABLE 11; MEAN VALUES AND STANDARD DEVIATIONS¹ OF THE MAJOR AND MINOR OXIDES AND CHLORINE IN THE 525°C. LABORATORY ASH OF 48 COAL SAMPLES BY COAL-BEARING AREA AND GEOLOGIC FORMATION

NUMBER AVER- AGED	MEAN VALUES AND STANDARD DEVIATIONS OF THE MAJOR AND MINOR OXIDES AND CHLORINE AS PERCENT OF THE ASH													
	ASH	SiO ₂	Al ₂ O ₃	CaO	MgO	Na ₂ O	K ₂ O	Fe ₂ O ₃	MnO	TiO ₂	P ₂ O ₅	SO ₃	Cl	TOTAL
HAMS FORK COAL REGION														
Adaville Formation														
14	6.4 (2.0)	53.1 (7.4)	11.8 (4.0)	5.7 (1.5)	2.95 (1.11)	0.12 (0.03)	0.58 (0.29)	9.5 (6.3)	0.11 (0.14)	0.50 (0.11)	0.23 (0.12)	8.4 (3.5)	0.1L ² (0)	93.12 (7.45)
GREEN RIVER COAL REGION														
Fort Union Formation														
2	10.2 (3.3)	51.0 (6.0)	14.0 (1.0)	8.8 (2.2)	2.60 (0.80)	0.27 (0.02)	0.15 (0.05)	3.9 (0.5)	0.037 (0.015)	0.99 (0.22)	0.19 (0.03)	13.0 (2.0)	0.1L (0)	95.03 (0.30)
Rock Springs Formation														
1	5.8	51.0	25.0	4.8	0.73	0.22	1.20	11.0	0.02L	0.86	1.70	1.8	0.1L	98.33
HANNA COAL FIELD														
Hanna Formation														
5	8.2 (1.8)	32.0 (4.0)	15.0 (3.0)	16.0 (4.0)	3.54 (1.29)	0.15 (0.03)	0.75 (0.15)	9.2 (2.0)	0.065 (0.029)	0.65 (0.38)	0.14 (0.09)	12.5 (2.7)	0.1L (0)	89.59 (3.04)
Ferris Formation														
6	10.8 (3.9)	32.5 (12.7)	12.5 (4.0)	21.0 (7.0)	3.06 (0.72)	0.29 (0.14)	0.96 (0.66)	6.0 (2.6)	0.040 (0.03)	0.48 (0.07)	0.24 (0.20)	10.3 (5.1)	0.1L (0)	87.74 (4.99)
POWDER RIVER COAL BASIN														
Fort Union Formation														
20	10.9 (5.3)	30.3 (8.0)	15.9 (2.1)	13.3 (6.2)	3.66 (0.98)	1.40 (1.16)	0.72 (0.42)	7.5 (4.2)	0.04 (0.03)	0.86 (0.28)	0.41 (0.19)	16.3 (5.0)	0.1L (0)	90.42 (4.30)
GRAND MEAN AND STANDARD DEVIATION OF ALL ANALYSES COMBINED														
48	9.2 (4.4)	38.7 (13.2)	14.3 (3.9)	12.0 (7.2)	3.26 (1.13)	0.69 (0.96)	0.70 (0.43)	8.0 (4.8)	0.061 (0.086)	0.69 (0.29)	0.33 (0.27)	12.4 (5.7)	0.1L (0)	91.15 (5.72)

¹Standard deviation is shown in parentheses below each mean.

²L means less than.

Note: These statistical summaries are not to be construed as absolutely characterizing any coal-bearing area or formation, but are presented as an aid to comparing these 48 analyses.

TABLE 12: MEAN VALUES AND STANDARD DEVIATIONS¹ OF MAJOR AND MINOR ELEMENTS OF 48 COAL SAMPLES BY COAL-BEARING AREA AND GEOLOGIC FORMATION REPORTED ON A WHOLE-COAL BASIS²

NUMBER AVER- AGED	MEAN VALUES AND STANDARD DEVIATIONS OF MAJOR AND MINOR ELEMENTS AS PERCENT ON A WHOLE-COAL BASIS										
	Si	Al	Ca	Mg	Na	K	Fe	Mn	Ti	P	Cl
HAMS FORK COAL REGION											
Adaville Formation											
14	1.6 (0.5)	0.38 (0.12)	0.26 (0.11)	0.11 (0.05)	0.006 (0.002)	0.032 (0.023)	0.47 (0.45)	0.007 (0.012)	0.019 (0.007)	0.0063 (0.0037)	0.008L ³ (0.002)
GREEN RIVER COAL REGION											
Fort Union Formation											
2	2.5 (1.1)	0.75 (0.20)	0.58 (0.05)	0.15 (0.005)	0.020 (0.006)	0.015 (0.009)	0.27 (0.06)	0.0025 (0.0002)	0.063 (0.031)	0.0079 (0.0013)	0.010L (0.003)
Rock Springs Formation											
1	1.4	0.77	0.20	0.026	0.009	0.056	0.43	0.0009L	0.030	0.0440	0.010L
HANNA COAL FIELD											
Hanna Formation											
5	1.2 (0.4)	0.65 (0.21)	0.94 (0.30)	0.16 (0.04)	0.009 (0.003)	0.052 (0.020)	0.54 (0.19)	0.004 (0.002)	0.029 (0.019)	0.0046 (0.0015)	0.009L (0.002)
Ferris Formation											
6	1.8 (1.2)	0.78 (0.45)	1.50 (0.3)	0.20 (0.07)	0.027 (0.019)	0.104 (0.095)	0.41 (0.15)	0.003 (0.002)	0.032 (0.014)	0.0117 (0.0106)	0.012L (0.004)
POWDER RIVER COAL BASIN											
Fort Union Formation											
20	1.7 (1.4)	0.96 (0.57)	0.89 (0.40)	0.22 (0.05)	0.089 (0.052)	0.080 (0.090)	0.59 (0.50)	0.003 (0.003)	0.054 (0.026)	0.0170 (0.0050)	0.011L (0.005)
GRAND MEAN AND STANDARD DEVIATION OF ALL ANALYSES COMBINED											
48	1.7 (1.1)	0.72 (0.48)	0.75 (0.49)	0.17 (0.07)	0.044 (0.052)	0.063 (0.074)	0.51 (0.42)	0.004 (0.007)	0.038 (0.025)	0.0121 (0.0088)	0.010L (0.004)

¹ Standard deviation is shown in parentheses below each mean.

² Calculated from determinations on laboratory ash.

³ L means less than.

Note: These statistical summaries are not to be construed as absolutely characterizing any coal-bearing area or formation, but are presented as an aid to comparing these 48 analyses.

TABLE 13: TRACE ELEMENT COMPOSITION OF THE

SAMPLE NUMBER	L ² A B	ASH %	TRACE ELEMENT CONCENTRATIONS IN PARTS PER MILLION OF THE ASH											LAB NUMBERS
			B	Ba	Be	Cd	Ce	Co	Cr	Cu	Ga	Ge	La	
HAMS FORK COAL REGION														
74-1	1	--	--	--	--	--	-	--	--	--	--	-	-	--
	2	5.1	--	--	27.0	2.30	-	49	85	95	--	-	-	WGS-1
74-2	1	8.8	1000s ³	2000s	7.0s	1.10	N ⁴	15s	50s	34	30s	N	N	D171859
	2	8.0	--	--	16.0	0.07	-	14	74	39	--	-	-	WGS-2
74-3	1	11.6	500s	1000s	7.0s	1.00	N	N	50s	32	30s	N	N	D171860
	2	8.5	--	--	16.0	0.09	-	10	89	42	--	-	-	WGS-3
74-4	1	7.7	1000s	2000s	2.0s	1.00	N	15s	70s	38	30s	N	N	D171861
	2	6.8	--	--	7.4	1.60	-	29	84	54	--	-	-	WGS-4
74-5	1	--	--	--	--	-	--	--	--	--	--	-	-	--
	2	3.9	--	--	35.0	1.00	-	79	84	94	--	-	-	WGS-5
74-6	1	4.9	1500s	2000s	15.0s	1.60	N	30s	200s	52	50s	N	N	D171855
	2	3.9	--	--	28.0	1.70	-	79	61	71	--	-	-	WGS-6
74-7	1	--	--	--	--	-	--	--	--	--	--	-	-	--
	2	4.8	--	--	21.0	0.73	-	21	65	63	--	-	-	WGS-7
74-8	1	--	--	--	--	-	--	--	--	--	--	-	-	--
	2	4.6	--	--	39.0	0.44	-	30	59	54	--	-	-	WGS-8
74-9	1	--	--	--	--	-	--	--	--	--	--	-	-	--
	2	3.8	--	--	23.0	3.40	-	29	68	50	--	-	-	WGS-9
74-10	1	7.2	1000s	1000s	10.0s	1.00L	N	7s	30s	30	20s	N	N	D171858
	2	6.4	--	--	21.0	0.93	-	27	57	41	--	-	-	WGS-10
74-11	1	4.4	1500s	3000s	15.0s	1.40	N	10s	30s	40	30s	N	N	D171857
	2	4.0	--	--	32.0	1.00	-	30	80	60	--	-	-	WGS-11
74-12	1	5.0	1500s	2000s	20.0s	1.10	N	15s	70s	38	30s	N	N	D171854
	2	4.3	--	--	27.0	0.60	-	25	62	46	--	-	-	WGS-12
74-13	1	4.8	1500s	5000s	7.0s	1.90	N	20s	50s	44	30s	N	N	D171856
	2	4.4	--	--	23.0	2.90	-	45	70	63	--	-	-	WGS-13
74-14	1	5.9	1500s	5000s	7.0s	1.00L	N	15s	70s	40	30s	N	N	D171853
	2	5.1	--	--	13.0	1.90	-	45	79	47	--	-	-	WGS-14
74-15	1	4.8	1500s	2000s	5.0s	1.00	N	10s	20s	42	20s	N	N	D170263
	2	4.2	--	--	11.0	1.90	-	23	54	59	--	-	-	WGS-15
74-16	1	7.5	1000s	2000s	30.0s	1.00L	N	10s	70s	36	70s	30s	N	D171852
	2	7.3	--	--	47.0	1.30	-	30	60	45	--	-	-	WGS-16
74-17	1	6.5	1500s	2000s	15.0s	1.00	N	10s	50s	40	30s	N	N	D171851
	2	5.4	--	--	35.0	0.65	-	29	59	53	--	-	-	WGS-17
74-18	1	4.8	2000s	2000s	3.0s	2.00	N	20s	30s	41	20s	N	N	D170262
	2	3.3	--	--	24.0	0.30	-	60	97	48	--	-	-	WGS-18
74-19	1	5.1	1500s	1500s	2.0s	1.00	N	15s	20s	40	20s	N	N	D170261
	2	4.5	--	--	8.8	1.90L	-	19	35	33	--	-	-	WGS-19

LABORATORY ASH OF 54 COAL SAMPLES¹

LAB NUMBERS	TRACE ELEMENT CONCENTRATIONS IN PARTS PER MILLION OF THE ASH														L A B
	Li	Mn	Mo	Nb	Nd	Ni	Pb	Sc	Sr	V	Y	Yb	Zn	Zr	
HAMS FORK COAL REGION															
--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1
WGS-1	33	190	39	--	--	120	63	--	--	250	--	--	610	--	2
D171859	27	390	N	N	--	70s	25L ⁵	15s	1000s	70s	70s	--	54	150s	1
WGS-2	24	10,000	24	--	--	64	39	--	--	160	--	--	74	--	2
D171860	27	4,260	N	15s	--	20s	25L	15s	1000s	100s	30s	--	64	200s	1
WGS-3	25	600	35	--	--	30	65	--	--	235	--	--	69	--	2
D171861	34	1,940	N	N	--	50s	25L	10s	1000s	150s	30s	--	108	150s	1
WGS-4	35	750	29L	--	--	54	100	--	--	320	--	--	120	--	2
--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1
WGS-5	25	630	25	--	--	170	61	--	--	230	--	--	1300	--	2
D171855	28	150L	N	15s	--	100s	25L	10s	300s	70s	50s	5s	274	200s	1
WGS-6	33	1,800	25L	--	--	170	22	--	--	220	--	--	280	--	2
--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1
WGS-7	16	560	21L	--	--	40	370	--	--	120	--	--	63	--	2
--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1
WGS-8	15	940	21L	--	--	79	170	--	--	150	--	--	68	--	2
--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1
WGS-9	23	530	26L	--	--	55	120	--	--	150	--	--	290	--	2
D171858	30	450	N	N	--	50s	25L	7s	200s	50s	30s	--	120	50s	1
WGS-10	27	2,600	31L	--	--	57	18	--	--	93	--	--	100	--	2
D171857	36	770	N	15s	--	70s	25L	15s	500s	70s	50s	5s	150	100s	1
WGS-11	37	1,900	25L	--	--	80	45	--	--	270	--	--	160	--	2
D171854	37	1,160	N	15s	--	50s	25L	15s	700s	100s	50s	5s	64	150s	1
WGS-12	32	1,130	23L	--	--	62	25	--	--	200	--	--	48	--	2
D171856	34	1,390	7s	15s	--	70s	25L	10s	500s	100s	30s	3s	196	150s	1
WGS-13	34	190	23	--	--	79	33	--	--	270	--	--	225	--	2
D171853	38	600	10s	N	--	70s	25L	15s	2000s	150s	50s	5s	134	150s	1
WGS-14	37	610	19	--	--	110	43	--	--	350	--	--	87	--	2
D170263	53	150L	5s	10s	--	20s	30	7s	500s	50s	20s	2s	94	200s	1
WGS-15	47	170	23L	--	--	40	120	--	--	210	--	--	83	--	2
D171852	38	150L	N	20s	--	70s	25L	20s	500s	100s	30s	3s	40	200s	1
WGS-16	35	120	27L	--	--	60	54	--	--	270	--	--	40	--	2
D171851	51	150L	N	20s	--	50s	25L	15s	1000s	70s	30s	3s	62	200s	1
WGS-17	52	170	18L	--	--	70	61	--	--	220	--	--	53	--	2
D170262	56	150L	N	10s	--	70s	30	10s	1000s	70s	30s	2s	174	150s	1
WGS-18	100	750	6L	--	--	30L	30	--	--	120	--	--	42	--	2
D170261	42	150L	N	N	--	30s	25	7s	700s	50s	30s	2s	106	150s	1
WGS-19	35	480	22	--	--	35	24	--	--	110	--	--	130	--	2

TABLE 13: TRACE ELEMENT COMPOSITION OF THE

SAMPLE NUMBER	L ² A B	ASH %	TRACE ELEMENT CONCENTRATIONS IN PARTS PER MILLION OF THE ASH											LAB NUMBERS
			B	Ba	Be	Cd	Ce	Co	Cr	Cu	Ga	Ge	La	
GREEN RIVER COAL REGION														
74-20	1	6.9	1500s	7000s	N	1.10	N	15s	70s	96	20s	N	70s	D171834 WGS-20
	2	6.3	--	--	4.7	--	-	30	79	130	--	-	--	
74-21	1	13.5	1000s	5000s	2.0s	1.00L	N	10s	70s	160	30s	N	70s	D171833 WGS-21
	2	11.1	--	--	5.4	2.70	-	9.9	84	220	--	-	--	
74-22	1	5.8	2000s	2000s	15.0s	2.00	N	15s	70s	82	30s	N	N	D170264 WGS-22
	2	10.1	--	--	41.0	0.89	-	24	100	100	--	-	-	
HANNA COAL FIELD														
74-23	1	8.5	300s	2000s	2.0s	3.00	N	20s	70s	222	30s	N	N	D170258 WGS-23
	2	7.8	--	--	9.0	2.90	-	39	100	280	--	-	-	
74-24	1	10.7	200s	2000s	N	2.00	N	15s	70s	98	20s	N	N	D170259 WGS-24
	2	12.5	--	--	4.8	0.80	-	29	88	96	--	-	-	
74-25	1	5.4	700s	5000s	3.0s	1.00L	N	20s	70s	118	30s	N	70s	D171832 WGS-25
	2	4.9	--	--	6.1	0.20	-	45	100	140	--	-	-	
74-26	1	7.2	150s	2000s	N	1.00	N	7s	70s	96	20s	N	70s	D170253 WGS-26
	2	8.3	--	--	3.6	1.30	-	24	65	90	--	-	-	
74-27	1	9.2	700s	2000s	2.0s	1.00L	N	7s	50s	92	15s	N	N	D170260 WGS-27
	2	9.4	--	--	6.4	2.40	-	14	54	100	--	-	-	
74-28	1	8.3	700s	5000s	2.0s	1.40	N	10s	30s	56	30s	N	N	D171835 WGS-28
	2	7.9	--	--	5.0	1.10	-	15	35	65	--	-	-	
74-29	1	14.1	200s	2000s	2.0s	1.10	N	10s	70s	64	30s	N	N	D171836 WGS-29
	2	--	--	--	--	--	-	--	--	--	--	-	-	
74-30	1	9.2	200s	5000s	2.0s	4.00	N	7s	30s	48	10s	N	N	D170257 WGS-30
	2	10.7	--	--	4.6	1.30	-	10	40	49	--	-	-	
74-31	1	17.1	100s	3000s	2.0s	1.00	N	10s	50s	50	20s	N	N	D170256 WGS-31
	2	15.6	--	--	5.7	0.96	-	14	64	50	--	-	-	
74-32	1	10.8	100s	3000s	3.0s	1.00	N	15s	70s	54	15s	N	N	D170255 WGS-32
	2	10.1	--	--	10.0	1.60	-	39	85	86	--	-	-	
74-33	1	--	--	--	--	--	-	--	--	--	--	-	-	-- WGS-33
	2	8.0	--	--	7.4	3.10	-	29	39	64	--	-	-	
74-34	1	5.3	200s	7000s	2.0s	1.00L	N	7s	50s	62	10s	N	N	D170254 WGS-34
	2	5.6	--	--	7.2	0.32	-	19	45	72	--	-	-	
POWDER RIVER COAL BASIN														
74-35	1	12.9	500s	1000s	2.0s	1.10	N	10s	100s	94	20s	N	N	D171838 WGS-35
	2	11.9	--	--	6.7	2.20	-	15	100	100	--	-	-	
74-36	1	21.7	300s	1000s	N	1.10	N	10s	100s	94	30s	N	N	D171837 WGS-36
	2	21.2	--	--	4.7	0.05	-	9.9	94	94	--	-	-	
74-37	1	11.3	500s	1500s	2.0s	1.40	N	10s	70s	131	30s	N	N	D171839 WGS-37
	2	10.6	--	--	8.4	0.18L	-	19	69	140	--	-	-	

LABORATORY ASH OF 54 COAL SAMPLES¹ - continued

LAB NUMBERS	TRACE ELEMENT CONCENTRATIONS IN PARTS PER MILLION OF THE ASH														L A B
	Li	Mn	Mo	Nb	Nd	Ni	Pb	Sc	Sr	V	Y	Yb	Zn	Zr	
GREEN RIVER COAL REGION															
D171834	97	390	10s	20s	N	30s	65	10s	1000s	100s	30s	3s	50	200s	1
WGS-20	100	--	--	--	--	35	100	--	--	--	--	--	57	--	2
D171833	122	170	30s	20s	N	20s	40	20s	500s	150s	30s	3s	82	300s	1
WGS-21	110	--	--	--	--	39	--	--	--	360	--	--	150	--	2
D170264	206	150L	10s	20s	N	30s	70	30s	3000s	150s	70s	7s	84	300s	1
WGS-22	170	270	59	--	--	64	140	--	--	490	--	--	99	--	2
HANNA COAL FIELD															
D170258	62	850	15s	10s	--	50s	35	20s	2000s	200s	30s	3s	252	150s	1
WGS-23	56	1,400	100	--	--	90	--	--	--	760	--	--	320	--	2
D171259	42	490	15s	N	--	50s	35	15s	3000s	150s	30s	3s	168	70s	1
WGS-24	36	930	64	--	--	55	80	--	--	400	--	--	200	--	2
D171832	55	530	20s	20s	N	70s	30	20s	500s	200s	50s	--	152	150s	1
WGS-25	51	940	82	--	--	90	57	--	--	550	--	--	240	--	2
D170253	41	150L	7s	10s	--	30s	35	15s	1500s	150s	30s	2s	82	70s	1
WGS-26	37	310	48	--	--	35	110	--	--	360	--	--	71	--	2
D171260	22	470	7s	N	--	20s	25	10s	2000s	70s	30s	2s	40	100s	1
WGS-27	33	1,100	74	--	--	39	44	--	--	240	--	--	39	--	2
D171835	46	290	20s	N	--	30s	30	10s	1000s	150s	30s	--	58	150s	1
WGS-28	41	600	50	--	--	35	45	--	--	210	--	--	62	--	2
D171836	40	150L	20s	20s	--	50s	30	10s	700s	200s	50s	3s	88	100s	1
WGS-29	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2
D170257	16	850	7s	N	--	30s	40	7s	3000s	70s	30s	2s	174	50s	1
WGS-30	25	1,200	28	--	--	34	68	--	--	150	--	--	150	--	2
D170256	34	150L	5s	N	--	20s	50	10s	2000s	100s	20s	2s	106	70s	1
WGS-31	23	89	19L	--	--	25	64	--	--	30	--	--	83	--	2
D170255	34	150L	5s	10s	--	50s	30	10s	1500s	100s	30s	3s	190	70s	1
WGS-32	33	240	39	--	--	80	99	--	--	360	--	--	230	--	2
--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1
WGS-33	29	620	24	--	--	64	64	--	--	190	--	--	180	--	2
D170254	11	150L	7s	N	--	20s	35	7s	3000s	70s	30s	2s	22	70s	1
WGS-34	28	640	36	--	--	30	28	--	--	160	--	--	30	--	2
POWDER RIVER COAL BASIN															
D171838	76	620	10s	20s	--	30s	30	20s	200s	200s	30s	3s	60	150s	1
WGS-35	71	1,200	42	--	--	44	70	--	--	550	--	--	76	--	2
D171837	50	390	N	20s	--	15s	40	15s	150s	200s	20s	2s	46	150s	1
WGS-36	42	520	42	--	--	19	47	--	--	--	--	--	51	--	2
D171839	42	460	N	15s	--	15s	25	20s	300s	200s	30s	2s	38	150s	1
WGS-37	39	830	28	--	--	25	18	--	--	--	--	--	63	--	2

TABLE 13: TRACE ELEMENT COMPOSITION OF THE

SAMPLE NUMBER	L ² A B	ASH %	TRACE ELEMENT CONCENTRATIONS IN PARTS PER MILLION OF THE ASH											LAB NUMBERS
			B	Ba	Be	Cd	Ce	Co	Cr	Cu	Ga	Ge	La	
POWDER RIVER COAL BASIN - continued														
74-38	1	7.6	500s	5000s	5.0s	1.40	N	30s	100s	216	30s	N	100s	D171827 WGS-38
	2	6.7	--	--	7.4	1.10	-	40	79	230	--	-	--	
74-39	1	6.3	700s	5000s	3.0s	1.40	N	20s	70s	170	50s	N	100s	D171826 WGS-39
	2	5.7	--	--	5.2	7.00L	-	29	70	190	--	-	--	
74-40	1	7.1	500s	5000s	2.0s	1.40	N	30s	70s	174	30s	N	100s	D171828 WGS-40
	2	6.0	--	--	6.6	2.90	-	29	69	210	--	-	--	
74-41	1	8.7	500s	5000s	5.0s	1.00L	N	30s	70s	176	30s	N	70s	D171831 WGS-41
	2	7.1	--	--	9.8	0.11	-	50	99	210	--	-	--	
74-42	1	10.4	500s	5000s	3.0s	1.30	N	30s	100s	162	50s	N	100s	D171830 WGS-42
	2	8.6	--	--	8.1	0.046	-	34	92	170	--	-	--	
74-43	1	7.5	700s	7000s	2.0s	1.00L	N	20s	70s	104	30s	N	N	D171829 WGS-43
	2	6.8	--	--	4.3	2.70	-	29	74	140	--	-	--	
74-44	1	7.9	700s	10,000s	5.0s	1.10	N	20s	70s	116	30s	N	70s	D171843 WGS-44
	2	7.2	--	--	9.7	0.97	-	40	75	130	--	-	--	
74-45	1	18.0	300s	5000s	5.0s	2.10	N	30s	100s	82	30s	N	70s	D171842 WGS-45
	2	15.9	--	--	10.0	0.44	-	62	110	94	--	-	--	
74-46	1	6.0	500s	10,000s	5.0s	1.40	N	30s	70s	114	30s	N	70s	D171844 WGS-46
	2	5.6	--	--	10.0	7.10	-	64	64	130	--	-	--	
74-47	1	5.4	500s	10,000s	2.0s	1.70	N	20s	50s	88	30s	N	N	D171841 WGS-47
	2	5.1	--	--	7.8	--	-	25	55	130	--	-	--	
74-48	1	7.4	500s	7000s	2.0s	1.90	N	15s	70s	135	30s	N	N	D171840 WGS-48
	2	5.9	--	--	8.4	0.91	-	30	84	160	--	-	--	
74-49	1	10.0	1000s	5000s	5.0s	1.00	N	20s	70s	56	30s	N	N	D171850 WGS-49
	2	8.6	--	--	11.0	0.90	-	45	94	74	--	-	--	
74-50	1	10.2	700s	3000s	15.0s	4.40	N	50s	100s	94	50s	N	100s	D171848 WGS-50
	2	8.8	--	--	30.0	4.00	-	90	110	110	--	-	--	
74-51	1	10.2	700s	5000s	10.0s	2.20	200s	30s	100s	74	30s	N	150s	D171847 WGS-51
	2	9.4	--	--	23.0	2.70	-	65	110	80	--	-	--	
74-52	1	9.9	700s	5000s	7.0s	3.40	200s	50s	100s	118	30s	N	100s	D171846 WGS-52
	2	8.6	--	--	16.0	5.20	-	100	120	110	--	-	--	
74-53	1	26.2	300s	1000s	5.0s	1.60	N	30s	100s	56	50s	N	N	D171845 WGS-53
	2	22.3	--	--	13.0	1.10	-	71	160	80	--	-	--	
74-54	1	14.0	500s	3000s	7.0s	2.50	N	30s	100s	70	50s	N	70s	D171849 WGS-54
	2	12.5	--	--	16.0	3.30	-	69	120	80	--	-	--	

LABORATORY ASH OF 54 COAL SAMPLES¹ - continued

LAB NUMBERS	TRACE ELEMENT CONCENTRATIONS IN PARTS PER MILLION OF THE ASH														L A B
	Li	Mn	Mo	Nb	Nd	Ni	Pb	Sc	Sr	V	Y	Yb	Zn	Zr	
POWDER RIVER COAL BASIN - continued															
D171827	32	380	10s	20s	N	70s	40	30s	1500s	300s	50s	--	98	200s	1
WGS-38	32	680	14	--	--	70	65	--	--	530	--	--	130	--	2
D171826	48	150L	7s	20s	N	70s	40	30s	2000s	200s	50s	5s	54	200s	1
WGS-39	33	220	17L	--	--	59	49	--	--	470	--	--	49	--	2
D171828	36	180	7s	20s	N	50s	35	30s	1500s	300s	50s	7s	68	200s	1
WGS-40	36	490	33	--	--	59	84	--	--	510	--	--	74	--	2
D171831	35	150L	N	20s	N	70s	40	30s	1000s	300s	70s	5s	170	200s	1
WGS-41	33	290	70L	--	--	140	15	--	--	630	--	--	180	--	2
D171830	36	310	7sL	20s	N	70s	30	30s	1000s	300s	70s	--	218	200s	1
WGS-42	33	550	34	--	--	99	55	--	--	540	--	--	210	--	2
D171829	30	150L	7s	30s	--	50s	30	15s	2000s	200s	30s	5s	64	200s	1
WGS-43	35	330	14	--	--	49	74	--	--	350	--	--	140	--	2
D171843	51	150L	15s	15s	N	70s	25	20s	1000s	200s	70s	--	356	150s	1
WGS-44	50	160	55	--	--	110	73	--	--	440	--	--	430	--	2
D171842	86	740	20s	15s	N	100s	25	30s	700s	200s	100s	--	472	150s	1
WGS-45	75	1,100	18L	--	--	180	75	--	--	590	--	--	510	--	2
D171844	43	150L	30s	15s	N	100s	40	30s	2000s	200s	100s	7s	508	150s	1
WGS-46	39	280	89	--	--	150	84	--	--	500	--	--	480	--	2
D171841	36	850	15s	15s	--	70s	25	20s	500s	200s	70s	--	336	200s	1
WGS-47	35	1,100	39	--	--	100	15	--	--	370	--	--	430	--	2
D171840	52	150L	15s	15s	--	50s	25	15s	200s	200s	50s	3s	220	150s	1
WGS-48	54	270	50	--	--	84	52	--	--	470	--	--	330	--	2
D171850	45	150L	7sL	15s	--	50s	25	15s	700s	200s	50s	5s	242	150s	1
WGS-49	44	180	22L	--	--	90	51	--	--	460	--	--	210	--	2
D171848	45	150L	30s	15s	N	100s	25	50s	500s	300s	150s	15s	800	200s	1
WGS-50	41	94	56	--	--	180	63	--	--	700	--	--	680	--	2
D171847	50	150L	10s	N	200s	100s	25L	20s	700s	200s	150s	15s	560	150s	1
WGS-51	40	160	64	--	--	210	59	--	--	600	--	--	680	--	2
D171846	36	150	20	N	150s	150s	35	30s	500s	300s	100s	10s	780	150s	1
WGS-52	32	170	93	--	--	230	110	--	--	720	--	--	780	--	2
D171845	68	150L	15s	20s	--	70s	45	20s	300s	200s	70s	--	258	150s	1
WGS-53	76	110	44	--	--	130	100	--	--	710	--	--	340	--	2
D171849	61	150L	20s	15s	N	70s	30	20s	500s	200s	100s	10s	344	150s	1
WGS-54	56	110	40	--	--	140	59	--	--	570	--	--	370	--	2

¹Analyses done by the U. S. Geological Survey and/or the Wyoming Geological Survey on separate sample splits.

²1, U. S. Geological Survey; 2, Wyoming Geological Survey

³"s" means semiquantitative analysis.

⁴"N" means not detected, at limit of detection or at value shown.

⁵L means less than.

TABLE 14: TRACE ELEMENT COMPOSITION OF 54 COAL SAMPLES

SAMPLE NUMBER	L ² A B	TRACE ELEMENT CONCENTRATIONS IN PARTS PER MILLION ON A WHOLE-COAL BASIS															LAB NUMBERS	
		As	B	Ba	Be	Cd	Ce	Co	Cr	Cu	F	Ga	Ge	Hg	La	Li		Mn
HAMS FORK COAL REGION																		
74-1	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
	2	--	--	--	1.4	0.120	--	2.5	4.3	4.8	--	--	--	0.07	--	1.7	10	WGS-1
74-2	1	1	100s ³	150s	0.7s	0.100	N ⁴	2.0s	5.0s	3.0	60	3s	N	0.05	N	2.4	34	D171059
	2	--	--	--	1.3	0.006	--	1.2	6.0	3.2	--	--	--	0.07	--	2.0	804	WGS-2
74-3	1	2	70s	100s	0.7s	0.100	N	N	7.0s	3.7	75	3s	N	0.13	N	3.1	492	D171860
	2	--	--	--	1.4	0.008L	--	0.9	7.6	3.6	--	--	--	0.15	--	2.2	51	WGS-3
74-4	1	1	70s	150s	0.2s	0.100	N	1.0s	5.0s	2.9	95	2s	N	0.03	N	2.6	151	D171861
	2	--	--	--	0.5	0.110	--	2.0	5.7	3.7	--	--	--	0.09	--	2.4	51	WGS-4
74-5	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	2	--	--	--	1.4	0.040	--	3.1	3.3	3.7	--	--	--	0.07	--	1.0	25	WGS-5
74-6	1	1L	70s	100s	0.7s	0.100	N	2.0s	10.0s	2.5	85	2s	N	0.03	N	1.4	8L	D171855
	2	--	--	--	1.1	0.070	--	3.1	2.4	2.8	--	--	--	0.08	--	1.3	71	WGS-6
74-7	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	2	--	--	--	1.0	0.035	--	1.0	3.1	3.0	--	--	--	0.06	--	0.8	27	WGS-7
74-8	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	2	--	--	--	1.8	0.020	--	1.4	2.7	2.5	--	--	--	0.10	--	0.7	43	WGS-8
74-9	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	2	--	--	--	0.9	0.130	--	1.1	2.6	1.9	--	--	--	0.03	--	0.9	20	WGS-9
74-10	1	1L	70s	70s	0.7s	0.10L	N	1.0s	2.0s	2.2	40	2s	N	0.02	N	2.2	32	D171858
	2	--	--	--	1.4	0.060	--	1.8	3.7	2.7	--	--	--	0.06	--	1.8	170	WGS-10
74-11	1	1L	70s	150s	0.7s	0.100	N	1.0s	2.0s	1.8	55	2s	N	0.02	N	1.6	34	D171857
	2	--	--	--	1.3	0.040	--	1.2	3.2	2.4	--	--	--	0.02	--	1.5	76	WGS-11
74-12	1	1L	70s	100s	1.0s	0.100	N	1.0s	3.0s	1.9	55	2s	N	0.03	N	1.8	58	D171854
	2	--	--	--	1.2	0.026	--	1.1	2.7	2.0	--	--	--	0.15	--	1.4	49	WGS-12
74-13	1	2	70s	200s	0.3s	0.100	N	1.0s	2.0s	2.1	55	2s	N	0.06	N	1.6	67	D171856
	2	--	--	--	1.0	0.130	--	2.0	3.1	2.8	--	--	--	0.09	--	1.5	8	WGS-13
74-14	1	1L	100s	300s	0.5s	0.10L	N	1.0s	5.0s	2.4	60	2s	N	0.03	N	2.2	35	D171853
	2	--	--	--	0.7	0.100	--	2.3	4.0	2.4	--	--	--	0.04	--	1.9	31	WGS-14
74-15	1	1	70s	100s	0.2s	0.050	N	0.5s	1.0s	2.0	25	1s	N	0.03	N	2.5	7L	D170263
	2	--	--	--	0.5	0.080	--	1.0	2.3	2.5	--	--	--	0.02	--	2.0	7	WGS-15
74-16	1	1L	70s	150s	2.0s	0.10L	N	1.0s	5.0s	2.7	45	5s	2s	0.10	N	2.8	12L	D171852
	2	--	--	--	3.5	0.100	--	2.2	4.4	3.3	--	--	--	0.07	--	2.6	9	WGS-16
74-17	1	1L	100s	150s	1.0s	0.100	N	1.0s	3.0s	2.6	45	2s	N	0.03	N	3.3	10L	D171851
	2	--	--	--	1.9	0.035	--	1.6	3.2	2.9	--	--	--	0.08	--	2.8	9	WGS-17
74-18	1	1	100s	100s	0.2s	0.100	N	1.0s	1.5s	2.0	45	1s	N	0.04	N	2.7	7L	D170262
	2	--	--	--	0.8	0.010	--	2.0	3.2	1.6	--	--	--	0.08	--	3.4	25	WGS-18
74-19	1	1	70s	70s	0.1s	0.100	N	0.7s	1.0s	2.0	30	1s	N	0.07	N	2.1	8L	D170261
	2	--	--	--	0.4	0.09L	--	0.9	1.6	1.5	--	--	--	0.12	--	1.6	22	WGS-19

REPORTED ON A WHOLE-COAL BASIS¹

LAB NUMBERS	TRACE ELEMENT CONCENTRATIONS IN PARTS PER MILLION ON A WHOLE-COAL BASIS																L A B
	Mo	Nb	Nd	Ni	Pb	Sb	Sc	Se	Sr	Th	U	V	Y	Yb	Zn	Zr	
HAMS FORK COAL REGION - continued																	
--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1
WGS-1	2.0	--	--	6.1	3.2	--	--	--	--	--	--	13	--	--	31.0	--	2
D171859	N	N	--	7.0s	2.2L ⁵	0.2	2.0s	0.4	100s	2.0L	0.5	7s	7.0s	--	4.8	15s	1
WGS-2	2.0	--	--	5.2	3.2	--	--	--	--	--	--	13	--	--	6.0	--	2
D171860	N	2s	--	2.0s	2.9L	0.5	2.0s	0.5	100s	2.0L	0.5	10s	3.0s	--	7.4	20s	1
WGS-3	3.0	--	--	2.6	5.6	--	--	--	--	--	--	20	--	--	5.9	--	2
D171861	N	N	--	5.0s	1.9L	0.1	1.0s	0.4	70s	3.0	0.2L	10s	2.0s	--	8.3	10s	1
WGS-4	2.0L	--	--	3.7	6.8	--	--	--	--	--	--	22	--	--	8.4	--	2
--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1
WGS-5	1.0	--	--	6.8	2.4	--	--	--	--	--	--	9	--	--	51.0	--	2
D171855	N	1s	--	5.0s	1.2L	0.1L	1.0s	0.3	15s	2.0L	0.2L	3s	2.0s	0.2s	13.4	10s	1
WGS-6	1.0L	--	--	6.7	0.9	--	--	--	--	--	--	9	--	--	11.0	--	2
--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1
WGS-7	1.0L	--	--	1.9	18.0	--	--	--	--	--	--	6	--	--	3.0	--	2
--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1
WGS-8	1.0L	--	--	3.6	8.0	--	--	--	--	--	--	7	--	--	3.1	--	2
--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1
WGS-9	1.0L	--	--	2.1	4.7	--	--	--	--	--	--	6	--	--	11.0	--	2
D171858	N	N	--	3.0s	1.8L	0.1L	1.0s	0.1	15s	2.0L	0.2L	3s	2.0s	--	8.6	3s	1
WGS-10	2.0L	--	--	3.7	1.2	--	--	--	--	--	--	6	--	--	6.8	--	2
D171857	N	1s	--	3.0s	1.1L	0.1L	1.0s	0.1L	20s	2.0L	0.2L	3s	2.0s	0.2s	6.6	5s	1
WGS-11	1.0L	--	--	3.2	1.8	--	--	--	--	--	--	11	--	--	6.4	--	2
D171854	N	1s	--	2.0s	1.3L	0.1L	1.0s	0.1	30s	2.0L	0.4	5s	2.0s	0.2s	3.2	7s	1
WGS-12	1.0L	--	--	2.7	1.1	--	--	--	--	--	--	9	--	--	2.1	--	2
D171856	0.7s	1s	--	3.0s	1.2L	0.1L	1.0s	0.4	20s	2.0L	1.0	5s	2.0s	0.2s	9.4	7s	1
WGS-13	1.0	--	--	3.5	1.5	--	--	--	--	--	--	12	--	--	10.0	--	2
D171853	1.0s	N	--	5.0s	1.5L	0.2	1.0s	0.4	100s	2.0L	0.2L	10s	3.0s	0.3s	7.9	10s	1
WGS-14	1.0	--	--	5.6	2.2	--	--	--	--	--	--	18	--	--	4.4	--	2
D170263	0.2s	0.5s	--	1.0s	1.4	0.3	0.3s	0.6	20s	2.0L	0.4	2s	1.0s	0.1s	4.5	10s	1
WGS-15	1.0L	--	--	1.7	5.2	--	--	--	--	--	--	9	--	--	3.5	--	2
D171852	N	2s	--	5.0s	1.9L	0.3	2.0s	0.3	30s	2.0L	0.4	7s	2.0s	0.2s	3.0	15s	1
WGS-16	2.0L	--	--	4.4	4.0	--	--	--	--	--	--	20	--	--	3.0	--	2
D171851	N	2s	--	3.0s	1.6L	0.2	1.0s	0.1	70s	2.0L	0.4	5s	2.0s	0.2s	4.0	15s	1
WGS-17	1.0L	--	--	3.8	3.3	--	--	--	--	--	--	12	--	--	2.9	--	2
D170262	N	0.5s	--	3.0s	1.4	0.2	0.5s	0.5	50s	2.0L	0.1L	3s	1.5s	0.1s	8.4	7s	1
WGS-18	0.2L	--	--	1.0L	1.0	--	--	--	--	--	--	4	--	--	1.4	--	2
D170261	N	N	--	2.0s	1.3	0.3	0.3s	1.0	30s	2.0L	0.7	2s	1.5s	0.1s	5.4	7s	1
WGS-19	1.0L	--	--	1.6	1.1	--	--	--	--	--	--	5	--	--	5.9	--	2

TABLE 14: TRACE ELEMENT COMPOSITION OF 54 COAL SAMPLES

SAMPLE NUMBER	L A B	TRACE ELEMENT CONCENTRATIONS IN PARTS PER MILLION ON A WHOLE-COAL BASIS																LAB NUMBERS	
		As	B	Ba	Be	Cd	Ce	Co	Cr	Cu	F	Ga	Ge	Hg	La	Li	Mn		
GREEN RIVER COAL REGION																			
74-20	1	1L	100s	500s	N	0.100	N	1.0s	5.0s	6.6	20L	2s	N	0.11	5s	6.7	27	D171834 WGS-20	
	2	--	--	--	0.3	--	--	1.9	5.0	8.4	--	--	--	--	--	6.3	--		
74-21	1	5	150s	700s	0.3s	0.10L	N	2.0s	10.0s	21.6	30	5s	N	0.37	10s	16.5	23	D171833 WGS-21	
	2	--	--	--	0.6	0.310	--	1.1	9.4	25.0	--	--	--	0.51	--	13.0	--		
74-22	1	2	100s	100s	1.0s	0.100	N	1.0s	5.0s	4.8	100	1.5s	N	0.08	N	12.0	9L	D170264 WGS-22	
	2	--	--	--	4.2	0.090	--	2.5	11.0	11.0	--	--	--	0.12	--	18.0	28		
HANNA COAL FIELD																			
74-23	1	4	20s	150s	0.2s	0.300	N	1.5s	7.0s	18.9	55	2s	N	0.10	N	5.3	73	D170258 WGS-23	
	2	--	--	--	0.7	0.230	--	3.1	8.0	22.0	--	--	--	0.25	--	4.4	109		
74-24	1	5	20s	200s	N	0.200	N	1.5s	7.0s	10.5	75	2s	N	0.10	N	4.5	53	D170259 WGS-24	
	2	--	--	--	0.6	0.100	--	3.7	11.0	12.0	--	--	--	0.17	--	4.5	116		
74-25	1	4	30s	300s	0.2s	0.10L	N	1.0s	3.0s	6.4	40	2s	N	0.08	3s	3.0	29	D171832 WGS-25	
	2	--	--	--	0.3	0.010	--	2.2	5.1	7.0	--	--	--	0.10	--	2.5	46		
74-26	1	2	10s	150s	N	0.100	N	0.5s	5.0s	6.9	20	1.5s	N	0.05	5s	3.0	11L	D170253 WGS-26	
	2	--	--	--	0.3	0.110	--	2.0	5.4	7.5	--	--	--	0.07	--	3.1	26		
74-27	1	5	70s	200s	0.2s	0.10L	N	0.7s	5.0s	8.5	30	1.5s	N	0.10	N	2.0	43	D170260 WGS-27	
	2	--	--	--	0.6	0.230	--	1.4	5.1	9.4	--	--	--	0.11	--	3.1	105		
74-28	1	2	70s	500s	0.2s	0.100	N	1.0s	2.0s	4.6	70	2s	N	0.05	N	3.8	24	D171835 WGS-28	
	2	--	--	--	0.4	0.090	--	1.2	2.8	5.2	--	--	--	0.09	--	3.3	48		
74-29	1	5	30s	300s	0.3s	0.200	N	2.0s	10.0s	9.0	95	5s	N	0.05	N	5.6	22L	D171836 WGS-29	
	2	--	--	--	0.6L	0.080	--	5.0	7.7	8.3	--	--	--	0.08	--	--	18		
74-30	1	4	20s	500s	0.2s	0.400	N	0.7s	3.0s	4.4	45	1s	N	0.05	N	1.5	78	D170257 WGS-30	
	2	--	--	--	0.5	0.140	--	1.1	4.3	5.3	--	--	--	0.22	--	2.7	128		
74-31	1	5	15s	500s	0.3s	0.200	N	1.5s	10.0s	8.5	140	3s	N	0.05	N	5.8	26L	D170256 WGS-31	
	2	--	--	--	0.9	0.150	--	2.3	10.0	7.8	--	--	--	0.10	--	3.7	14		
74-32	1	4	10s	300s	0.3s	0.100	N	1.5s	7.0s	5.8	90	1.5s	N	0.05	N	3.7	17L	D170255 WGS-32	
	2	--	--	--	1.1	0.170	--	4.0	8.6	8.7	--	--	--	0.06	--	3.4	25		
74-33	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	-- WGS-33
	2	--	--	--	0.6	0.250	--	2.4	3.2	5.2	--	--	--	0.12	--	2.4	50		
74-34	1	1	10s	300s	0.1s	0.10L	N	0.3s	3.0s	3.3	20L	.5s	N	0.03	N	0.6	8L	D170254 WGS-34	
	2	--	--	--	0.4	0.018	--	1.1	2.5	4.0	--	--	--	0.06	--	1.6	36		
POWDER RIVER COAL BASIN																			
74-35	1	3	70s	150s	0.2s	0.100	N	2.0s	15.0s	12.1	50	2s	N	0.09	N	9.8	79	D171838 WGS-35	
	2	--	--	--	0.8	0.260	--	1.8	12.0	13.0	--	--	--	0.16	--	8.5	150		
74-36	1	3	70s	200s	N	0.200	N	2.0s	20.0s	20.4	110	7s	N	0.15	N	10.9	84	D171837 WGS-36	
	2	--	--	--	1.0	0.012	--	2.1	20.0	20.0	--	--	--	0.30	--	9.0	112		
74-37	1	2	70s	150s	0.2s	0.200	N	1.0s	7.0s	14.8	55	3s	N	0.12	N	4.7	52	D171839 WGS-37	
	2	--	--	--	0.9	0.02L	--	2.1	7.4	15.0	--	--	--	0.18	--	4.2	88		

REPORTED ON A WHOLE-COAL BASIS - continued

LAB NUMBERS	TRACE ELEMENT CONCENTRATIONS IN PARTS PER MILLION ON A WHOLE-COAL BASIS																L A B
	Mo	Nb	Nd	Ni	Pb	Sb	Sc	Se	Sr	Th	U	V	Y	Yb	Zn	Zr	
GREEN RIVER COAL REGION - continued																	
D171834	1.0s	2s	N	2.0s	4.5	0.9	1.0s	0.3	70s	2.0L	0.5	7s	2.0s	0.2s	3.5	15s	1
WGS-20	--	--	--	2.2	6.4	--	--	--	--	--	--	--	--	--	3.6	--	2
D171833	5.0s	3s	N	3.0s	5.4	0.5	3.0s	2.1	70s	4.1	1.5	20s	5.0s	0.5s	11.1	50s	1
WGS-21	--	--	--	4.4	--	--	--	--	--	--	--	40	--	--	17.0	--	2
D170264	0.7s	1s	--	2.0s	4.1	1.1	1.5s	1.2	150s	2.0L	1.5	10s	5.0s	0.5s	4.9	15s	1
WGS-22	6.0	--	--	6.5	15.0	--	--	--	--	--	--	50	--	--	10.0	--	2
HANNA COAL FIELD - continued																	
D170258	1.5s	1s	--	5.0s	3.0	0.5	1.5s	0.8	150s	2.0L	2.0	15s	2.0s	0.2s	21.4	15s	1
WGS-23	8.0	--	--	7.0	--	--	--	--	--	--	--	59	--	--	25.0	--	2
D170259	1.5s	N	--	5.0s	3.7	0.6	1.5s	0.8	300s	2.0L	2.1	15s	3.0s	0.3s	18.0	7s	1
WGS-24	8.0	--	--	6.9	10.0	--	--	--	--	--	--	51	--	--	25.0	--	2
D171832	1.0s	1s	N	3.0s	1.6	0.2	1.0s	0.4	30s	3.4	0.8	10s	3.0s	--	8.2	7s	1
WGS-25	4.0	--	--	4.4	2.8	--	--	--	--	--	--	27	--	--	12.0	--	2
D170253	0.5s	0.7s	--	2.0s	2.5	0.3	1.0s	0.5	100s	2.0L	1.5	10s	2.0s	0.2s	5.9	5s	1
WGS-26	4.0	--	--	2.9	9.4	--	--	--	--	--	--	30	--	--	5.9	--	2
D170260	0.7s	N	--	2.0s	2.3	0.7	1.0s	0.5	200s	2.0L	1.3	7s	3.0s	0.2s	3.7	10s	1
WGS-27	7.0	--	--	3.7	4.2	--	--	--	--	--	--	23	--	--	3.7	--	2
D171835	2.0s	N	--	2.0s	2.5	0.4	1.0s	0.1L	70s	2.0L	1.1	15s	2.0s	--	4.8	15s	1
WGS-28	4.0	--	--	2.8	3.6	--	--	--	--	--	--	17	--	--	4.9	--	2
D171836	3.0s	3s	--	7.0s	4.2	0.6	2.0s	0.3	100s	3.8	2.1	30s	7.0s	0.5s	12.4	15s	1
WGS-29	3.0	--	--	2.0L	8.6	--	--	--	--	--	--	20	--	--	7.7	--	2
D170257	0.7s	N	--	3.0s	3.7	0.3	0.7s	0.2	300s	2.0L	0.8	7s	3.0s	0.2s	16.0	5s	1
WGS-30	3.0	--	--	3.7	7.3	--	--	--	--	--	--	17	--	--	17.0	--	2
D170256	1.0s	N	--	3.0s	8.5	0.5	1.5s	0.1	300s	4.2	1.5	15s	3.0s	0.3s	18.1	10s	1
WGS-31	3.0L	--	--	3.9	10.0	--	--	--	--	--	--	5	--	--	13.0	--	2
D170255	0.5s	1s	--	5.0s	3.2	0.5	1.0s	0.2	150s	2.9	1.3	10s	3.0s	0.3s	20.5	7s	1
WGS-32	4.0	--	--	8.1	10.0	--	--	--	--	--	--	37	--	--	24.0	--	2
--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1
WGS-33	2.0	--	--	5.2	5.2	--	--	--	--	--	--	16	--	--	15.0	--	2
D170254	0.3s	N	--	1.0s	1.9	0.2	0.3s	0.2	150s	2.0L	0.5	3s	1.5s	0.1s	1.2	3s	1
WGS-34	2.0	--	--	1.7	1.6	--	--	--	--	--	--	9	--	--	1.7	--	2
POWDER RIVER COAL BASIN - continued																	
D171838	2.0s	2s	--	5.0s	3.9	0.3	2.0s	1.2	20s	3.7	1.5	20s	5.0s	0.5s	7.7	20s	1
WGS-35	5.0	--	--	5.3	8.3	--	--	--	--	--	--	66	--	--	9.0	--	2
D171837	N	5s	--	3.0s	8.7	0.6	3.0s	1.5	30s	4.1	1.9	50s	5.0s	0.5s	10.0	30s	1
WGS-36	9.0	--	--	4.2	10.0	--	--	--	--	--	--	--	--	--	11.0	--	2
D171839	N	2s	--	2.0s	2.8	0.3	2.0s	0.7	30s	2.0L	0.9	20s	3.0s	0.2s	4.3	15s	1
WGS-37	3.0	--	--	2.7	2.0	--	--	--	--	--	--	--	--	--	6.7	--	2

TABLE 14; TRACE ELEMENT COMPOSITION OF 54 COAL SAMPLES

SAMPLE NUMBER	L ² A B	TRACE ELEMENT CONCENTRATIONS IN PARTS PER MILLION ON A WHOLE-COAL BASIS																LAB NUMBERS
		As	B	Ba	Be	Cd	Ce	Co	Cr	Cu	F	Ga	Ge	Hg	La	Li	Mn	
POWDER RIVER COAL BASIN - continued																		
74-38	1	3	30s	300s	0.3s	0.100	N	2.0s	7.0s	16.4	45	2s	N	0.21	7s	2.4	29	D171827
	2	--	--	--	0.5	0.080	--	2.7	5.3	16.0	--	--	--	0.24	--	2.2	46	WGS-38
74-39	1	1	50s	300s	0.2s	0.100	N	2.0s	5.0s	10.7	45	3s	N	0.29	7s	3.0	10L	D171826
	2	--	--	--	0.3	0.40L	--	1.7	4.0	11.0	--	--	--	0.21	--	1.9	13	WGS-39
74-40	1	2	30s	300s	0.2s	0.100	N	2.0s	5.0s	12.4	45	2s	N	0.13	7s	2.6	13	D171828
	2	--	--	--	0.4	0.180	--	1.8	4.2	13.0	--	--	--	0.10	--	2.2	30	WGS-40
74-41	1	2	50s	500s	0.5s	0.10L	N	3.0s	7.0s	15.3	65	3s	N	0.19	7s	3.0	13L	D171831
	2	--	--	--	0.7	0.008	--	3.6	7.1	15.0	--	--	--	0.57	--	2.4	21	WGS-41
74-42	1	3	50s	500s	0.3s	0.100	N	3.0s	10.0s	16.8	60	5s	N	0.22	10s	3.7	33	D171830
	2	--	--	--	0.7	0.004	--	3.0	8.0	15.0	--	--	--	0.25	--	2.9	48	WGS-42
74-43	1	1	50s	500s	0.2s	0.10L	N	2.0s	5.0s	7.8	50	2s	N	0.17	N	2.3	12L	D171829
	2	--	--	--	0.3	0.190	--	2.0	5.1	10.0	--	--	--	0.09	--	2.4	23	WGS-43
74-44	1	4	50s	700s	0.5s	0.100	N	2.0s	5.0s	9.2	85	2s	N	0.12	5s	4.0	12L	D171843
	2	--	--	--	0.7	0.070	--	2.9	5.4	10.0	--	--	--	0.12	--	3.6	12	WGS-44
74-45	1	8	50s	1000s	1.0s	0.400	N	5.0s	15.0s	14.8	190	5s	N	0.17	15s	15.5	133	D171842
	2	--	--	--	1.7	0.070	--	10.0	19.0	15.0	--	--	--	0.11	--	12.0	175	WGS-45
74-46	1	1	30s	700s	0.3s	0.100	N	2.0s	5.0s	6.8	85	2s	N	0.04	5s	2.6	9L	D171844
	2	--	--	--	0.6	0.400	--	3.6	3.6	7.4	--	--	--	0.11	--	2.2	16	WGS-46
74-47	1	3	30s	500s	0.1s	0.100	N	1.0s	3.0s	4.8	55	2s	N	0.07	N	1.9	48	D171841
	2	--	--	--	0.4	0.600	--	1.3	2.8	7.1	--	--	--	0.07	--	1.8	60	WGS-47
74-48	1	3	30s	500s	0.2s	0.100	N	1.0s	5.0s	10.0	65	2s	N	0.13	N	3.8	11L	D171840
	2	--	--	--	0.5	0.054	--	1.8	5.0	10.0	--	--	--	0.24	--	3.2	16	WGS-48
74-49	1	3	100s	500s	0.5s	0.100	N	2.0s	7.0s	5.6	110	3s	N	0.04	N	4.5	15L	D171850
	2	--	--	--	1.0	0.080	--	4.0	8.4	6.6	--	--	--	0.11	--	3.9	16	WGS-49
74-50	1	4	70s	300s	1.5s	0.400	N	5.0s	10.0s	9.6	90	5s	N	0.16	10s	4.6	16L	D171848
	2	--	--	--	2.7	0.360	--	8.0	10.0	10.0	--	--	--	0.16	--	3.7	8	WGS-50
74-51	1	4	70s	500s	1.0s	0.200	20s	3.0s	10.0s	7.5	95	3s	N	0.11	15s	5.1	16L	D171847
	2	--	--	--	2.2	0.260	--	6.1	11.0	7.5	--	--	--	0.08	--	3.8	15	WGS-51
74-52	1	8	70s	500s	0.7s	0.300	20s	5.0s	10.0s	11.7	85	3s	N	0.21	10s	3.6	15	D171846
	2	--	--	--	1.4	0.450	--	9.0	11.0	10.0	--	--	--	0.07	--	2.8	15	WGS-52
74-53	1	8	70s	300s	1.5s	0.400	N	7.0s	30.0s	14.7	255	15s	N	0.22	N	17.8	41L	D171845
	2	--	--	--	2.9	0.250	--	16.0	37.0	18.0	--	--	--	0.09	--	17.0	25	WGS-53
74-54	1	4	70s	500s	1.0s	0.400	N	5.0s	15.0s	9.8	135	7s	N	0.13	10s	8.5	22L	D171849
	2	--	--	--	2.0	0.420	--	8.7	16.0	10.0	--	--	--	0.18	--	7.0	14	WGS-54

REPORTED ON A WHOLE-COAL BASIS - continued

LAB NUMBERS	TRACE ELEMENT CONCENTRATIONS IN PARTS PER MILLION ON A WHOLE-COAL BASIS																L A B
	Mo	Nb	Nd	Ni	Pb	Sb	Sc	Se	Sr	Th	U	V	Y	Yb	Zn	Zr	
POWDER RIVER COAL BASIN - continued																	
D171827	1.0s	2s	N	5.0s	3.0	0.7	2.0s	0.7	100s	3.3	0.8	20s	3.0s	--	7.4	15s	1
WGS-38	1.0L	--	--	4.7	4.4	--	--	--	--	--	--	36	--	--	8.7	--	2
D171826	1.0s	2s	N	5.0s	2.5	0.3	2.0s	6.7	150s	2.0L	0.6	15s	3.0s	0.3s	3.4	15s	1
WGS-39	1.0L	--	--	3.4	2.8	--	--	--	--	--	--	27	--	--	2.8	--	2
D171828	1.0s	2s	N	3.0s	2.5	0.4	2.0s	1.2	100s	2.0L	0.2L	20s	3.0s	0.5s	4.8	15s	1
WGS-40	2.0	--	--	3.6	5.1	--	--	--	--	--	--	31	--	--	4.5	--	2
D171831	N	2s	N	7.0s	3.5	0.4	3.0s	1.1	100s	2.0L	0.9	30s	7.0s	0.5s	14.8	15s	1
WGS-41	5.0L	--	--	10.0	1.1	--	--	--	--	--	--	45	--	--	13.0	--	2
D171830	1.0sL	2s	N	7.0s	3.1	0.5	3.0s	1.5	100s	3.3	1.0	30s	7.0s	--	22.7	20s	1
WGS-42	3.0	--	--	8.6	4.8	--	--	--	--	--	--	47	--	--	19.0	--	2
D171829	1.0s	2s	--	3.0s	2.3	0.2	1.0s	1.3	150s	2.0L	0.6	15s	2.0s	0.3s	4.8	15s	1
WGS-43	1.0L	--	--	3.4	5.1	--	--	--	--	--	--	24	--	--	10.0	--	2
D171843	1.0s	1s	N	5.0s	2.0	0.3	2.0s	0.4	70s	4.2	0.8	15s	5.0s	--	28.1	10s	1
WGS-44	4.0	--	--	8.6	5.3	--	--	--	--	--	--	32	--	--	31.0	--	2
D171842	3.0s	3s	N	15.0s	4.5	0.5	5.0s	1.4	150s	5.2	1.7	30s	15.0s	--	85.0	30s	1
WGS-45	3.0L	--	--	29.0	12.0	--	--	--	--	--	--	95	--	--	82.0	--	2
D171844	2.0s	1s	N	7.0s	2.4	0.2	2.0s	0.1L	100s	2.0L	0.5	10s	7.0s	0.5s	30.5	10s	1
WGS-46	5.0	--	--	8.4	4.7	--	--	--	--	--	--	28	--	--	27.0	--	2
D171841	1.0s	1s	--	3.0s	1.3	0.2	1.0s	0.4	30s	2.0L	0.2L	10s	3.0s	--	18.1	10s	1
WGS-47	2.0	--	--	5.1	0.8	--	--	--	--	--	--	19	--	--	22.0	--	2
D171840	1.0s	1s	--	3.0s	1.8	0.3	1.0s	0.2	15s	2.0L	0.6	15s	3.0s	0.2s	16.3	10s	1
WGS-48	3.0	--	--	5.0	3.1	--	--	--	--	--	--	28	--	--	20.0	--	2
D171850	1.0sL	2s	--	5.0s	2.5	0.2	2.0s	0.1L	70s	3.0	0.6	20s	5.0s	0.5s	24.2	15s	1
WGS-49	2.0L	--	--	8.0	4.6	--	--	--	--	--	--	41	--	--	19.0	--	2
D171848	3.0s	2s	N	10.0s	2.6	0.4	5.0s	0.8	50s	5.4	1.6	30s	15.0s	2.0s	81.6	20s	1
WGS-50	5.0	--	--	16.0	5.6	--	--	--	--	--	--	62	--	--	60.0	--	2
D171847	1.0s	N	20s	10.0s	2.6L	0.3	2.0s	1.0	70s	3.7	0.8	20s	15.0s	2.0s	57.1	15s	1
WGS-51	6.0	--	--	20.0	5.6	--	--	--	--	--	--	57	--	--	64.0	--	2
D171846	2.0s	N	15s	15.0s	3.5	0.4	3.0s	1.2	50s	3.8	1.6	30s	10.0s	1.0s	77.2	15s	1
WGS-52	8.0	--	--	20.0	10.0	--	--	--	--	--	--	62	--	--	67.0	--	2
D171845	5.0s	5s	--	20.0s	11.8	0.7	5.0s	1.4	70s	6.2	2.9	50s	20.0s	--	67.6	50s	1
WGS-53	10.0	--	--	29.0	23.0	--	--	--	--	--	--	160	--	--	76.0	--	2
D171849	3.0s	2s	N	10.0	4.2	0.4	3.0s	0.8	70s	4.3	1.8	30s	15.0s	2.0s	48.2	20s	1
WGS-54	5.0	--	--	18.0	7.4	--	--	--	--	--	--	72	--	--	47.0	--	2

¹ Analyses done by the U. S. Geological Survey and/or the Wyoming Geological Survey on separate sample splits.

² 1, U. S. Geological Survey; 2, Wyoming Geological Survey.

³ "s" means semiquantitative analysis.

⁴ "N" means not detected, at limit of detection or at value shown.

⁵ L means less than.

TABLE 15: MEAN VALUES AND STANDARD DEVIATIONS¹ OF THE TRACE ELEMENTS IN THE LABORATORY

NUMBER AVER- AGED	L ² A B	ASH %	MEAN VALUES AND STANDARD DEVIATIONS OF TRACE ELEMENTS IN PARTS PER MILLION OF THE ASH											
			B	Ba	Be	Cd	Ce	Co	Cr	Cu	Ga	Ge	La	
HAMS PORK COAL REGION														
Adaville Formation														
14	1	6.4 (2.0)	1500s (300)	2000s (1000)	10.0s (7.0)	1.22L (0.34)	N --	15s (7)	70s (50)	39 (5)	30s (15)	N ⁴ --	N --	
19	2	5.2 (1.5)	-- --	-- --	23.9 (10.4)	1.30L (0.91)	-- --	35 (19)	70 (15)	56 (16)	-- --	-- --	-- --	
GREEN RIVER COAL REGION														
Fort Union Formation														
2	1	10.2 (3.3)	1500s (200)	7000s (1000)	1.0s (1.0)	1.05L (0.05)	N --	15s (2)	70s (0)	128 (32)	20s (5)	N --	70s (0)	
2	2	8.7 (2.4)	-- --	-- --	5.1 (0.4)	2.70 ⁶ --	-- --	20 (10)	82 (2)	175 (45)	-- --	-- --	-- --	
Rock Springs Formation														
1	1	5.8	2000s	2000s	15.0s	2.00	N	15s	70s	82	30s	N	N	
1	2	10.1	--	--	41.0	0.89	--	24	100	100	--	--	--	
HANNA COAL FIELD														
Hanna Formation														
5	1	8.2 (1.8)	500s (200)	2000s (1000)	1.5s (0.1)	1.60L (0.80)	N --	15s (7)	70s (7)	125 (49)	20s (7)	N --	N ⁷ --	
5	2	8.6 (2.5)	-- --	-- --	6.0 (1.8)	1.52 (1.00)	-- --	30 (11)	81 (19)	141 (72)	-- --	-- --	-- --	
Ferris Formation														
6	1	10.8 (3.9)	200s (200)	5000s (1500)	2.0s (0.3)	1.58L (1.09)	N --	10s (3)	50s (15)	56 (6)	20s (10)	N --	N --	
7	2	9.7 (3.1)	-- --	-- --	6.7 (1.8)	1.40 (0.86)	-- --	21 (10)	51 (18)	64 (13)	-- --	-- --	-- --	
POWDER RIVER COAL BASIN														
Fort Union Formation														
20	1	10.9 (5.3)	500s (150)	5000s (3000)	5.0s (3.0)	1.72L (0.85)	N ⁹ --	20s (10)	70s (15)	116 (43)	30s (10)	N --	50s (50)	
20	2	9.7 (4.8)	-- --	-- --	10.8 (6.2)	2.30L (2.17)	-- --	46 (24)	92 (24)	133 (47)	-- --	-- --	-- --	
GRAND MEAN AND STANDARD DEVIATION OF ALL ANALYSES BY LABORATORY														
48	1	9.2 (4.4)	700s (500)	5000s (2000)	7.0s (7.0)	1.52L (0.78)	N ⁹ --	20s (10)	70s (30)	87 (50)	30s (10)	N ⁴ --	N ¹³ --	
53	2	7.9 (4.0)	-- --	-- --	14.9 (11.0)	1.71L (1.57) ¹⁵	-- --	36 (21)	78 (24)	99 (56)	-- --	-- --	-- --	

¹ Standard deviation is shown in parentheses below each mean.

² 1, U. S. Geological Survey; 2, Wyoming Geological Survey.

³ L means less than.

⁴ One sample averaged 30 ppm.

⁵ Three samples averaged 1.5s (3) ppm; an "N" without a footnote means not detected, at limit of detection or at value shown.

⁶ Only one analysis represented.

⁷ Two samples exhibited 70 ppm.

ASH OF 54 COAL SAMPLES BY COAL-BEARING AREA AND GEOLOGIC FORMATION

NUMBER AVER- AGED	MEAN VALUES AND STANDARD DEVIATIONS OF TRACE ELEMENTS IN PARTS PER MILLION OF THE ASH														L A B
	Li	Mn	Mo	Nb	Nd	Ni	Pb	Sc	Sr	V	Y	Yb	Zn	Zr	
HAMS FORK COAL REGION - continued															
Adaville Formation															
14	38 (9)	850L (1100)	N ⁵ --	10s (7)	--	70s (20)	26L (2)	15s (5)	700s (500)	100s (30)	30s (15)	2s (2)	117 (63)	150s (50)	1
19	35 (18)	1270 (2150)	24L (7)	--	--	74L (40)	77 (80)	--	--	210 (70)	--	--	200 (290)	--	2
GREEN RIVER COAL REGION - continued															
Fort Union Formation															
2	110 (13)	280 (110)	20s (10)	20s (0)	N --	20s (5)	53 (13)	15s (5)	700s (200)	150s (20)	30s (0)	3s (0)	66 (16)	200s (50)	1
2	105 (5)	--	--	--	--	37 (2)	100 ⁶ --	--	--	360 ⁶ --	--	--	100 (46)	--	2
Rock Springs Formation															
1	206	150L	10s	20s	--	30s	70	30s	3000s	150s	70s	7s	84	300s	1
1	170	270	59	--	--	64	140	--	--	490	--	--	99	--	2
HANNA COAL FIELD															
Hanna Formation															
5	44 (14)	498L (222)	15s (5)	7s (7)	N --	50s (15)	32 (4)	15s (3)	1500s (700)	150s (50)	30s (7)	2s ¹⁷ (0.5)	137 (73)	100s (30)	1
5	43 (9)	936 (356)	74 (17)	--	--	62 (24)	73 (25)	--	--	460 (180)	--	--	170 (100)	--	2
Ferris Formation															
6	30 (13)	290L (256)	10s (7)	N ⁸ --	--	30s (15)	36 (7)	10s (1)	2000s (1000)	100s (50)	30s (10)	2s (0.5)	106 (60)	100s (30)	1
7	30 (6)	564 (352)	33L (10)	--	--	45 (20)	61 (22)	--	--	180 (100)	--	--	120 (70)	--	2
POWDER RIVER COAL BASIN - continued															
Fort Union Formation															
20	48 (15)	290L (210)	15sL (10)	15s (7)	N ¹⁰ --	70s (30)	32L (7)	20s (10)	1000s (700)	200s (50)	70s (30)	7s ¹¹ (5)	280 (230)	150s (20)	1
20	45 (14)	440 (350)	43L (22)	--	--	110 (60)	61 (25)	--	--	540 ¹² (100)	--	--	310 (220)	--	2
GRAND MEAN AND STANDARD DEVIATION OF ALL ANALYSES BY LABORATORY - continued															
48	48 (30)	470L (660)	10sL (10)	15s (7)	N ¹⁰ --	55s (28)	32L (10)	15s (10)	1000s (700)	150s (70)	50s (30)	5s ¹⁴ (3)	185 (180)	150s (50)	1
53	44 (26)	810 ¹⁵ (1400)	38L ¹⁵ (22)	--	--	81L (51)	70 ¹⁵ (54)	--	--	360 ¹⁶ (190)	--	--	230 (240)	--	2

⁸ Two samples average 5s (7) ppm.

⁹ Two samples exhibited 200 ppm.

¹⁰ Two samples averaged 150 ppm.

¹¹ Only 14 samples averaged.

¹² Only 18 samples averaged.

¹³ Eighteen samples averaged 100 (20) ppm.

¹⁴ Only 40 samples averaged.

¹⁵ Only 51 samples averaged.

¹⁶ Only 50 samples averaged.

¹⁷ Only 4 samples averaged.

TABLE 16: MEAN VALUES AND STANDARD DEVIATIONS¹ OF THE TRACE ELEMENTS IN 54 COAL SAMPLES ON A

NUMBER AVER- AGED	L ² A B	MEAN VALUES AND STANDARD DEVIATIONS OF TRACE ELEMENTS IN PARTS PER MILLION ON A WHOLE-COAL BASIS																
		As	B	Ba	Be	Cd	Ce	Co	Cr	Cu	F	Ga	Ge	Hg	La	Li	Mn	
HAMS FORK COAL REGION																		
Adaville Formation																		
14	1	1.0L ³ (0.3)	70s ⁴ (15)	150s (70)	0.7s (0.5)	0.100L (0.010)	N	1.0s (0.5)	3.0s (2.0)	2.4 (0.5)	55 (19)	2.0s (1.0)	N ⁵	0.05 (0.03)	N	2.3 (0.6)	68L (120)	
19	2	--	--	--	1.2 (0.7)	0.060 (0.040)	--	1.7 (0.7)	3.6 (1.4)	2.8 (0.8)	--	--	--	0.08 (0.04)	--	1.8 (0.7)	80 (170)	
GREEN RIVER COAL REGION																		
Fort Union Formation																		
2	1	3.0L (2.0)	150s (20)	300s (200)	0.15s (0.1)	0.100L (0)	N	1.5s (0.5)	7.0s (2.0)	14.1 (7.5)	25L (5)	3.0s (1.5)	N	0.24 (0.13)	7s (2)	11.6 (4.9)	25 (2)	
2	2	--	--	--	0.45 (0.15)	0.310 ⁸ --	--	1.5 (0.4)	7.2 (2.2)	16.7 (8.3)	--	--	--	0.51 ⁸ --	--	9.6 (3.3)	--	
Rock Springs Formation																		
1	1	2.0	100s	100s	1.0s	0.100	N	1.0s	5.0s	4.8	100	1.0s	N	0.08	N	12.0	9L	
1	2	--	--	--	4.2	0.090	--	2.5	11.0	11.0	--	--	--	0.12	--	18.0	28	
HANNA COAL FIELD																		
Hanna Formation																		
5	1	4.0 (1.0)	30s (20)	200s (50)	0.1s (0.1)	0.160L (0.089)	N	1.0s (0.5)	5.0s (1.5)	10.2 (4.6)	44 (19)	1.5s (0.2)	N	0.09 (0.02)	N ⁹	3.6 (1.2)	42L (21)	
5	2	--	--	--	0.5 (0.2)	0.136 (0.084)	--	2.5 (0.8)	6.9 (2.3)	11.6 (5.5)	--	--	--	0.14 (0.06)	--	3.5 (0.8)	80 (37)	
Ferris Formation																		
6	1	4.0 (2.0)	20s (20)	300s (100)	0.2s (0.07)	0.150L (0.100)	N	1.0s (0.5)	7.0s (3.0)	5.9 (2.1)	77L (38)	2.0s (1.5)	N	0.05 (0.01)	N	3.5 (1.9)	29L (23)	
7	2	--	--	--	0.6L (0.2)	0.130 ¹³ (0.070)	--	2.4 (1.4)	5.6 (2.9)	6.4 (1.7)	--	--	--	0.10 (0.05)	--	2.9 ¹³ (0.7)	46 (36)	
POWDER RIVER COAL BASIN																		
Fort Union Formation																		
20	1	3.5 (2.0)	50s (20)	500s (200)	0.5s (0.5)	0.190L (0.120)	N ¹⁴	3.0s (1.5)	10.0s (7.0)	11.4 (4.2)	89 (52)	5.0s (3.0)	N	0.15 (0.06)	5s (5)	5.7 (4.4)	33L (32)	
20	2	--	--	--	1.1 (0.8)	0.210L (0.170)	--	4.6 (3.8)	10.1 (7.8)	12.0 (3.7)	--	--	--	0.17 (0.11)	--	4.8 (3.9)	45 (47)	
GRAND MEAN AND STANDARD DEVIATION OF ALL ANALYSES BY LABORATORY																		
48	1	3.0L (2.0)	70s (30)	300s (200)	0.5s (0.4)	0.151L (0.099)	N ¹⁴	2.0s (1.5)	7.0s (5.0)	8.0 (5.4)	70L (43)	3.0s (2.0)	N ⁵	0.10 (0.08)	N ¹⁸	4.6 (3.9)	43L (72)	
54	2	--	--	--	1.1L (0.8)	0.140L ²⁰ (0.130)	--	3.0 (2.7)	6.8 (5.8)	8.1 (5.6)	--	--	--	0.13 (0.10)	--	3.8 ²¹ (3.7)	61 ²⁰ (112)	

¹ Standard deviation is shown in parentheses below each mean.

² 1, U. S. Geological Survey; 2, Wyoming Geological Survey.

³ L means less than.

⁴ "s" means semiquantitative analysis.

⁵ One sample exhibited 2s ppm; an "N" without a footnote means not detected, at limit of detection or at value shown.

⁶ Three samples averaged 0.7s (0.3) ppm.

⁷ Only 10 samples averaged.

⁸ Only one analysis represented.

⁹ Two samples averaged 3s (1) ppm.

¹⁰ Only 4 samples averaged.

¹¹ Two samples averaged 2s (1) ppm.

¹² Only 5 samples averaged.

¹³ Only 6 samples averaged.

¹⁴ Two samples at 20s ppm.

¹⁵ Two samples averaged 15s (2) ppm.

¹⁶ Only 14 samples averaged.

WHOLE-COAL BASIS BY COAL-BEARING AREA AND GEOLOGIC FORMATION

NUMBER AVER- AGED	L A B	MEAN VALUES AND STANDARD DEVIATIONS OF TRACE ELEMENTS IN PARTS PER MILLION ON A WHOLE-COAL BASIS															
		Mo	Nb	Nd	Ni	Pb	Sb	Sc	Se	Sr	Th	U	V	Y	Yb	Zn	Zr
HAMS FORK COAL REGION - continued																	
Adaville Formation																	
14	1	N ⁶ --	0.7 _s (0.7)	--	3.0 _s (1.5)	1.6L (0.5)	0.2L (0.1)	1.0 _s (0.5)	0.4L (0.2)	50 _s (30)	2.0L (0.2)	0.4L (0.2)	5 _s (3)	2.0 _s (1.5)	0.15 _s ⁷ (0.07)	6.8 (2.8)	10 _s (5)
19	2	1.3L (0.6)	--	--	3.7L (1.7)	4.0 (3.9)	--	--	--	--	--	--	11 (5)	--	--	9.3 (11.7)	--
GREEN RIVER COAL REGION - continued																	
Fort Union Formation																	
2	1	3.0 _s (2.0)	2.0 _s (0.5)	N	2.0 _s (0.5)	4.9 (0.4)	0.7 (0.2)	2.0 _s (1.0)	1.2 (0.9)	70 _s (0)	3.1L (1.1)	1.0 (0.5)	15 _s (7)	3.0 _s (1.5)	0.30 _s (0.15)	7.3 (3.8)	30 _s (15)
2	2	--	--	--	3.3 (1.1)	6.4 ⁸ --	--	--	--	--	--	--	--	--	--	10.3 (9.5)	--
Rock Springs Formation																	
1	1	0.7 _s	0.5 _s	--	2.0 _s	4.1	1.1	1.5 _s	1.2	150 _s	2.0L	1.5	10 _s	5.0 _s	0.50 _s	4.9	15 _s
1	2	6.0	--	--	6.5	15.0	--	--	--	--	--	--	50	--	--	10.0	--
HANNA COAL FIELD - continued																	
Hanna Formation																	
5	1	1.0 _s (0.5)	0.5 _s (0.5)	N	3.0 _s (1.5)	2.6 (0.7)	0.5 (0.2)	1.0 _s (0.2)	0.6 (0.2)	150 _s (100)	2.0L (0.5)	1.5 (0.5)	10 _s (3)	2.0 _s (0.5)	0.2 _s ¹⁰ (0.05)	11.4 (7.0)	10 _s (3)
5	2	6.2 (0.6)	--	--	5.0 (1.7)	6.6 ¹⁰ (3.1)	--	--	--	--	--	--	38 (14)	--	--	14.3 (9.1)	--
Ferris Formation																	
6	1	1.5 _s (1.0)	N ¹¹ --	--	3.0 _s (2.0)	4.0 (2.1)	0.4 (0.1)	1.0 _s (0.5)	0.2L (0.07)	150 _s (100)	2.8L (0.9)	1.2 (0.5)	10 _s (10)	3.0 _s (1.5)	0.3 _s ¹² (0.15)	12.2 (7.0)	10 _s (5)
7	2	3.0L (0.8)	--	--	3.9L (2.0)	6.6 ¹³ (3.0)	--	--	--	--	--	--	17 (9)	--	--	11.9 (7.1)	--
POWDER RIVER COAL BASIN - continued																	
Fort Union Formation																	
20	1	1.5 _s L (1.0)	2.0 _s (1.5)	N ¹⁵ --	7.0 _s (5.0)	3.6L (2.4)	0.4 (0.2)	3.0 _s (1.5)	1.2L (1.3)	70 _s (50)	3.3L (1.3)	1.1L (0.7)	20 _s (15)	7.0 _s (5.0)	0.7 _s ¹⁶ (0.7)	30.7 (27.5)	20 _s (10)
20	2	4.2 (2.5)	--	--	10.7 (8.2)	6.3 (4.8)	--	--	--	--	--	--	52 ¹⁷ (33)	--	--	30.0 (25.3)	--
GRAND MEAN AND STANDARD DEVIATION OF ALL ANALYSES BY LABORATORY																	
48	1	1.0 _s (1.0)	1.5 _s (1.0)	N ¹⁵ --	5.0 _s (5.0)	3.0L (2.0)	0.4L (0.2)	1.5 _s (1.0)	0.8L (1.0)	100 _s (70)	2.7L (1.1)	0.9L (0.6)	15 _s (10)	5.0 _s (5.0)	0.5 _s ¹⁹ (0.5)	17.9 (21.2)	15 _s (10)
54	2	3.2 ²⁰ (2.4)	--	--	6.5L (6.1)	5.7 ²² (4.4)	--	--	--	--	--	--	30 ²² (28)	--	--	17.8 (19.8)	--

¹⁷ Only 18 samples averaged.

¹⁸ Sixteen samples averaged 7s (3) ppm.

¹⁹ Only 36 samples averaged.

²⁰ Only 52 samples averaged.

²¹ Only 53 samples averaged.

²² Only 51 samples averaged.

Note: These statistical summaries are not to be construed as absolutely characterizing any coal-bearing area or formation, but are presented as an aid to comparing these analyses.

TABLE 17: COMPARISON OF MEAN VALUES AND STANDARD DEVIATIONS OF 13 TRACE ELEMENTS (IN PPM¹ ON A WHOLE-COAL BASIS) IN 48 SAMPLES ANALYZED BY BOTH THE WYOMING GEOLOGICAL SURVEY AND THE U. S. GEOLOGICAL SURVEY

	<i>Wyoming Geological Survey</i>		<i>U. S. Geological Survey</i>	
	MEAN	STANDARD DEVIATION	MEAN	STANDARD DEVIATION
Be	1.0L ³	(0.8)	0.5s ⁴	(0.5)
Cd ⁵	0.144L	(0.139)	0.151L	(0.100)
Co	3.1	(2.9)	2.0s	(1.5)
Cr	7.3	(6.0)	7.0s	(5.0)
Cu	8.7	(5.6)	8.0	(5.4)
Hg ⁶	0.14	(0.11)	0.10	(0.08)
Li ⁶	4.1	(3.8)	4.6	(3.9)
Mn ⁵	65.0	(119.0)	44.0L	(74.0)
Mo ⁵	3.4L	(2.4)	1.0s	(1.0)
Ni	6.7L	(6.4)	5.0s	(3.0)
Pb ⁷	5.5	(4.3)	2.9L	(2.1)
V ⁷	33.0	(28.0)	15.0s	(10.0)
Zn	17.7	(20.1)	17.9	(21.2)

¹"PPM" means parts per million.

²The two laboratories analyzed different splits of the same sample.

³L means less than.

⁴"s" means semiquantitative analysis.

⁵Only 46 samples averaged.

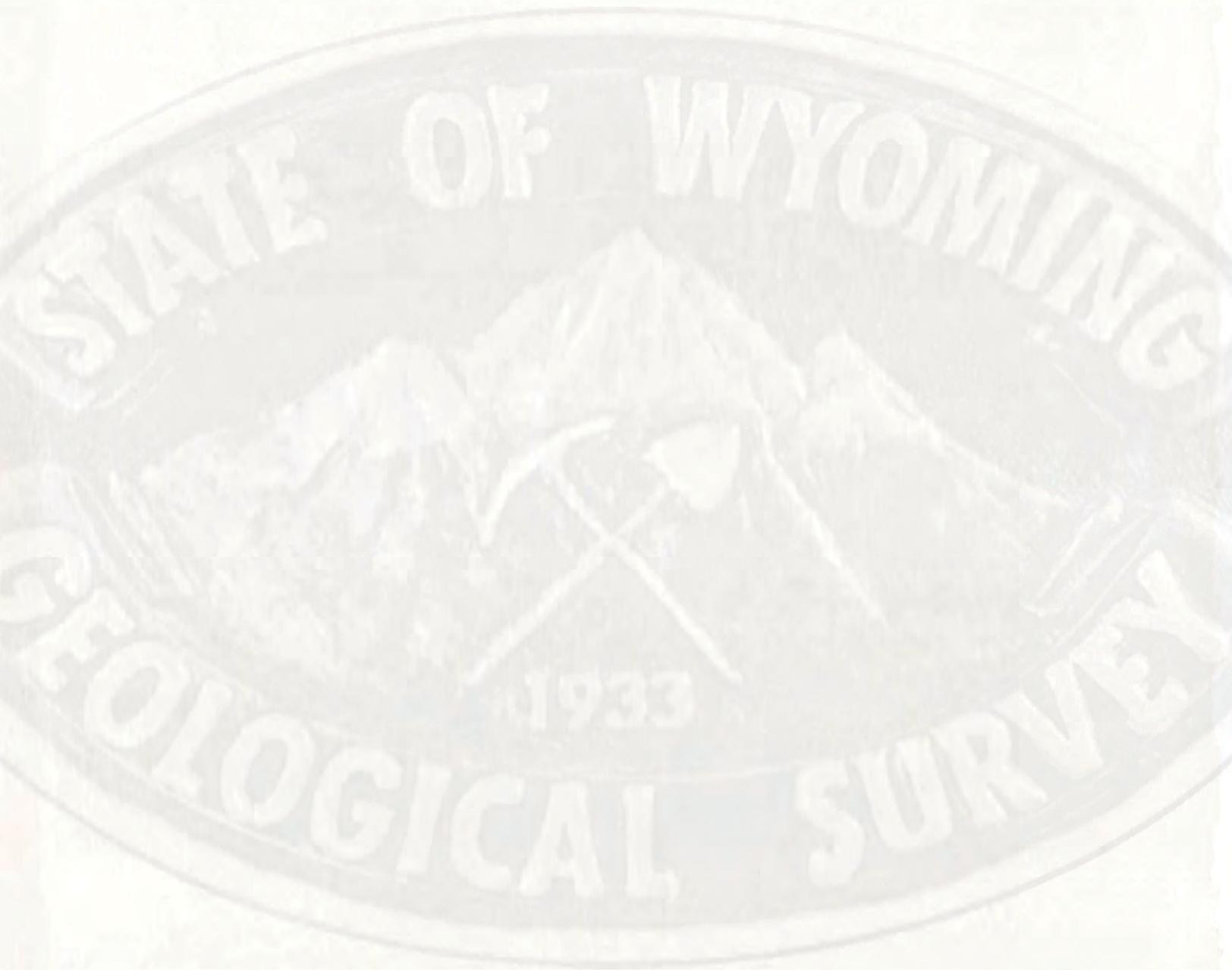
⁶Only 47 samples averaged.

⁷Only 45 samples averaged.

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Notes



APPENDIX A: MEASURED SECTIONS OF 54 COAL SAMPLES COLLECTED IN 1974
FROM 30 DIFFERENT SAMPLE SITES

The measured sections in this appendix are arranged in the same order as the various tables of analyses: by coal-bearing area, sample number, and geologic formation. Each section is described in a tabulated form with illustrations. Company analyses of many coals are also provided for comparison with results in this report.

HAMS FORK COAL REGION

Nineteen samples of coal were collected from the Upper Cretaceous Adaville Formation in the Hams Fork Coal Region (Coal Samples Nos. 74-1 to 74-19). All these samples came from either the Kemmerer Coal Company's Elkol or Sorensen strip mines near Kemmerer, Wyoming (Figure 7). The Elkol mine is the extreme eastern portion of the mined area from which only the Adaville No. 1 coal is mined. The Sorensen mine is applied to the rest of the mine area from which the Adaville No. 2 through the Adaville No. 11 coals are mined.

A generalized section of the sampled coal-bearing rocks is included on Figure 7. Both the coal seam names and the sample numbers are shown. Figure 8 is a more detailed map of the sample sites in the Kemmerer Coal Field of the Hams Fork Coal Region.

SAMPLED COAL-BEARING ROCKS

ADAVILLE FORMATION

COAL SEAM
DESIGNATION

ADAVILLE #11 ← 74-1

ADAVILLE #10
(UPPER BENCH) ← 74-2

ADAVILLE #10
(LOWER BENCH) ← 74-3

ADAVILLE #9

ADAVILLE #8

ADAVILLE #7

ADAVILLE #6
(UPPER BENCH) ← 74-4

ADAVILLE #6
(LOWER BENCH) ← 74-5

ADAVILLE #5 ← 74-6

ADAVILLE #4 RIDER ← 74-7

ADAVILLE #4
(UPPER BENCH) ← 74-8, 11

ADAVILLE #4
(LOWER BENCH) ← 74-9, 12

ADAVILLE #3
UPPER RIDER

ADAVILLE #3
MIDDLE RIDER ← 74-13

ADAVILLE #3
LOWER RIDER ← 74-14

ADAVILLE #3 ← 74-15

ADAVILLE #2
UPPER RIDER ← 74-16

ADAVILLE #2
MIDDLE RIDER

ADAVILLE #2
LOWER RIDER ← 74-17

ADAVILLE #2 ← 74-18

ADAVILLE #1 ← 74-19

0 12 24 miles
HORIZONTAL SCALE



EXPLANATION

-  Bituminous
-  Subbituminous

x⁷⁴⁻¹ Sample number

← Sampled coal

VERTICAL SCALE

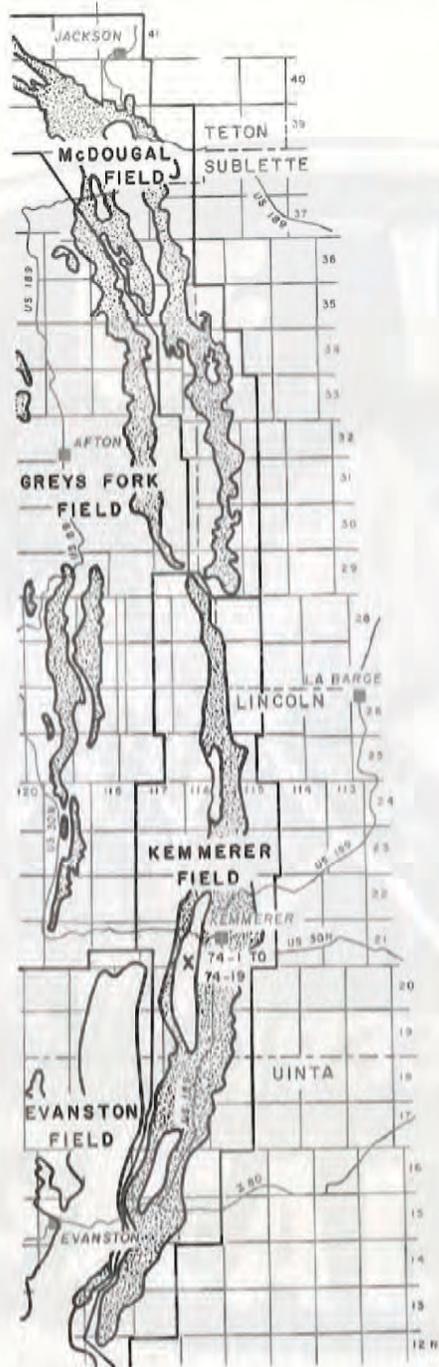
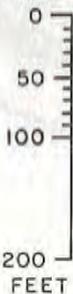


FIGURE 7: GENERALIZED SECTION AND INDEX MAP OF 19 SAMPLES (NOS. 74-1 TO 74-19) COLLECTED IN THE HAMS FORK COAL REGION IN 1974

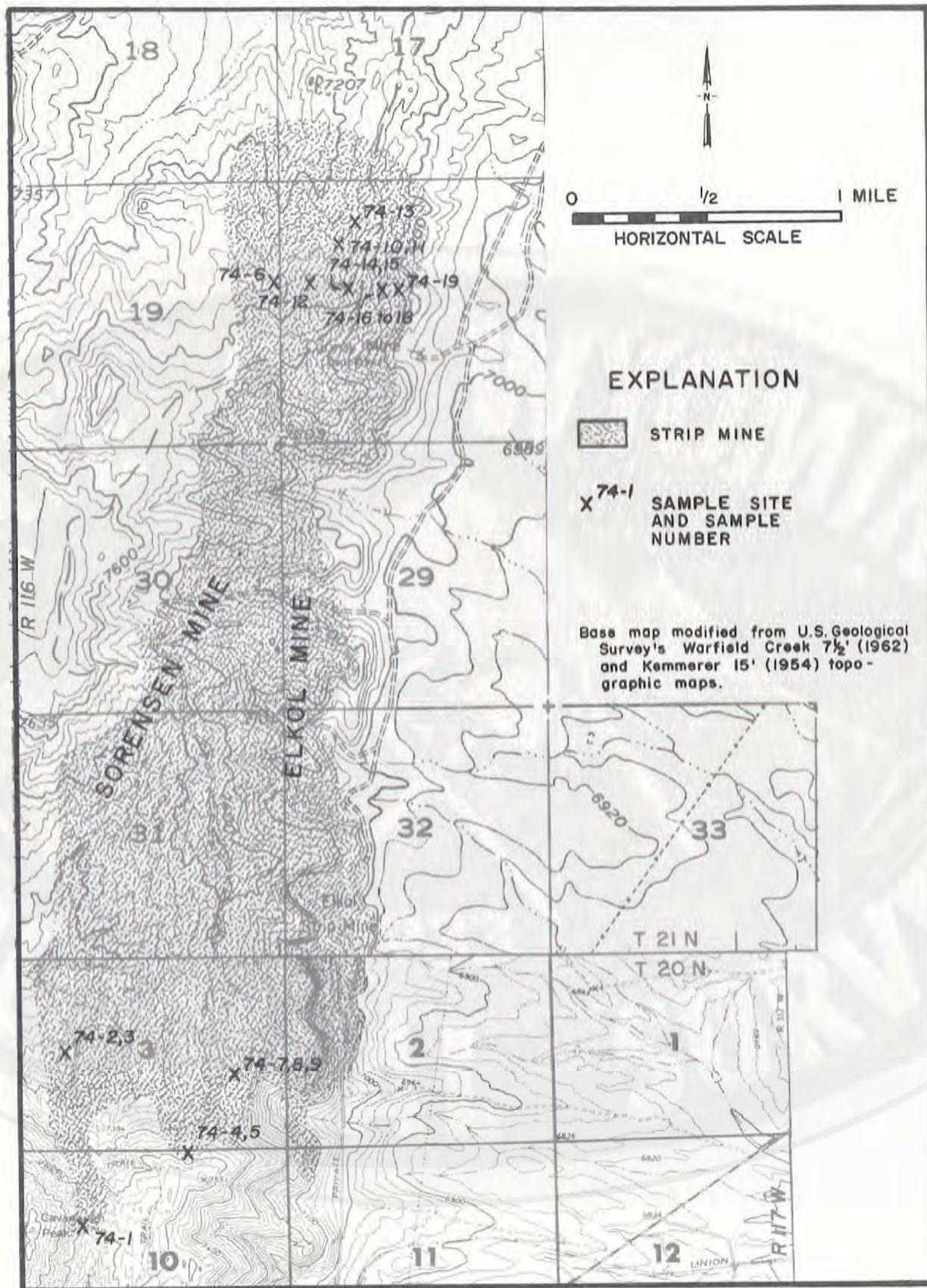


FIGURE 8: DETAILED LOCATION MAP OF COAL SAMPLES 74-1 THROUGH 74-19 COLLECTED IN 1974 FROM KEMMERER COAL COMPANY'S SORENSEN AND ELKOL STRIP MINES, LINCOLN COUNTY, WYOMING

SAMPLE NO. 74-1: ADAVILLE NO. 11 COAL

INDEX MAPS: Figures 7 and 8

SAMPLE NO.: 74-1

COAL NAMES(S): Adaville No. 11

GEOLOGIC FORMATION: Adaville

AGE: Upper Cretaceous

COAL FIELD: Kemmerer

COAL-BEARING AREA: Hams Fork Region

MEASURED SECTION: See Figure 9

TOTAL SECTION MEASURED (FEET): 141.1

COVER AT SAMPLING POINT (FEET): 30

ELEVATION TOP OF SAMPLED COAL: 7500+

STRIKE: 10-35°

DIP: 17°W

MAJOR JOINT ORIENTATIONS IN COAL:

60-66°, 342-345°, 320-324°

STATE: Wyoming

COUNTY: Lincoln

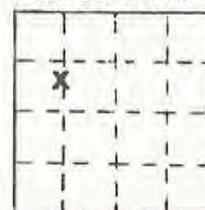
SECTION: 10

TOWNSHIP: T20N

RANGE: R117W

QUADRANGLE: Warfield Creek 7 1/2'

LOCATION
IN SECTION



COAL DESCRIPTION: See Figure 10

THICKNESS OF COAL (FEET): 13

THICKNESS SAMPLED (FEET): 13

TYPE OF SAMPLE: Face-channel

CONDITION OF SAMPLE: Weathered

TYPE OF EXPOSURE: Strip mine

MINE NAME: Sorensen

DATE OF SAMPLING: 8/14/74

SAMPLE COLLECTOR: Wyoming Geological Survey

COMPLETION DATE OF ANALYSES

U. S. Bureau of Mines: 8/30/74

Wyoming Geological Survey: 3/18/75

U. S. Geological Survey:

LABORATORY NUMBERS

K-46567

WGS-1

None

APPARENT RANK OF COAL: Subbituminous C

MISCELLANEOUS COMMENTS: Based on many company analyses, Kemmerer Coal Company reports that the Adaville #11 coal averages 1320 Btu/pound higher than Sample No. 74-1 on a dry basis. They also report the coal has an average as-received sulfur content of 0.34% not the 1.1% exhibited by Sample No. 74-1. Sample No. 74-1 is probably atypical in these two regards because it was very weathered where it was sampled. Although other weathered samples in the Sorensen mine also show higher than normal sulfur contents, this is the only sample in which the heat value was materially low as well. A quick comparison of the oxygen content of the sampled Adaville coals shows this sample is almost 5% higher than any other -- a further indication of its weathered condition.

AVERAGE ANALYSIS OF ADAVILLE NO. 11 COAL PROVIDED BY
KEMMERER COAL COMPANY (DRILL CUTTINGS)

	<u>As Received</u>	<u>Dry Basis</u>
Moisture	25.01%	--
Ash	2.79%	--
Heat Value	--	12,280 Btu/lb.
Sulfur	0.34%	--

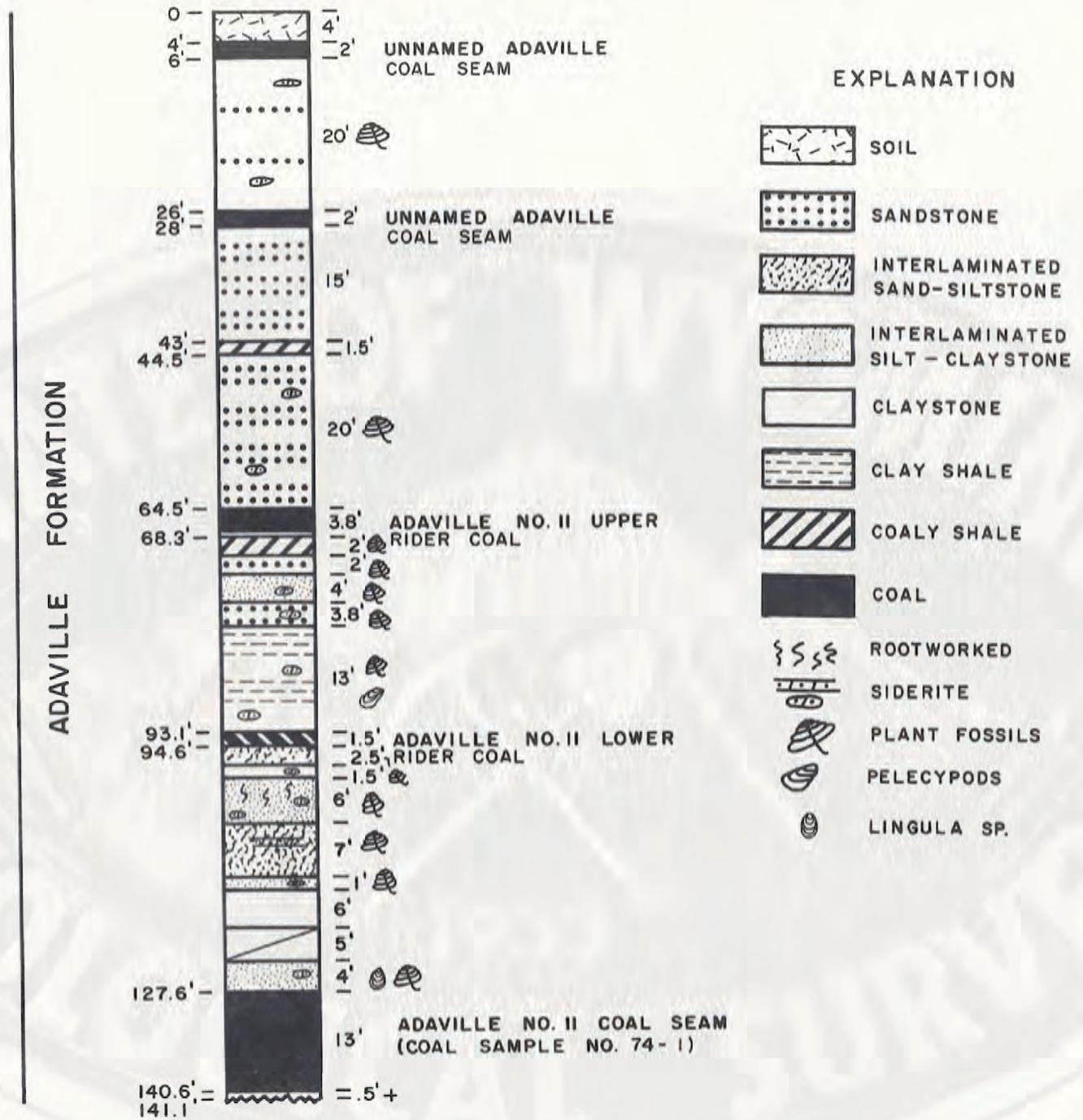


FIGURE 9: MEASURED SECTION AT THE ADAVILLE NO. 11 SAMPLE SITE IN THE SORENSEN MINE (COAL SAMPLE NO. 74-1)

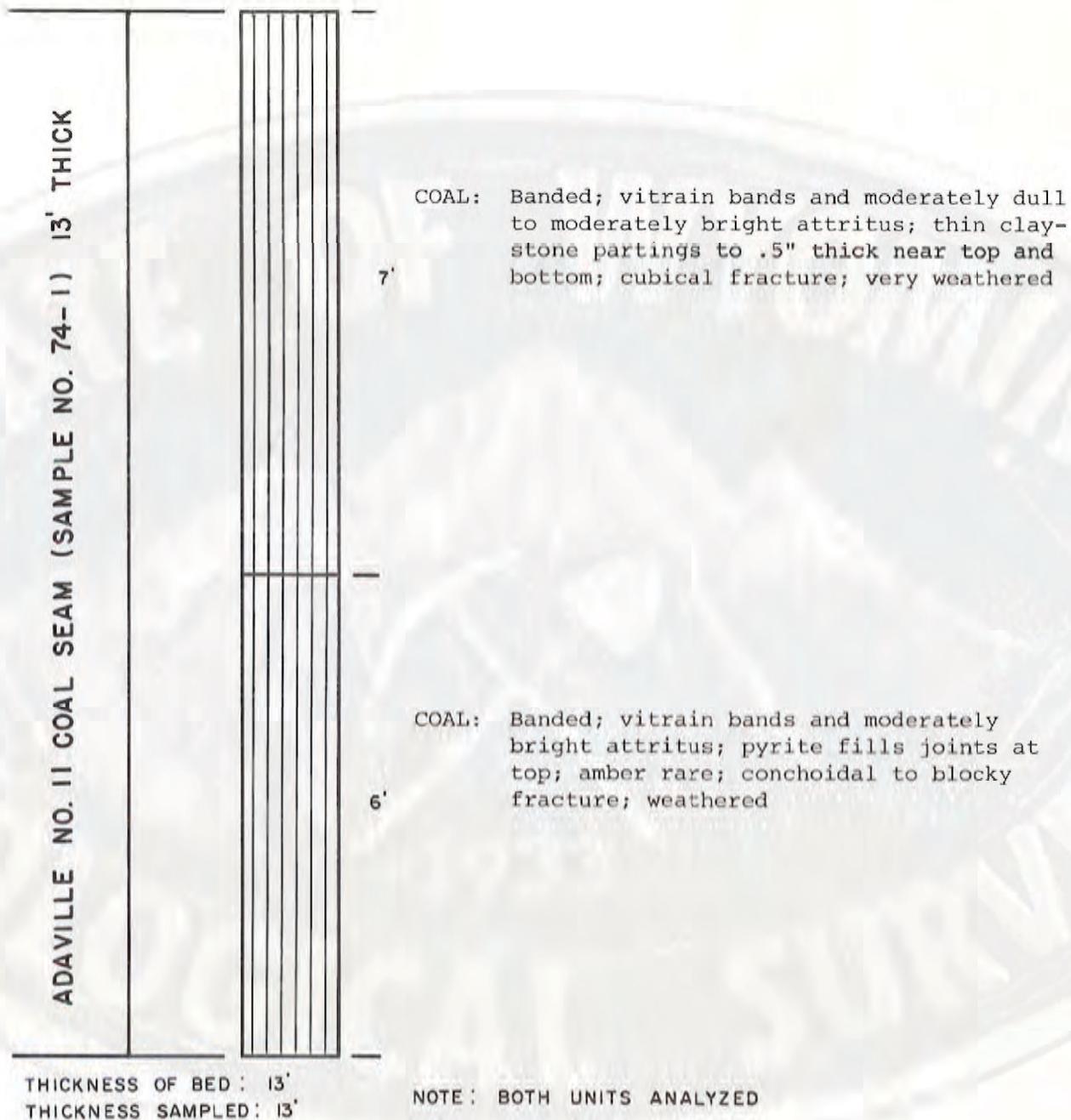


FIGURE 10: MEGASCOPIC DESCRIPTION OF THE ADAVILLE NO. 11 COAL IN THE SORENSEN MINE (COAL SAMPLE NO. 74-1)

SAMPLE NO. 74-2: ADAVILLE NO. 10 COAL (UPPER BENCH)

INDEX MAPS: See Figures 7 and 8

SAMPLE NO.: 74-2

COAL NAME(S): Adaville No. 10
(Upper Bench)

GEOLOGIC FORMATION: Adaville

AGE: Upper Cretaceous

COAL FIELD: Kemmerer

COAL-BEARING AREA: Hams Fork Region

MEASURED SECTION: See Figure 11

TOTAL SECTION MEASURED (FEET): 68.9

COVER AT SAMPLING POINT (FEET): 15

ELEVATION TOP OF SAMPLED COAL: 7200+

STRIKE: 4°

DIP: 17°W

MAJOR JOINT ORIENTATIONS IN COAL:

76-78°, 57-66°, 335-350°

STATE: Wyoming

COUNTY: Lincoln

SECTION: 3

TOWNSHIP: T20N

RANGE: R117W

QUADRANGLE: Warfield Creek 7 1/2'

LOCATION
IN SECTION



COAL DESCRIPTION: See Figure 12

THICKNESS OF COAL (FEET): 4.8

THICKNESS SAMPLED (FEET): 4.8

TYPE OF SAMPLE: Face-channel

CONDITION OF SAMPLE: Weathered

TYPE OF EXPOSURE: Strip mine

MINE NAME: Sorensen

DATE OF SAMPLING: 8/12/74

SAMPLE COLLECTOR: Wyoming Geological Survey

COMPLETION DATE OF ANALYSES

U. S. Bureau of Mines: 8/30/74

Wyoming Geological Survey: 3/18/75

U. S. Geological Survey: 6/13/75

LABORATORY NUMBERS

K-46569

WGS-2

D171859

APPARENT RANK OF COAL: Subbituminous B

MISCELLANEOUS COMMENTS: Based on company analyses provided by the Kemmerer Coal Company, the Adaville No. 10 (upper bench) averages 0.3% sulfur (as received) not 0.9%. Again the sample was weathered where it was sampled.

AVERAGE ANALYSIS OF THE UPPER BENCH OF THE ADAVILLE NO. 10 COAL
PROVIDED BY KEMMERER COAL COMPANY

	<u>As Received</u>	<u>Dry Basis</u>
Moisture	23.11%	--
Ash	5.11%	--
Heat Value	--	10,948 Btu/lb.
Sulfur	0.30%	--

SAMPLE NO. 74-3: ADAVILLE NO. 10 COAL (LOWER BENCH)

INDEX MAPS: See Figures 7 and 8

SAMPLE NO.: 74-3

COAL NAMES(S): Adaville No. 10
(Lower Bench)

GEOLOGIC FORMATION: Adaville

AGE: Upper Cretaceous

COAL FIELD: Kemmerer

COAL-BEARING AREA: Hams Fork Region

MEASURED SECTION: See Figure 11

TOTAL SECTION MEASURED (FEET): 68.9

COVER AT SAMPLING POINT (FEET): 40

ELEVATION TOP OF SAMPLED COAL: 7175+

STRIKE: 4°

DIP: 17°W

MAJOR JOINT ORIENTATIONS IN COAL:

See Sample No. 74-2

STATE: Wyoming

COUNTY: Lincoln

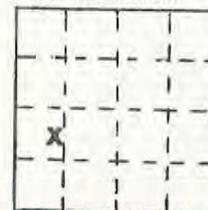
SECTION: 3

TOWNSHIP: T20N

RANGE: R117W

QUADRANGLE: Warfield Creek 7 1/2'

LOCATION
IN SECTION



COAL DESCRIPTION: See Figure 13

THICKNESS OF COAL (FEET): 7.95+

THICKNESS SAMPLED (FEET): 7.05

TYPE OF SAMPLE: Face-channel

CONDITION OF SAMPLE: Weathered

TYPE OF EXPOSURE: Strip mine

MINE NAME: Sorensen

DATE OF SAMPLING: 8/12/74

SAMPLE COLLECTOR: Wyoming Geological Survey

COMPLETION DATE OF ANALYSES

U. S. Bureau of Mines: 8/30/74

Wyoming Geological Survey: 3/18/75

U. S. Geological Survey: 6/13/74

LABORATORY NUMBERS

K-46570

WGS-3

D171860

APPARENT RANK OF COAL: Subbituminous B

MISCELLANEOUS COMMENTS: Based on company analyses provided by the Kemmerer Coal Company, the Adaville No. 10 (lower bench) averages 0.27% sulfur not the 1.8% exhibited by Sample No. 74-3. Again the sample was collected under relatively shallow cover and showed evidence of weathering.

AVERAGE ANALYSIS OF THE LOWER BENCH OF THE ADAVILLE NO. 10 COAL
PROVIDED BY KEMMERER COAL COMPANY

	<u>As Received</u>	<u>Dry Basis</u>
Moisture	23.93%	--
Ash	4.79%	--
Heat Value	--	12,318 Btu/lb.
Sulfur	0.27%	--

ADAVILLE FORMATION

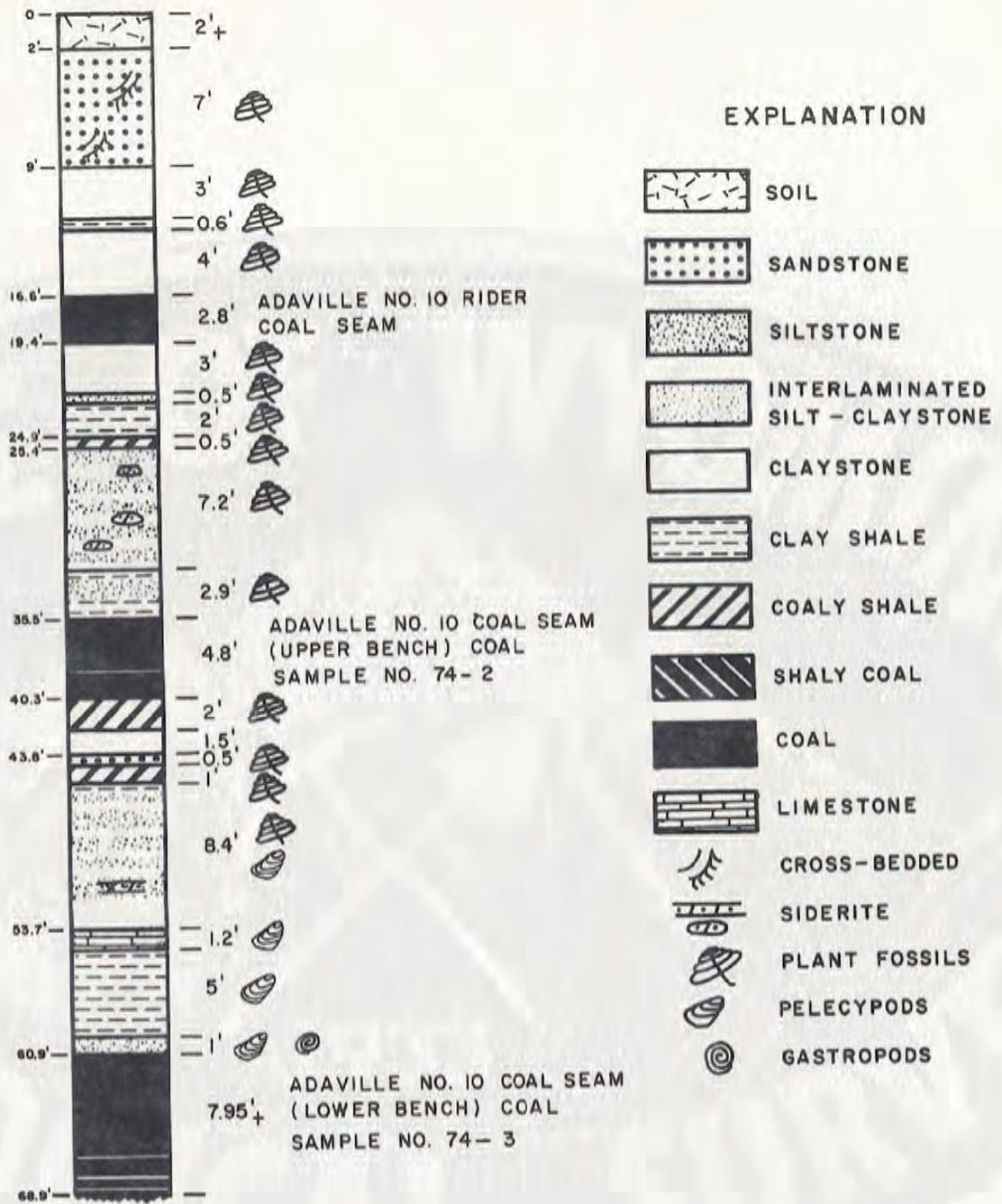


FIGURE 11: MEASURED SECTION AT THE ADAVILLE NO. 10 SAMPLE SITE IN THE SORENSEN MINE (COAL SAMPLE NOS. 74-2 AND 74-3)

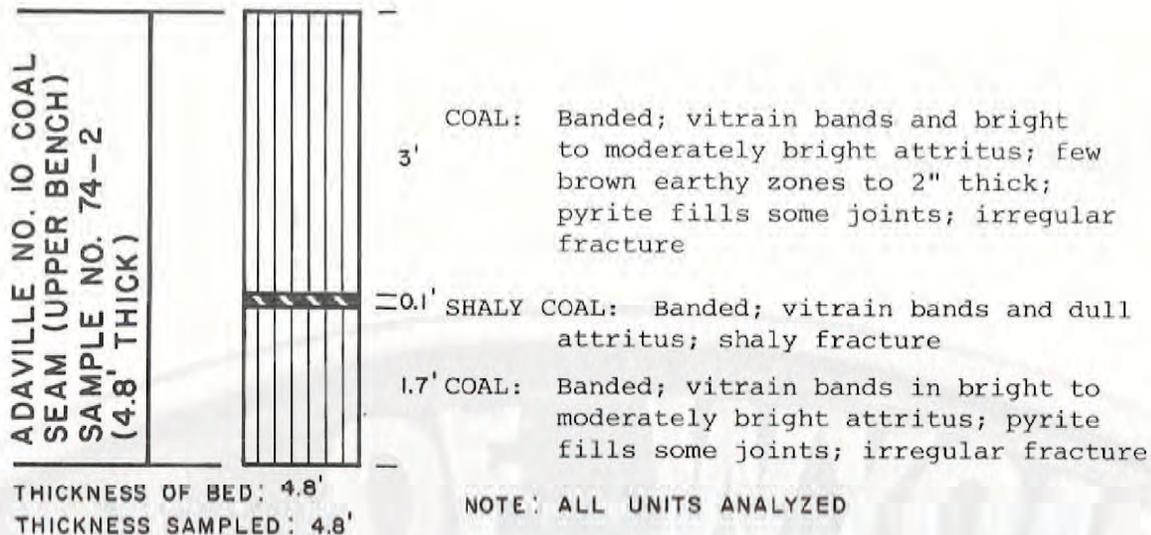


FIGURE 12: MEGASCOPIIC DESCRIPTION OF THE UPPER BENCH OF THE ADAVILLE NO. 10 COAL IN THE SORENSEN MINE (COAL SAMPLE NO. 74-2)

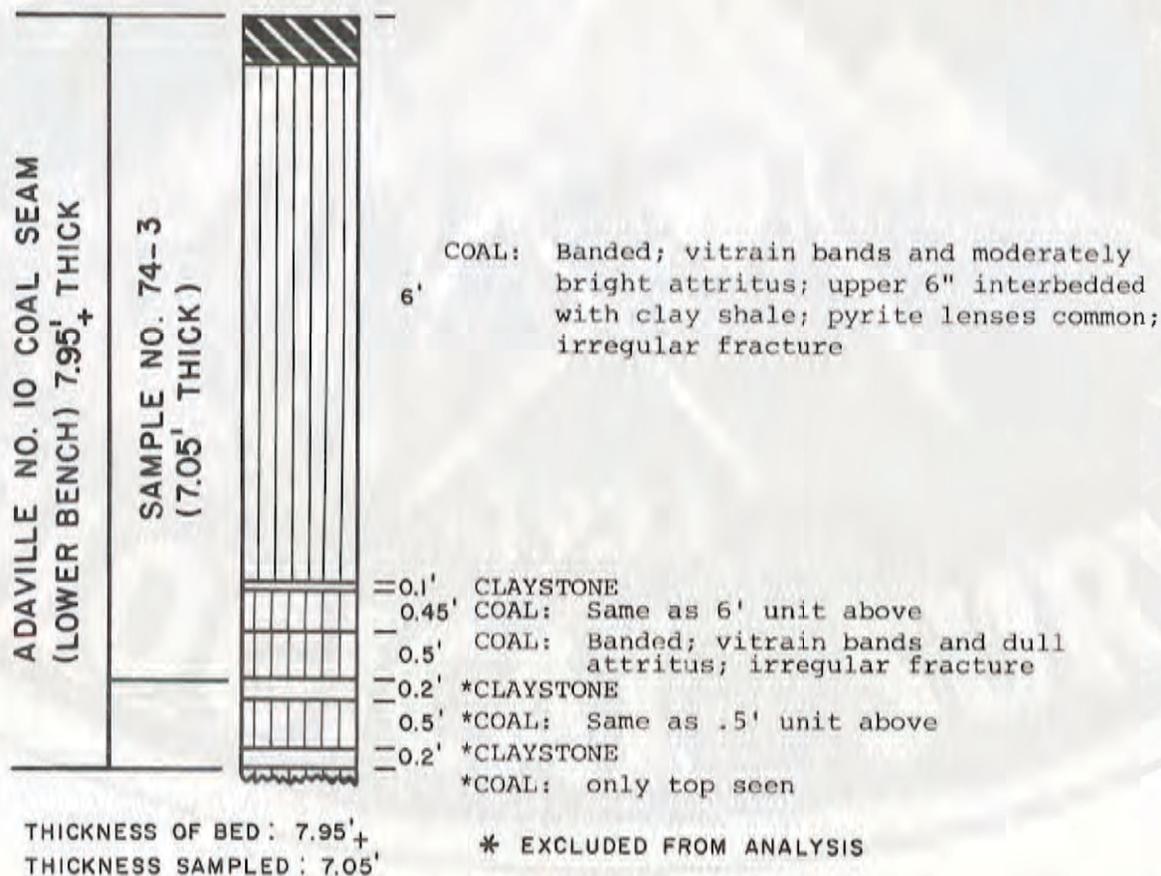


FIGURE 13: MEGASCOPIIC DESCRIPTION OF THE LOWER BENCH OF THE ADAVILLE NO. 10 COAL IN THE SORENSEN MINE (COAL SAMPLE NO. 74-3)

SAMPLE NO. 74-4: ADAVILLE NO. 6 COAL (UPPER BENCH)

INDEX MAPS: *See Figures 7 and 8*

SAMPLE NO.: 74-4

COAL NAME(S): *Adaville No. 6
(Upper Bench)*

GEOLOGIC FORMATION: *Adaville*

AGE: *Upper Cretaceous*

COAL FIELD: *Kemmerer*

COAL-BEARING AREA: *Hams Fork Region*

MEASURED SECTION: *See Figure 14*

TOTAL SECTION MEASURED (FEET): 144.7

COVER AT SAMPLING POINT (FEET): 35-40

ELEVATION TOP OF SAMPLED COAL: 7435

STRIKE: 10°

DIP: 17-20°W

MAJOR JOINT ORIENTATIONS IN COAL:

65°, 11°

STATE: *Wyoming*

COUNTY: *Lincoln*

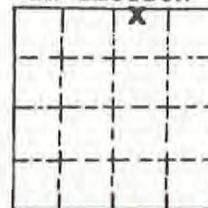
SECTION: 10

TOWNSHIP: *T20N*

RANGE: *R117W*

QUADRANGLE: *Warfield Creek 7 1/2'*

LOCATION
IN SECTION



COAL DESCRIPTION: *See Figure 15*

THICKNESS OF COAL (FEET): 8.8

THICKNESS SAMPLED (FEET): 8.8

TYPE OF SAMPLE: *Face-channel*

CONDITION OF SAMPLE: *Weathered*

TYPE OF EXPOSURE: *Strip mine*

MINE NAME: *Sorensen*

DATE OF SAMPLING: 8/14/74

SAMPLE COLLECTOR: *Wyoming Geological Survey*

COMPLETION DATE OF ANALYSES

U. S. Bureau of Mines: 8/30/74

Wyoming Geological Survey: 3/18/75

U. S. Geological Survey: 6/13/75

LABORATORY NUMBERS

K-46568

WGS-4

D171861

APPARENT RANK OF COAL: *Subbituminous C*

MISCELLANEOUS COMMENTS: *Although this coal was weathered as much as samples 74-1, 2, and 3, its moisture, ash, sulfur, and heat values were nearly identical to those provided by the Kemmerer Coal Company.*

AVERAGE ANALYSIS OF THE UPPER BENCH OF THE ADAVILLE NO. 6 COAL
PROVIDED BY KEMMERER COAL COMPANY

	<u>As Received</u>	<u>Dry Basis</u>
Moisture	23.47%	--
Ash	7.77%	--
Heat Value	--	11,709 Btu/lb.
Sulfur	0.56%	--

SAMPLE NO. 74-5: ADAVILLE NO. 6 (LOWER BENCH)

INDEX MAPS: See Figures 7 and 8

SAMPLE NO.: 74-5

COAL NAMES(S): Adaville No. 6
(Lower Bench)

GEOLOGIC FORMATION: Adaville

AGE: Upper Cretaceous

COAL FIELD: Kemmerer

COAL-BEARING AREA: Hams Fork Region

MEASURED SECTION: See Figure 14

TOTAL SECTION MEASURED (FEET): 144.7

COVER AT SAMPLING POINT (FEET): 136.2

ELEVATION TOP OF SAMPLED COAL: 7335

STRIKE: 10°

DIP: 17-20°W

MAJOR JOINT ORIENTATIONS IN COAL:

See Sample No. 74-4

STATE: Wyoming

COUNTY: Lincoln

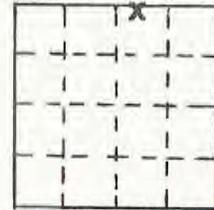
SECTION: 10

TOWNSHIP: T20N

RANGE: R117W

QUADRANGLE: Warfield Creek 7 1/2'

LOCATION
IN SECTION



COAL DESCRIPTION: See Figure 16

THICKNESS OF COAL (FEET): 8.0

THICKNESS SAMPLED (FEET): 8.0

TYPE OF SAMPLE: Face-channel

CONDITION OF SAMPLE: Weathered

TYPE OF EXPOSURE: Strip mine

MINE NAME: Sorensen

DATE OF SAMPLING: 8/14/74

SAMPLE COLLECTOR: Wyoming Geological Survey

COMPLETION DATE OF ANALYSES

U. S. Bureau of Mines: 8/26/74

Wyoming Geological Survey: 3/18/75

U. S. Geological Survey:

LABORATORY NUMBERS

K-46429

WGS-5

None

APPARENT RANK OF COAL: Subbituminous C

MISCELLANEOUS COMMENTS: Although this sample was weathered, its proximate analysis compared favorably with an average analysis provided by Kemmerer Coal Company.

AVERAGE ANALYSIS OF THE LOWER BENCH OF THE ADAVILLE NO. 6 COAL
PROVIDED BY KEMMERER COAL COMPANY

	<u>As Received</u>	<u>Dry Basis</u>
Moisture	23.65%	--
Ash	4.29%	--
Heat Value	--	12,326 Btu/lb.
Sulfur	0.42%	--

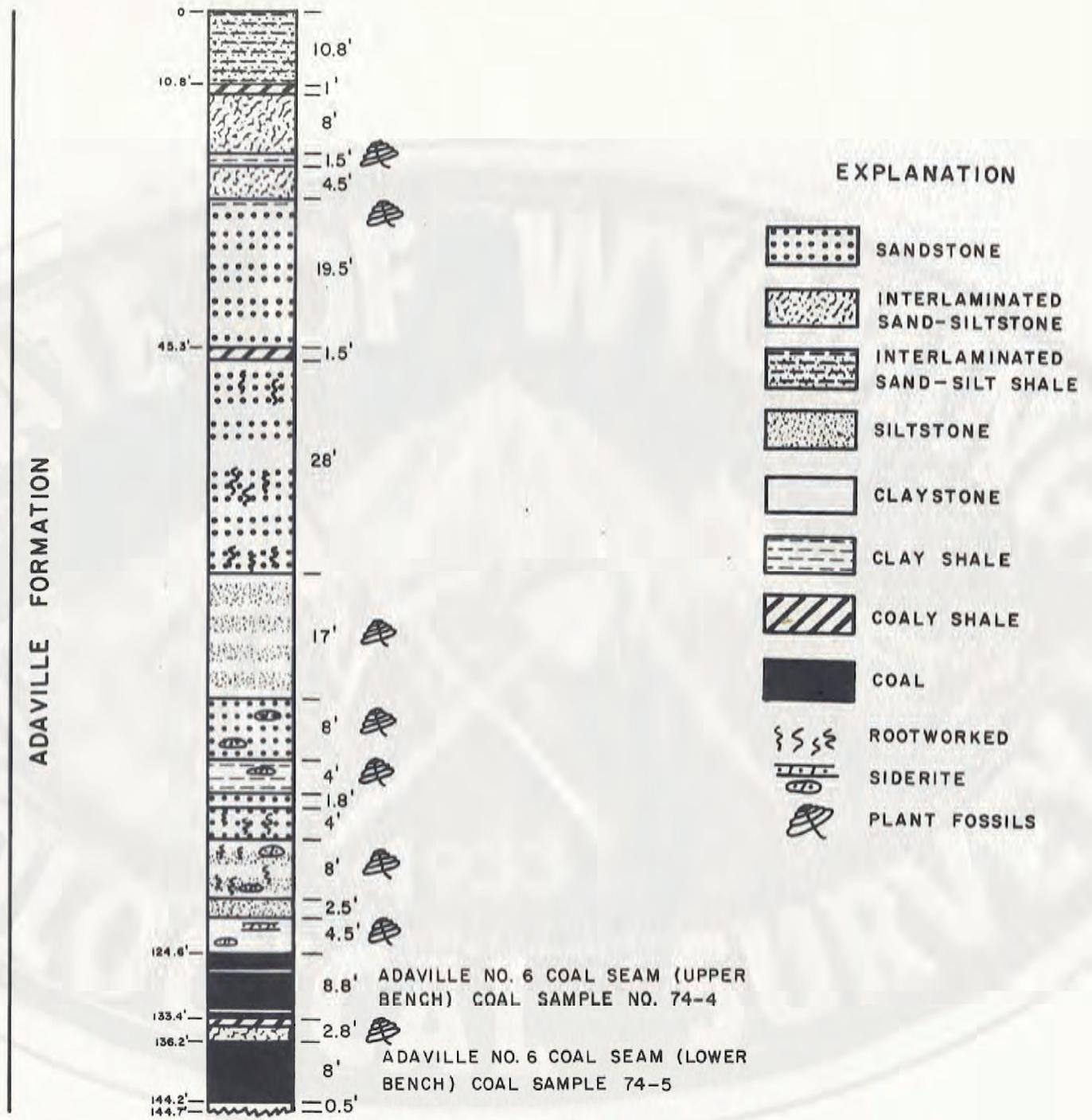


FIGURE 14: MEASURED SECTION AT THE ADAVILLE NO. 6 SAMPLE SITE IN THE SORENSEN MINE (COAL SAMPLE NOS. 74-4 AND 74-5)

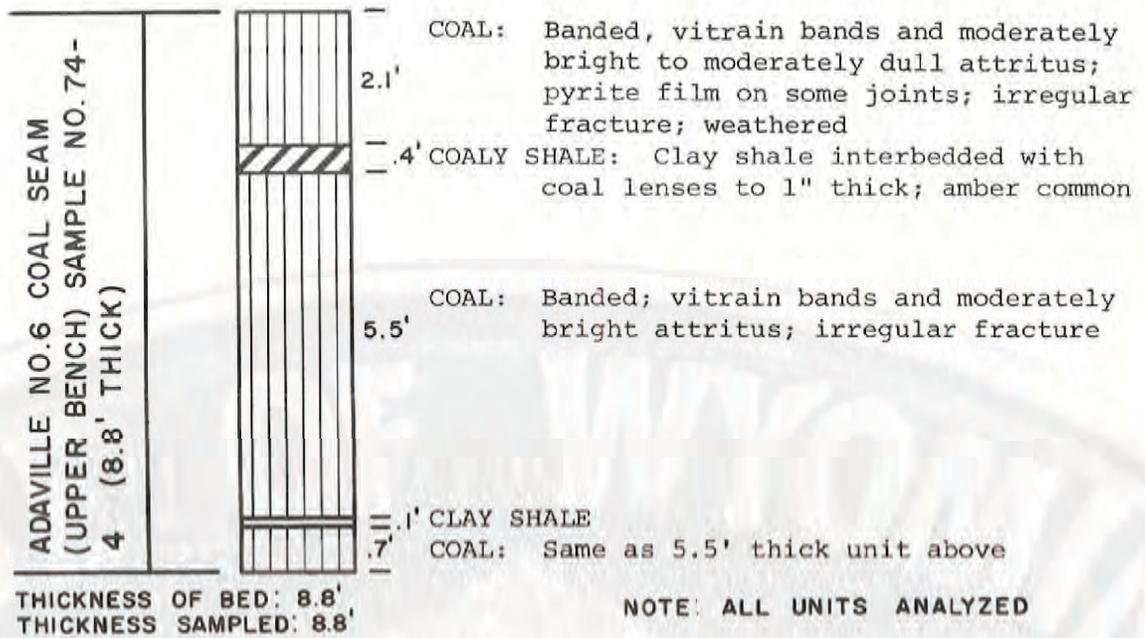


FIGURE 15: MEGASCOPIC DESCRIPTION OF THE UPPER BENCH OF THE ADAVILLE NO. 6 COAL IN THE SORENSEN MINE (COAL SAMPLE NO. 74-4)

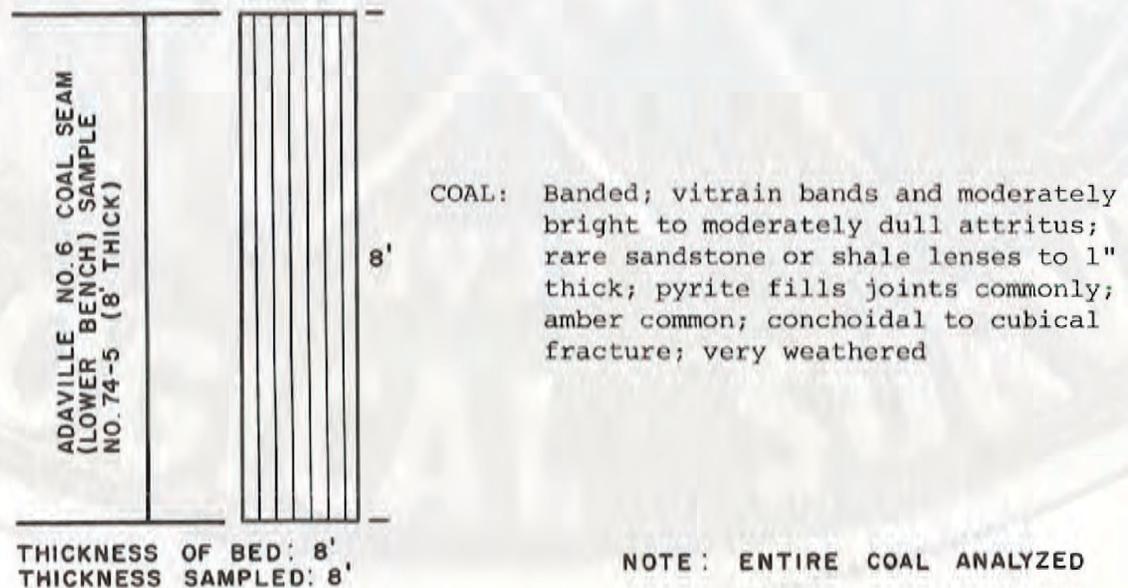


FIGURE 16: MEGASCOPIC DESCRIPTION OF THE LOWER BENCH OF THE ADAVILLE NO. 6 COAL IN THE SORENSEN MINE (COAL SAMPLE NO. 74-5)

SAMPLE NO. 74-6: ADAVILLE NO. 5 COAL

INDEX MAPS: *See Figures 7 and 8*

SAMPLE NO.: 74-6

COAL NAME(S): *Adaville No. 5*

GEOLOGIC FORMATION: *Adaville*

AGE: *Upper Cretaceous*

COAL FIELD: *Kemmerer*

COAL-BEARING AREA: *Hams Fork Region*

MEASURED SECTION: *See Figure 17*

TOTAL SECTION MEASURED (FEET): *105.0*

COVER AT SAMPLING POINT (FEET): *96.5*

ELEVATION TOP OF SAMPLED COAL: *7280?*

STRIKE: *10-351°*

DIP: *16-26°W*

MAJOR JOINT ORIENTATIONS IN COAL:
See Sample No. 74-19

STATE: *Wyoming*

COUNTY: *Lincoln*

SECTION: *19*

TOWNSHIP: *T21N*

RANGE: *R116W*

QUADRANGLE: *Kemmerer 15'*

LOCATION
IN SECTION



COAL DESCRIPTION: *See Figure 18*

THICKNESS OF COAL (FEET): *8.5*

THICKNESS SAMPLED (FEET): *8.5*

TYPE OF SAMPLE: *Face-channel*

CONDITION OF SAMPLE: *Weathered*

TYPE OF EXPOSURE: *Strip mine*

MINE NAME: *Sorensen*

DATE OF SAMPLING: *8/23/74*

SAMPLE COLLECTOR: *Wyoming Geological Survey*

COMPLETION DATE OF ANALYSES

U. S. Bureau of Mines: *9/17/74*

Wyoming Geological Survey: *3/18/75*

U. S. Geological Survey: *6/13/75*

LABORATORY NUMBERS

K-47332

WGS-6

D171855

APPARENT RANK OF COAL: *Subbituminous B*

MISCELLANEOUS COMMENTS: *This sample location is only approximate.*

AVERAGE ANALYSIS OF THE ADAVILLE NO. 5 COAL
PROVIDED BY KEMMERER COAL COMPANY

	<u>As Received</u>	<u>Dry Basis</u>
Moisture	21.24%	--
Ash	6.79%	--
Heat Value	--	12,044 Btu/lb.
Sulfur	0.30%	--

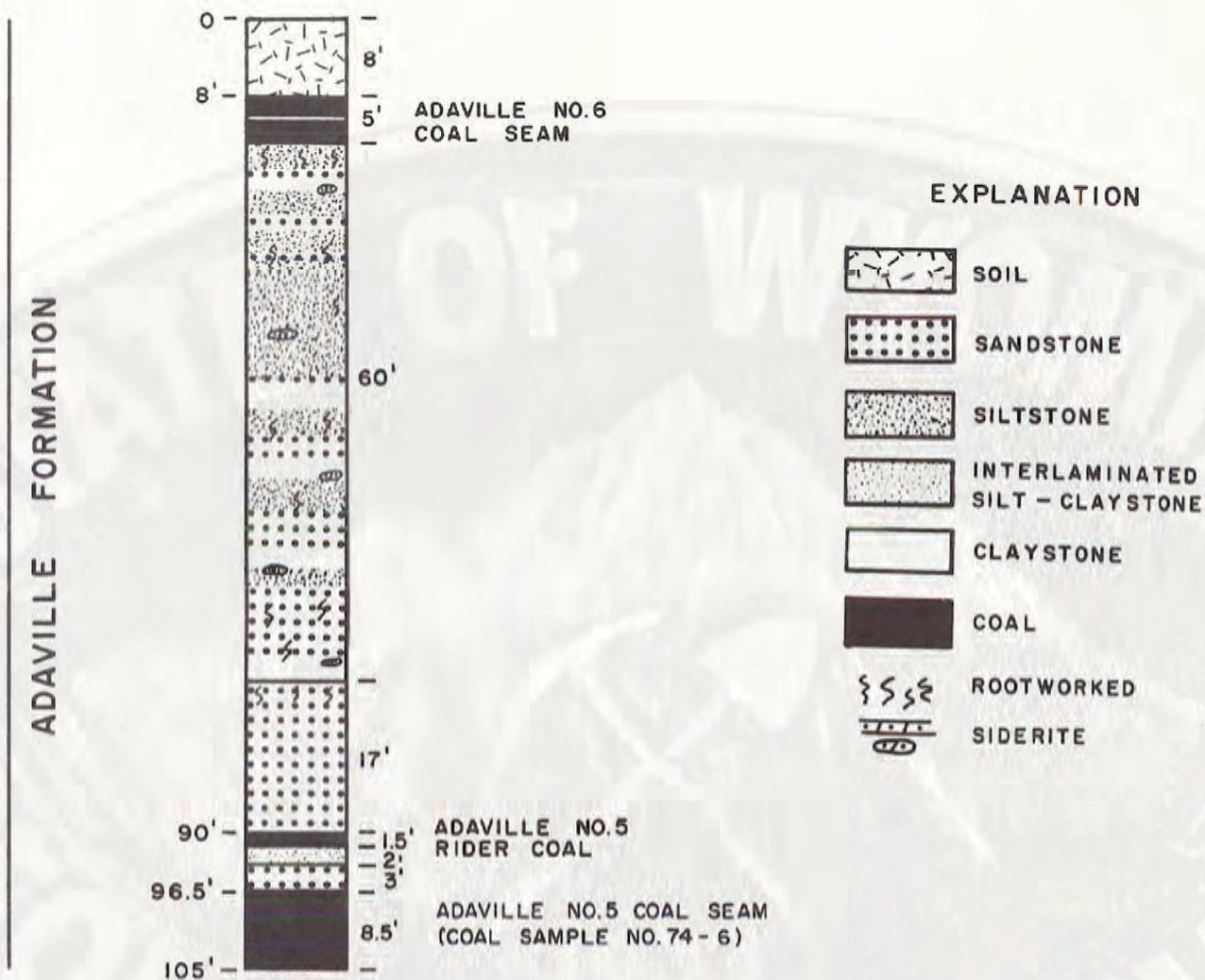


FIGURE 17: MEASURED SECTION AT THE ADAVILLE NO. 5 SAMPLE SITE IN THE SORENSEN MINE (COAL SAMPLE NO. 74-6)



COAL: Banded; vitrain bands and moderately bright attritus; claystone lenses to 1" thick rare; splits into 5 thin benches southward; iron stained; splintery to cubical fracture; weathered

NOTE: ENTIRE UNIT ANALYZED

FIGURE 18: MEGASCOPIC DESCRIPTION OF THE ADAVILLE NO. 5 COAL IN THE SORENSEN MINE (COAL SAMPLE NO. 74-6)

SAMPLE NO. 74-7: ADAVILLE NO. 4 RIDER COAL

INDEX MAPS: See Figures 7 and 8

SAMPLE NO.: 74-7

COAL NAMES(S): Adaville No. 4 Rider

GEOLOGIC FORMATION: Adaville

AGE: Upper Cretaceous

COAL FIELD: Kemmerer

COAL-BEARING AREA: Hams Fork Region

MEASURED SECTION: See Figure 20

TOTAL SECTION MEASURED (FEET): 182.3

COVER AT SAMPLING POINT (FEET): 80.0

ELEVATION TOP OF SAMPLED COAL: 7400+

STRIKE: 346°

DIP: 28°W

MAJOR JOINT ORIENTATIONS IN COAL:

See Sample No. 74-9

STATE: Wyoming

COUNTY: Lincoln

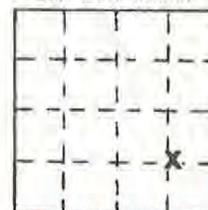
SECTION: 3

TOWNSHIP: T20N

RANGE: R117W

QUADRANGLE: Warfield Creek 7 1/2'

LOCATION
IN SECTION



COAL DESCRIPTION: See Figure 21

THICKNESS OF COAL (FEET): 11.5

THICKNESS SAMPLED (FEET): 11.5

TYPE OF SAMPLE: Face-channel

CONDITION OF SAMPLE: Weathered

TYPE OF EXPOSURE: Strip mine

MINE NAME: Sorensen

DATE OF SAMPLING: 8/13/74

SAMPLE COLLECTOR: Wyoming Geological Survey

COMPLETION DATE OF ANALYSES

U. S. Bureau of Mines: 8/26/74

Wyoming Geological Survey: 3/18/75

U. S. Geological Survey:

LABORATORY NUMBERS

K-46428

WGS-7

None

APPARENT RANK OF COAL: Subbituminous B

MISCELLANEOUS COMMENTS: Kemmerer Coal Company reports an average sulfur value of 0.5% compared to this sample's 1.0% (as received). The sample was weathered, and this could account for the difference.

AVERAGE ANALYSIS OF THE ADAVILLE NO. 4 RIDER COAL
PROVIDED BY KEMMERER COAL COMPANY (SOUTHERN END OF MINE)

	<u>As Received</u>	<u>Dry Basis</u>
Moisture	23.52%	--
Ash	4.32%	--
Heat Value	--	12,221 Btu/lb.
Sulfur	0.51%	--

SAMPLE NO. 74-8: ADAVILLE NO. 4 (UPPER BENCH)

INDEX MAPS: See Figures 7 and 8

SAMPLE NO.: 74-8

COAL NAME(S): Adaville No. 4
(Upper Bench)

GEOLOGIC FORMATION: Adaville

AGE: Upper Cretaceous

COAL FIELD: Kemmerer

COAL-BEARING AREA: Hams Fork Region

MEASURED SECTION: See Figure 20

TOTAL SECTION MEASURED (FEET): 182.3

COVER AT SAMPLING POINT (FEET): 100.0

ELEVATION TOP OF SAMPLED COAL: 7380+

STRIKE: 346°

DIP: 28°W

MAJOR JOINT ORIENTATIONS IN COAL:
See Sample No. 74-9

STATE: Wyoming

COUNTY: Lincoln

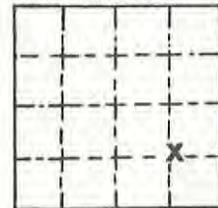
SECTION: 3

TOWNSHIP: T20N

RANGE: R117W

QUADRANGLE: Warfield Creek 7 1/2'

LOCATION
IN SECTION



COAL DESCRIPTION: See Figure 22

THICKNESS OF COAL (FEET): 5

THICKNESS SAMPLED (FEET): 5

TYPE OF SAMPLE: Face-channel

CONDITION OF SAMPLE: Weathered

TYPE OF EXPOSURE: Strip mine

MINE NAME: Sorensen

DATE OF SAMPLING: 8/13/74

SAMPLE COLLECTOR: Wyoming Geological Survey

COMPLETION DATE OF ANALYSES

U. S. Bureau of Mines: 8/26/74

Wyoming Geological Survey: 3/18/75

U. S. Geological Survey:

LABORATORY NUMBERS

K-46427

WGS-8

None

APPARENT RANK OF COAL: Subbituminous B

MISCELLANEOUS COMMENTS: Again the as received sulfur content of this sample (1.3%) is higher than the average determined by the Kemmerer Coal Company. Their average is only 0.20%. This sample was weathered where collected.

AVERAGE ANALYSIS OF THE UPPER BENCH OF THE ADAVILLE NO. 4 COAL
PROVIDED BY KEMMERER COAL COMPANY (SOUTHERN END OF MINE)

	<u>As Received</u>	<u>Dry Basis</u>
Moisture	25.09%	--
Ash	2.89%	--
Heat Value	--	12,356 Btu/lb.
Sulfur	0.20%	

SAMPLE NO. 74-9: ADAVILLE NO. 4 (LOWER BENCH)

INDEX MAPS: See Figures 7 and 8

SAMPLE NO.: 74-9

COAL NAMES(S): Adaville No. 4
(Lower Bench)

GEOLOGIC FORMATION: Adaville

AGE: Upper Cretaceous

COAL FIELD: Kemmerer

COAL-BEARING AREA: Hams Fork Region

MEASURED SECTION: See Figure 20

TOTAL SECTION MEASURED (FEET): 182.3

COVER AT SAMPLING POINT (FEET): 60.0

ELEVATION TOP OF SAMPLED COAL: 7355+

STRIKE: 346°

DIP: 28°W

MAJOR JOINT ORIENTATIONS IN COAL:
65-68°, 334-345°, 310°, 104°

STATE: Wyoming

COUNTY: Lincoln

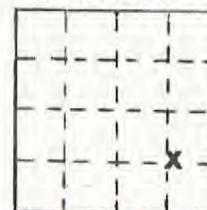
SECTION: 3

TOWNSHIP: T20N

RANGE: R117W

QUADRANGLE: Warfield Creek 7 1/2'

LOCATION
IN SECTION



COAL DESCRIPTION: See Figure 23

THICKNESS OF COAL (FEET): 12.2

THICKNESS SAMPLED (FEET): 12.0

TYPE OF SAMPLE: Face-channel

CONDITION OF SAMPLE: Weathered

TYPE OF EXPOSURE: Strip mine

MINE NAME: Sorensen

DATE OF SAMPLING: 8/13/74

SAMPLE COLLECTOR: Wyoming Geological Survey

COMPLETION DATE OF ANALYSES

U. S. Bureau of Mines: 8/26/74

Wyoming Geological Survey: 3/18/75

U. S. Geological Survey:

LABORATORY NUMBERS

K-46426

WGS-9

None

APPARENT RANK OF COAL: Subbituminous B

MISCELLANEOUS COMMENTS: Despite the badly weathered nature of the sample, the proximate analysis, sulfur content, and heat value all compare very favorably with the Kemmerer Coal Company's analyses.

AVERAGE ANALYSIS OF THE LOWER BENCH OF THE ADAVILLE NO. 4 COAL
PROVIDED BY KEMMERER COAL COMPANY (SOUTHERN END OF MINE)

	<u>As Received</u>	<u>Dry Basis</u>
Moisture	24.25%	--
Ash	2.15%	--
Heat Value	--	12,592 Btu/lb.
Sulfur	0.60%	

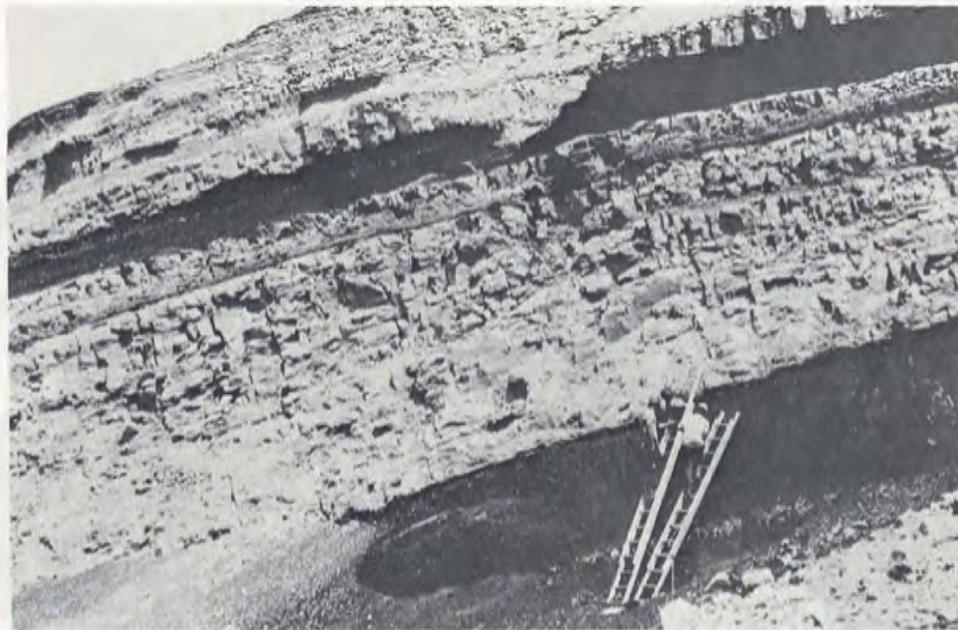


FIGURE 19: SAMPLE SITE FOR COAL SAMPLE NOS. 74-7, 8, AND 9 (LOWER BENCH OF THE ADAVILLE NO. 4 COAL IS 12.2 FOOT THICK AND DIPS 28° TO THE WEST AT THIS SITE. THE UPPER COAL IN THE PICTURE IS THE 5 FOOT THICK, UPPER BENCH OF THE ADAVILLE NO. 4 COAL).

ADAVILLE FORMATION

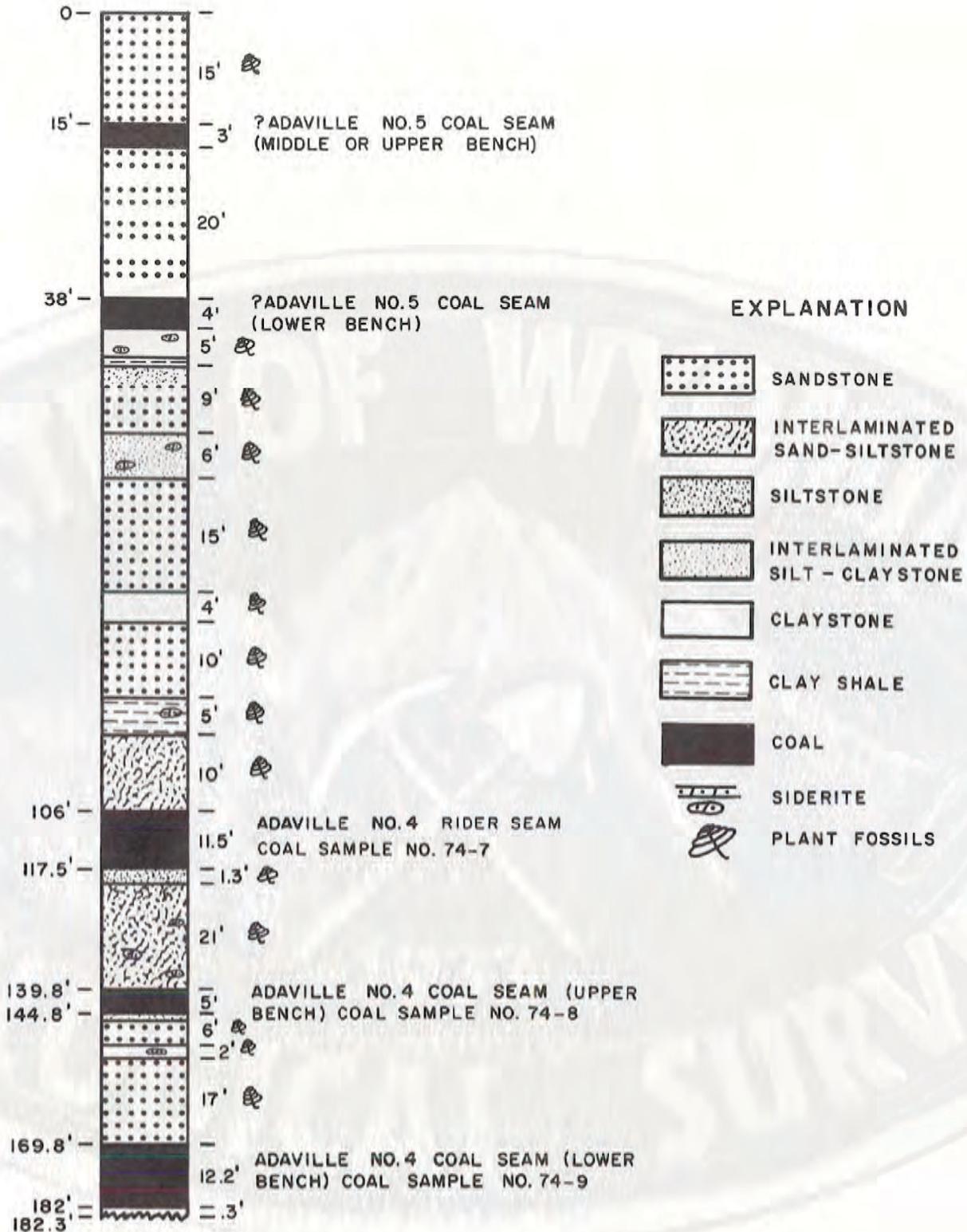


FIGURE 20: MEASURED SECTION AT THE ADAVILLE NO. 4 SAMPLE SITE IN THE SOUTHERN PART OF THE SORENSEN MINE (COAL SAMPLE NOS. 74-7, 8, AND 9)



COAL: Banded; vitrain bands and moderately bright attritus; pyrite fills joints in upper foot (not mined); conchoidal to cubical fracture

THICKNESS OF BED: 11.5'
THICKNESS SAMPLED: 11.5'

NOTE: ENTIRE COAL ANALYZED

FIGURE 21: MEGASCOPIC DESCRIPTION OF THE ADAVILLE NO. 4 RIDER COAL IN THE SOUTHERN PART OF THE SORENSEN MINE (COAL SAMPLE NO. 74-7)

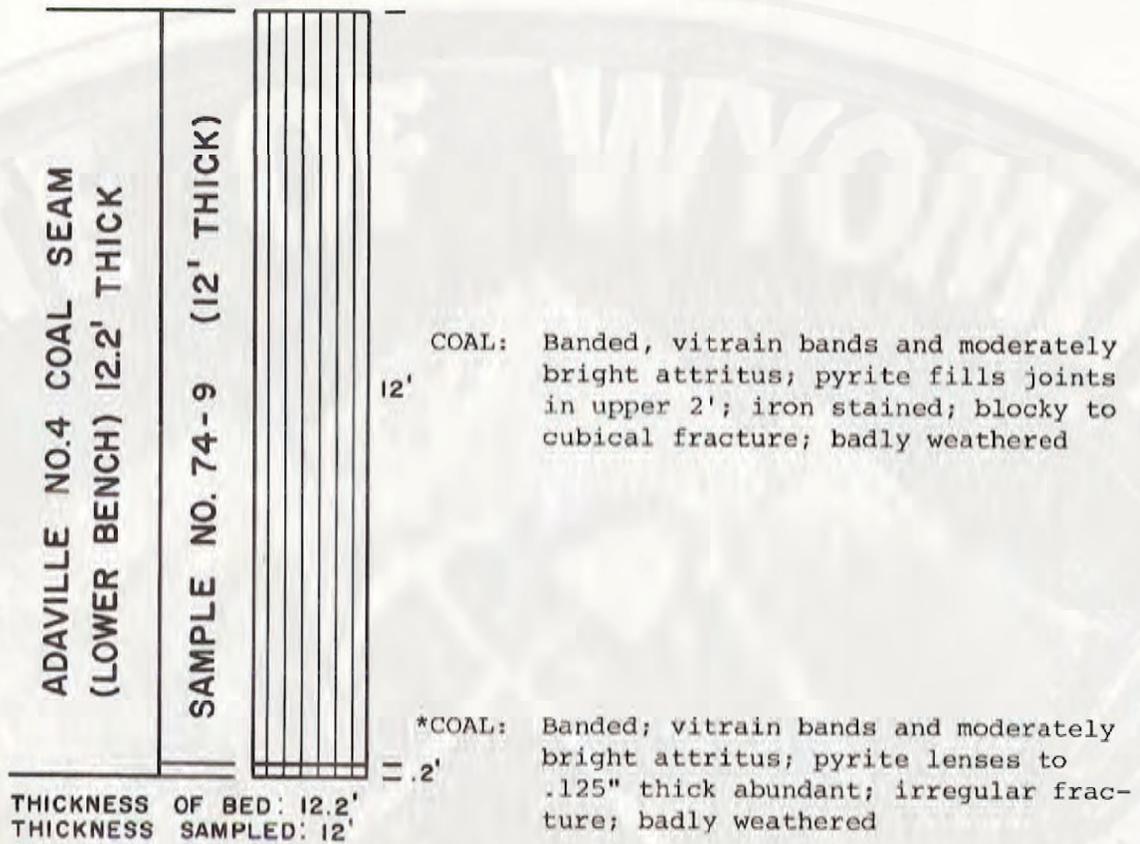


COAL: Banded; vitrain bands and moderately bright attritus; joints filled with pyrite; irregular fracture; very weathered

THICKNESS OF BED: 5'
THICKNESS SAMPLED: 5'

NOTE: ENTIRE COAL ANALYZED

FIGURE 22: MEGASCOPIC DESCRIPTION OF THE UPPER BENCH OF THE ADAVILLE NO. 4 COAL IN THE SOUTHERN PART OF THE SORENSEN MINE (COAL SAMPLE NO. 74-8)



* EXCLUDED FROM ANALYSIS

FIGURE 23: MEGASCOPIC DESCRIPTION OF THE LOWER BENCH OF THE ADAVILLE NO. 4 COAL IN THE SOUTHERN PART OF THE SORENSEN MINE (COAL SAMPLE NO. 74-9)

SAMPLE NO. 74-10: ADAVILLE NO. 4 RIDER COAL

INDEX MAPS: See Figures 7 and 8

SAMPLE NO.: 74-10

COAL NAME(S): Adaville No. 4 Rider

GEOLOGIC FORMATION: Adaville

AGE: Upper Cretaceous

COAL FIELD: Kemmerer

COAL-BEARING AREA: Hams Fork Region

MEASURED SECTION: See Figure 24

TOTAL SECTION MEASURED (FEET): 133.2

COVER AT SAMPLING POINT (FEET): 81.3

ELEVATION TOP OF SAMPLED COAL: 7200+

STRIKE: 0°

DIP: 18°W

MAJOR JOINT ORIENTATIONS IN COAL:
65°

STATE: Wyoming

COUNTY: Lincoln

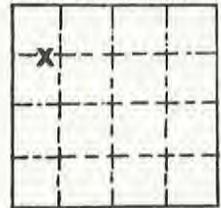
SECTION: 20

TOWNSHIP: T21N

RANGE: R116W

QUADRANGLE: Kemmerer 15'

LOCATION
IN SECTION



COAL DESCRIPTION: See Figure 25

THICKNESS OF COAL (FEET): 5

THICKNESS SAMPLED (FEET): 5

TYPE OF SAMPLE: Face-channel

CONDITION OF SAMPLE: Weathered

TYPE OF EXPOSURE: Strip mine

MINE NAME: Sorensen

DATE OF SAMPLING: 8/23/74

SAMPLE COLLECTOR: Wyoming Geological Survey

COMPLETION DATE OF ANALYSES

U. S. Bureau of Mines: 9/17/74

Wyoming Geological Survey: 3/18/75

U. S. Geological Survey: 6/13/75

LABORATORY NUMBERS

K-47331

WGS-10

D171858

APPARENT RANK OF COAL: Subbituminous B

MISCELLANEOUS COMMENTS: The analysis of this sample is very similar to the Kemmerer Coal Company analyses. See Sample No. 74-7 for an average company analysis.

SAMPLE NO. 74-11: ADAVILLE NO. 4 COAL (UPPER BENCH)

INDEX MAPS: *See Figures 7 and 8*

SAMPLE NO.: 74-11

COAL NAMES(S): *Adaville No. 4
(Upper Bench)*

GEOLOGIC FORMATION: *Adaville*

AGE: *Upper Cretaceous*

COAL FIELD: *Kemmerer*

COAL-BEARING AREA: *Hams Fork Region*

MEASURED SECTION: *See Figure 24*

TOTAL SECTION MEASURED (FEET): *133.2*

COVER AT SAMPLING POINT (FEET): *113.9*

ELEVATION TOP OF SAMPLED COAL: *7170±*

STRIKE: *0°*

DIP: *18°W*

MAJOR JOINT ORIENTATIONS IN COAL:

See Sample No. 74-10

STATE: *Wyoming*

COUNTY: *Lincoln*

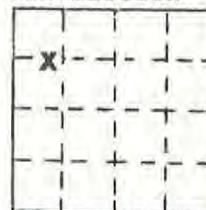
SECTION: *20*

TOWNSHIP: *T21N*

RANGE: *R116W*

QUADRANGLE: *Kemmerer 15'*

LOCATION
IN SECTION



COAL DESCRIPTION: *See Figure 26*

THICKNESS OF COAL (FEET): *7*

THICKNESS SAMPLED (FEET): *6*

TYPE OF SAMPLE: *Face-channel*

CONDITION OF SAMPLE: *Weathered*

TYPE OF EXPOSURE: *Strip mine*

MINE NAME: *Sorensen*

DATE OF SAMPLING: *8/23/74*

SAMPLE COLLECTOR: *Wyoming Geological Survey*

COMPLETION DATE OF ANALYSES

U. S. Bureau of Mines: *9/13/74*

Wyoming Geological Survey: *3/18/75*

U. S. Geological Survey: *6/13/75*

LABORATORY NUMBERS

K-47195

WGS-11

D171857

APPARENT RANK OF COAL: *Subbituminous B*

MISCELLANEOUS COMMENTS: *The analysis of this sample is very similar to the Kemmerer Coal Company analyses.*

*AVERAGE ANALYSIS OF THE UPPER BENCH OF THE ADAVILLE NO. 4 COAL
PROVIDED BY KEMMERER COAL COMPANY (NORTHERN END OF MINE)*

	<u>As Received</u>	<u>Dry Basis</u>
Moisture	23.98%	--
Ash	3.44%	--
Heat Value	--	12,117 Btu/lb.
Sulfur	0.27%	--

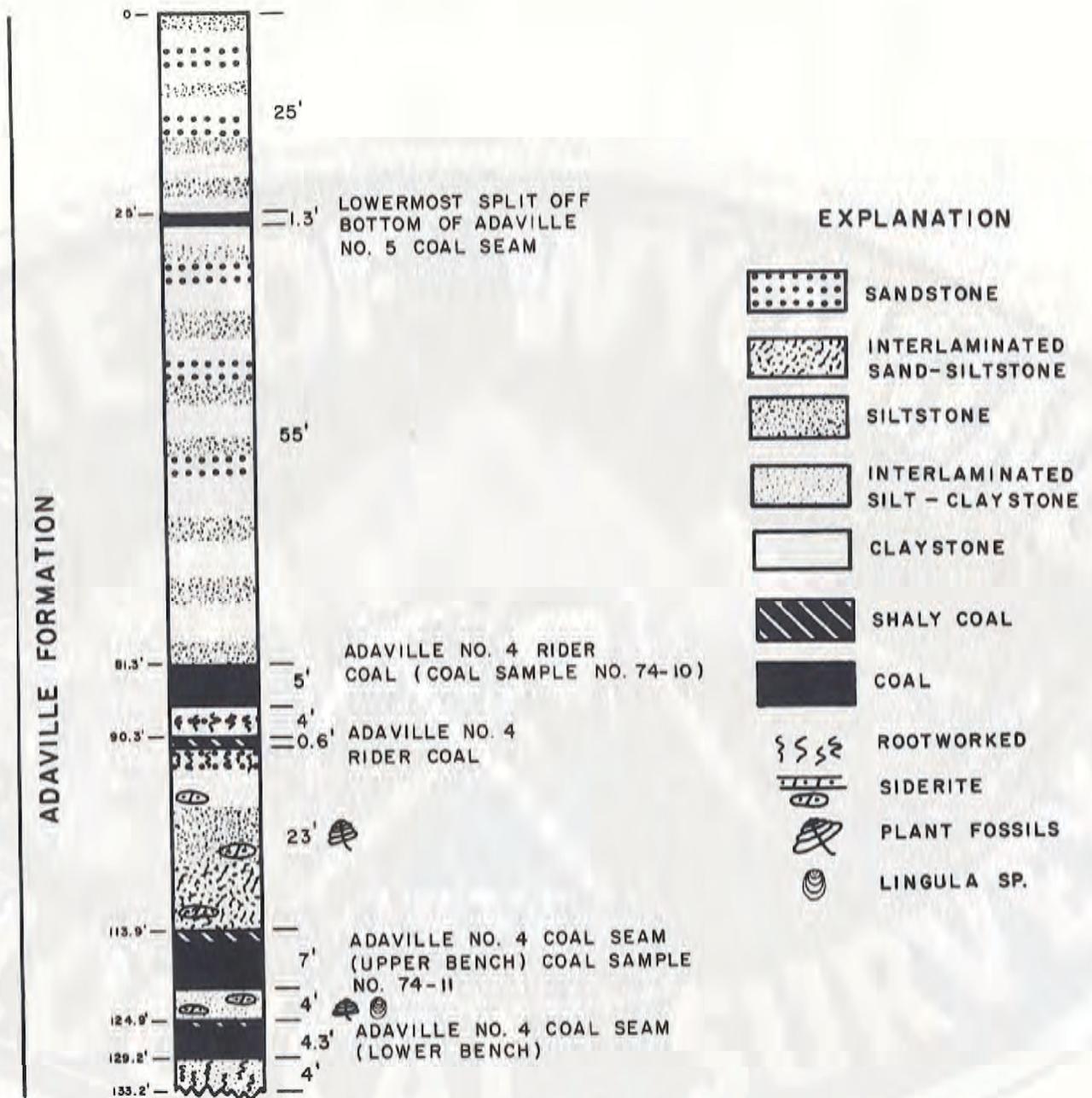


FIGURE 24: MEASURED SECTION AT THE MOST NORTHERLY ADAVILLE NO. 4 SAMPLE SITE IN THE SORENSEN MINE (COAL SAMPLE NOS. 74-10 AND 74-11)

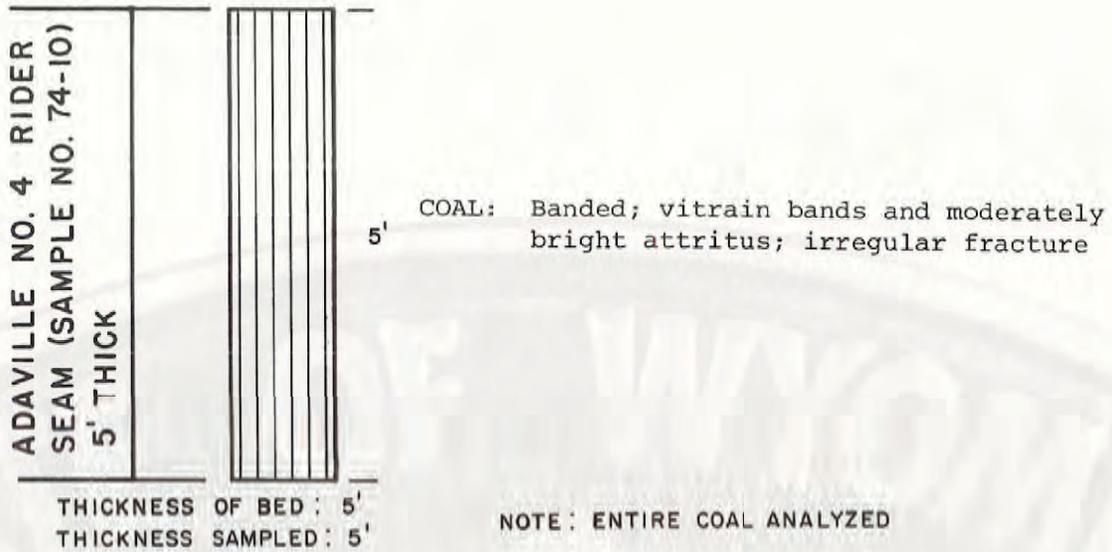


FIGURE 25: MEGASCOPIIC DESCRIPTION OF THE ADAVILLE NO. 4 RIDER COAL FROM THE NORTHERNMOST SAMPLE SITE IN THE SORENSEN MINE (COAL SAMPLE NO. 74-10)

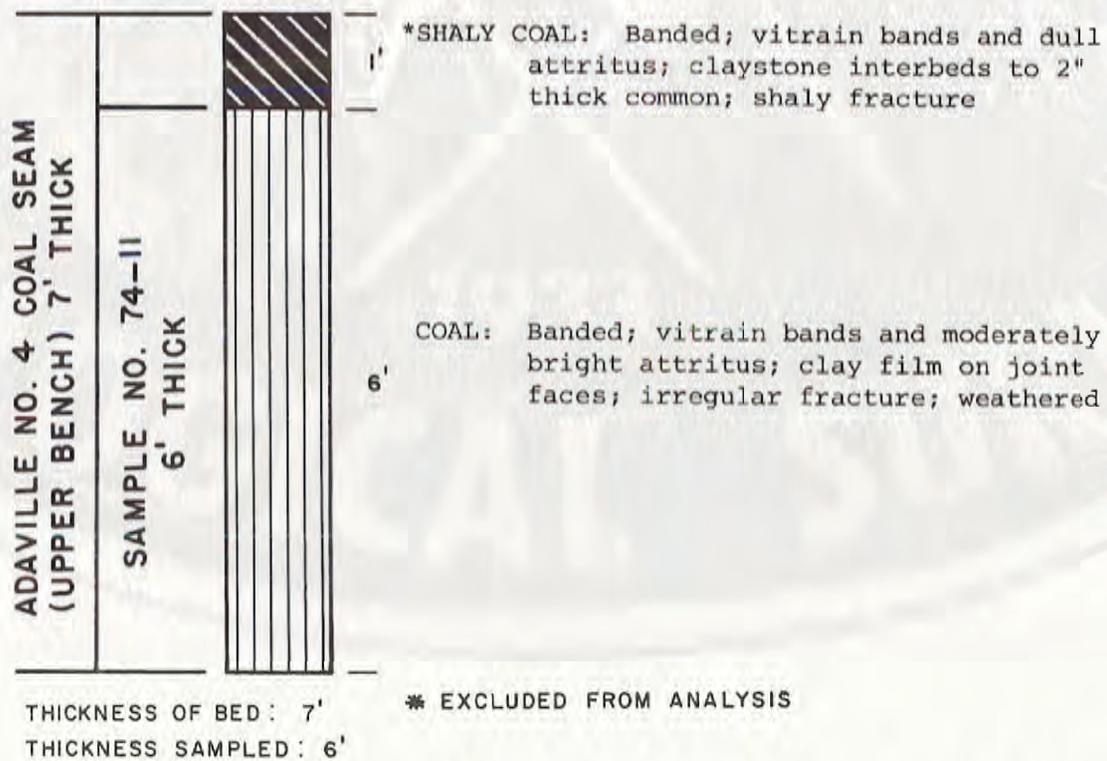


FIGURE 26: MEGASCOPIIC DESCRIPTION OF THE UPPER BENCH OF THE ADAVILLE NO. 4 COAL FROM THE NORTHERNMOST SAMPLE SITE IN THE SORENSEN MINE (COAL SAMPLE NO. 74-11)

SAMPLE NO. 74-12: ADAVILLE NO. 4 (LOWER BENCH)

INDEX MAPS: See Figures 7 and 8

SAMPLE NO.: 74-12

COAL NAME(S): Adaville No. 4

(Lower Bench)
GEOLOGIC FORMATION: Adaville

AGE: Upper Cretaceous

COAL FIELD: Kemmerer

COAL-BEARING AREA: Hams Fork Region

MEASURED SECTION: See Figure 27

TOTAL SECTION MEASURED (FEET): 129.8

COVER AT SAMPLING POINT (FEET): 100.0

ELEVATION TOP OF SAMPLED COAL: 7260+

STRIKE: 10-351°

DIP: 26°W

MAJOR JOINT ORIENTATIONS IN COAL:

See Sample No. 74-19

STATE: Wyoming

COUNTY: Lincoln

SECTION: 20

TOWNSHIP: T21N

RANGE: R116W

QUADRANGLE: Kemmerer 15'

LOCATION
IN SECTION



COAL DESCRIPTION: See Figure 28

THICKNESS OF COAL (FEET): 6.95

THICKNESS SAMPLED (FEET): 6.55

TYPE OF SAMPLE: Face-channel

CONDITION OF SAMPLE: Fresh

TYPE OF EXPOSURE: Strip mine

MINE NAME: Sorensen

DATE OF SAMPLING: 8/22/74

SAMPLE COLLECTOR: Wyoming Geological Survey

COMPLETION DATE OF ANALYSES

U. S. Bureau of Mines: 9/13/74

Wyoming Geological Survey: 3/18/75

U. S. Geological Survey: 6/13/75

LABORATORY NUMBERS

K-47199

WGS-12

D171854

APPARENT RANK OF COAL: Subbituminous B

MISCELLANEOUS COMMENTS: The analysis of this sample is similar to the Kemmerer Coal Company analyses.

AVERAGE ANALYSIS OF THE LOWER BENCH OF THE ADAVILLE NO. 4 COAL
PROVIDED BY KEMMERER COAL COMPANY (NORTHERN END OF MINE)

	<u>As Received</u>	<u>Dry Basis</u>
Moisture	23.63%	--
Ash	2.67%	--
Heat Value	--	12,240 Btu/lb.
Sulfur	0.23%	--

ADAVILLE FORMATION

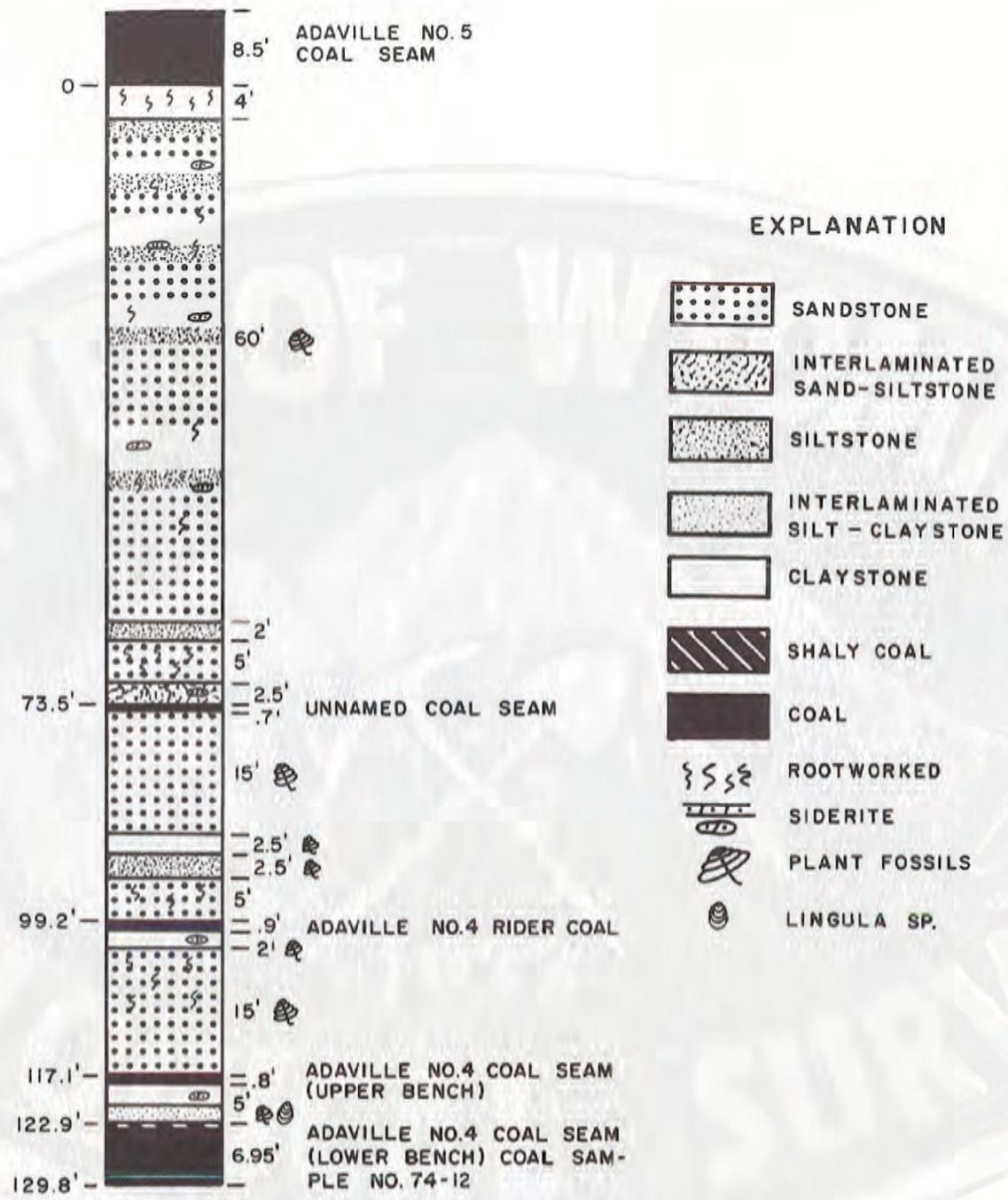


FIGURE 27: MEASURED SECTION AT THE ADAVILLE NO. 4 SAMPLE SITE IN THE NORTHERN PART OF THE SORENSEN MINE (COAL SAMPLE NO. 74-12)

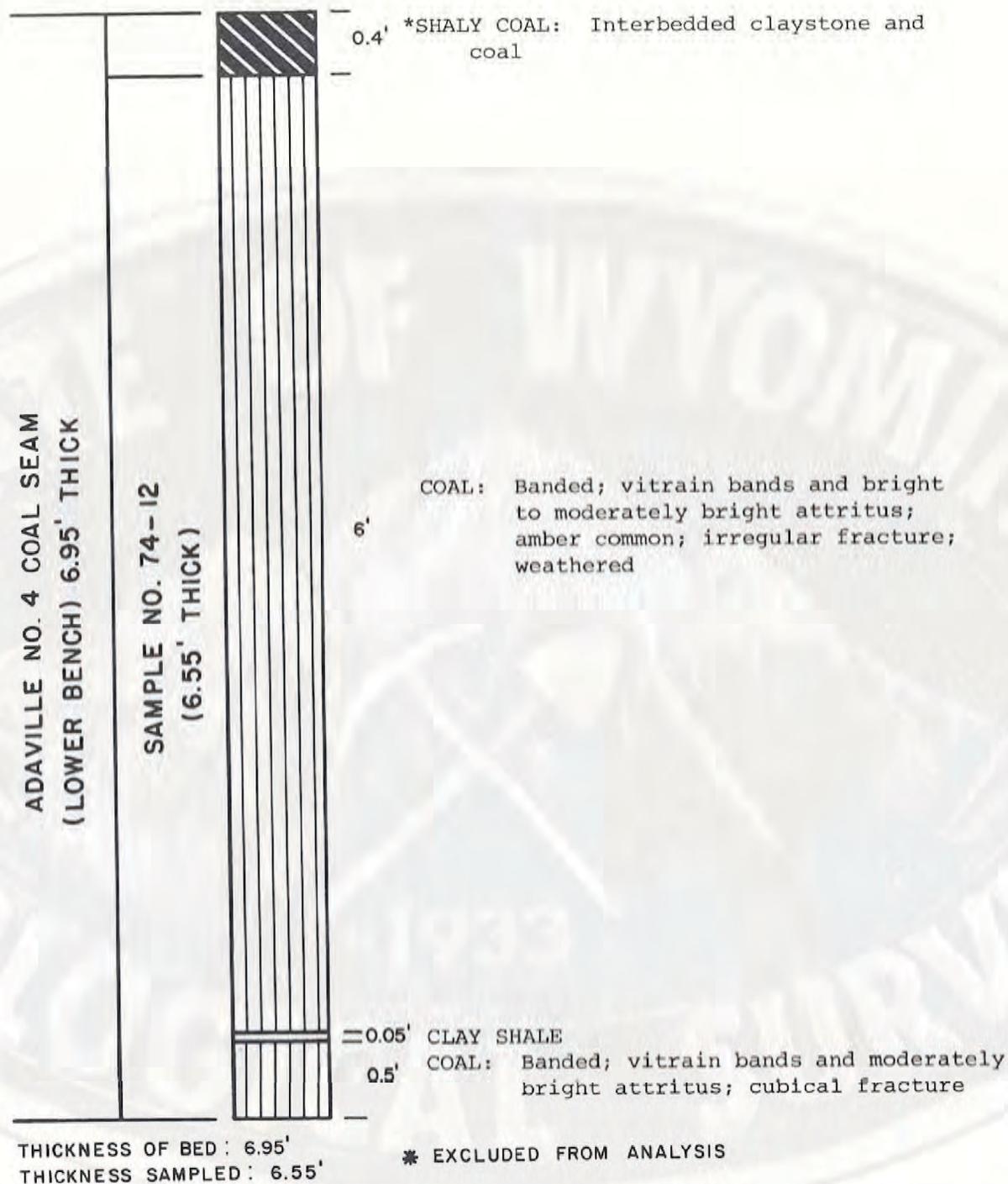


FIGURE 28: MEGASCOPIC DESCRIPTION OF THE LOWER BENCH OF THE ADAVILLE NO. 4 COAL IN THE NORTHERN PART OF THE SORENSEN MINE (COAL SAMPLE NO. 74-12)

SAMPLE NO. 74-13: ADAVILLE NO. 3 MIDDLE RIDER

INDEX MAPS: See Figures 7 and 8

SAMPLE NO.: 74-13

COAL NAMES(S): Adaville No. 3
Middle Rider

GEOLOGIC FORMATION: Adaville

AGE: Upper Cretaceous

COAL FIELD: Kemmerer

COAL-BEARING AREA: Hams Fork Region

MEASURED SECTION: See Figure 29

TOTAL SECTION MEASURED (FEET): 124.3

COVER AT SAMPLING POINT (FEET): 70.0

ELEVATION TOP OF SAMPLED COAL: 7210+

STRIKE: 0°

DIP: 17°W

MAJOR JOINT ORIENTATIONS IN COAL:
None measured.

STATE: Wyoming

COUNTY: Lincoln

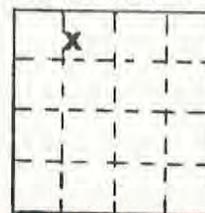
SECTION: 20

TOWNSHIP: T21N

RANGE: R116W

QUADRANGLE: Kemmerer 15'

LOCATION
IN SECTION



COAL DESCRIPTION: See Figure 30

THICKNESS OF COAL (FEET): 10.6

THICKNESS SAMPLED (FEET): 10.0

TYPE OF SAMPLE: Face-channel

CONDITION OF SAMPLE: Weathered

TYPE OF EXPOSURE: Strip mine

MINE NAME: Sorensen

DATE OF SAMPLING: 8/22/74

SAMPLE COLLECTOR: Wyoming Geological Survey

COMPLETION DATE OF ANALYSES

U. S. Bureau of Mines: 9/13/74

Wyoming Geological Survey: 3/18/75

U. S. Geological Survey: 6/13/75

LABORATORY NUMBERS

K-47198

WGS-13

D171856

APPARENT RANK OF COAL: Subbituminous B

MISCELLANEOUS COMMENTS: This coal is only mined locally.

AN ANALYSIS OF THE ADAVILLE NO. 3 MIDDLE RIDER COAL
PROVIDED BY KEMMERER COAL COMPANY (CORE SAMPLE)

	<u>As Received</u>	<u>Dry Basis</u>
Moisture	21.37%	--
Ash	6.42%	--
Heat Value	--	11,987 Btu/lb.
Sulfur	0.30%	--

ADAVILLE FORMATION

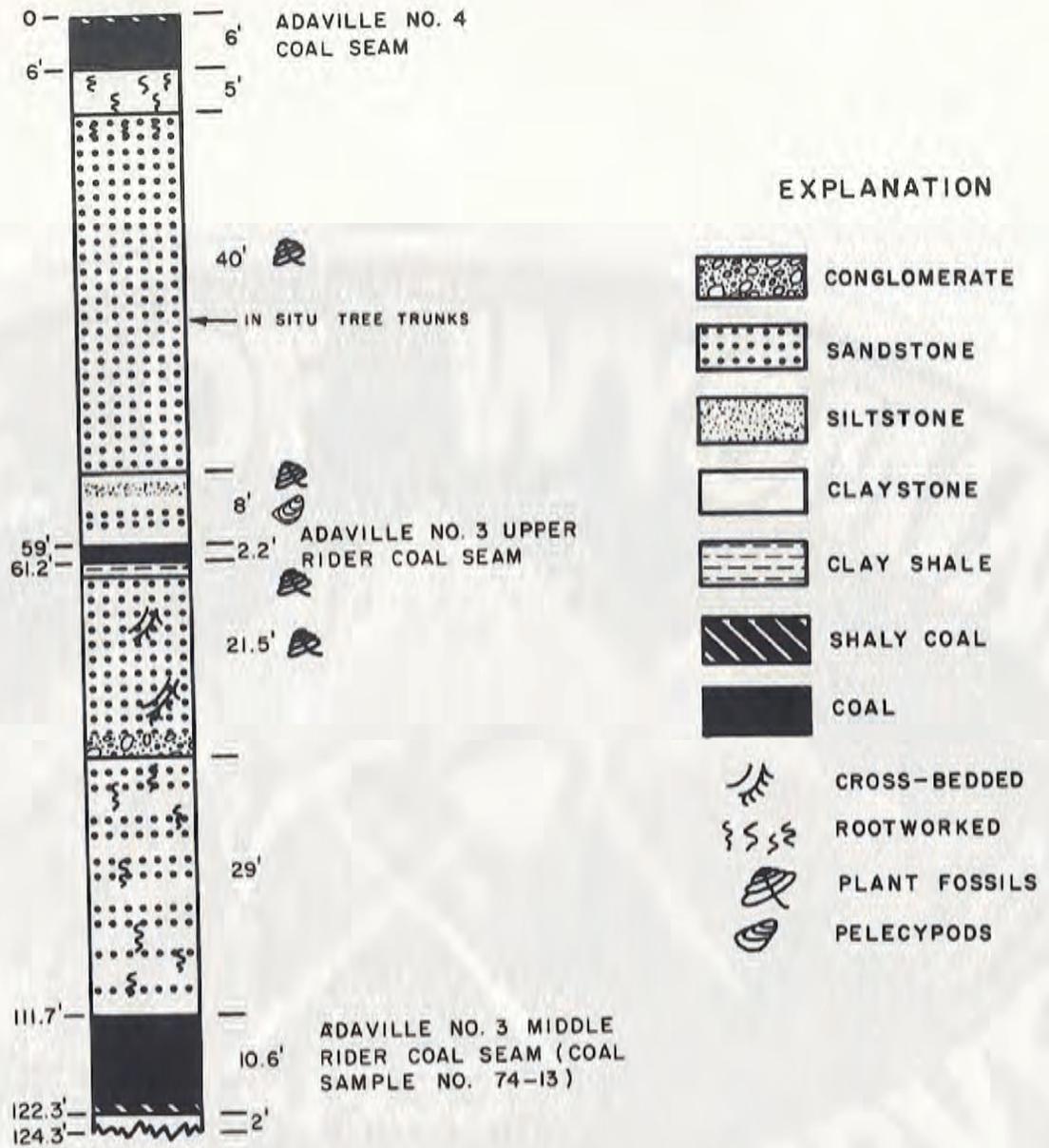


FIGURE 29: MEASURED SECTION AT THE ADAVILLE NO. 3 MIDDLE RIDER SAMPLE SITE IN THE SORENSEN MINE (COAL SAMPLE NO. 74-13)



COAL: Banded; vitrain bands and bright to moderately bright attritus; clay commonly in joints, iron stained; thins southward to 2' thick as a result of splitting off the bottom; splintery to cubical fracture; weathered

*SHALY COAL: Banded; vitrain bands and dull attritus; shaly fracture; weathered

THICKNESS OF BED: 10.6'
 THICKNESS SAMPLED: 10'

* EXCLUDED FROM ANALYSIS

FIGURE 30: MEGASCOPIIC DESCRIPTION OF THE ADAVILLE NO. 3 MIDDLE RIDER COAL IN THE SORENSEN MINE (COAL SAMPLE NO. 74-13)

SAMPLE NO. 74-14: ADAVILLE NO. 3 LOWER RIDER

INDEX MAPS: *See Figures 7 and 8*

SAMPLE NO.: 74-14

COAL NAME(S): *Adaville No. 3
Lower Rider*

GEOLOGIC FORMATION: *Adaville*

AGE: *Upper Cretaceous*

COAL FIELD: *Kemmerer*

COAL-BEARING AREA: *Hams Fork Region*

MEASURED SECTION: *See Figure 31*

TOTAL SECTION MEASURED (FEET): 221.1

COVER AT SAMPLING POINT (FEET): 100.0

ELEVATION TOP OF SAMPLED COAL: 7260+

STRIKE: *10°-351°*

DIP: *20°W*

MAJOR JOINT ORIENTATIONS IN COAL:

See Sample No. 74-19

STATE: *Wyoming*

COUNTY: *Lincoln*

SECTION: 20

TOWNSHIP: *T21N*

RANGE: *R116W*

QUADRANGLE: *Kemmerer 15'*

LOCATION
IN SECTION



COAL DESCRIPTION: *See Figure 32*

THICKNESS OF COAL (FEET): 8.5

THICKNESS SAMPLED (FEET): 6.5

TYPE OF SAMPLE: *Face-channel*

CONDITION OF SAMPLE: *Fresh*

TYPE OF EXPOSURE: *Strip mine*

MINE NAME: *Sorensen*

DATE OF SAMPLING: *8/21/74*

SAMPLE COLLECTOR: *Wyoming Geological Survey*

COMPLETION DATE OF ANALYSES

U. S. Bureau of Mines: *9/13/74*

Wyoming Geological Survey: *3/18/75*

U. S. Geological Survey: *6/13/75*

LABORATORY NUMBERS

K-47197

WGS-14

D171853

APPARENT RANK OF COAL: *Subbituminous B*

MISCELLANEOUS COMMENTS: *The analysis of this sample is similar to analyses provided by the Kemmerer Coal Company.*

AVERAGE ANALYSIS OF THE ADAVILLE NO. 3 LOWER RIDER COAL
PROVIDED BY KEMMERER COAL COMPANY

	<u>As Received</u>	<u>Dry Basis</u>
Moisture	22.79%	--
Ash	3.27%	--
Heat Value	--	12,463 Btu/lb.
Sulfur	0.34%	--

SAMPLE NO. 74-15: ADAVILLE NO. 3 COAL

INDEX MAPS: *See Figures 7 and 8*

SAMPLE NO.: 74-15

COAL NAMES(S): *Adaville No. 3*

GEOLOGIC FORMATION: *Adaville*

AGE: *Upper Cretaceous*

COAL FIELD: *Kemmerer*

COAL-BEARING AREA: *Hams Fork Region*

MEASURED SECTION: *See Figure 31*

TOTAL SECTION MEASURED (FEET): 221.1

COVER AT SAMPLING POINT (FEET): 150.0

ELEVATION TOP OF SAMPLED COAL: 7210+

STRIKE: 10°-351°

DIP: 20°

MAJOR JOINT ORIENTATIONS IN COAL:

See Sample No. 74-19

STATE: *Wyoming*

COUNTY: *Lincoln*

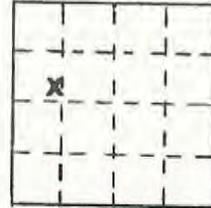
SECTION: 20

TOWNSHIP: *T21N*

RANGE: *R116W*

QUADRANGLE: *Kemmerer 15'*

LOCATION
IN SECTION



COAL DESCRIPTION: *See Figure 33*

THICKNESS OF COAL (FEET): 33.6

THICKNESS SAMPLED (FEET): 33.6

TYPE OF SAMPLE: *Face-channel*

CONDITION OF SAMPLE: *Fresh*

TYPE OF EXPOSURE: *Strip mine*

MINE NAME: *Sorensen*

DATE OF SAMPLING: *8/21/74*

SAMPLE COLLECTOR: *Wyoming Geological Survey*

COMPLETION DATE OF ANALYSES

U. S. Bureau of Mines: *9/17/74*

Wyoming Geological Survey: *3/18/75*

U. S. Geological Survey: *2/12/75*

LABORATORY NUMBERS

K-47333

WGS-15

D170263

APPARENT RANK OF COAL: *Subbituminous B*

MISCELLANEOUS COMMENTS: *This coal averages 51 feet thick in places, but thins southward.*

AVERAGE ANALYSIS OF THE ADAVILLE NO. 3 COAL
PROVIDED BY KEMMERER COAL COMPANY

	<u>As Received</u>	<u>Dry Basis</u>
Moisture	21.60%	--
Ash	3.03%	--
Heat Value	--	12,509 Btu/lb.
Sulfur	0.28%	--

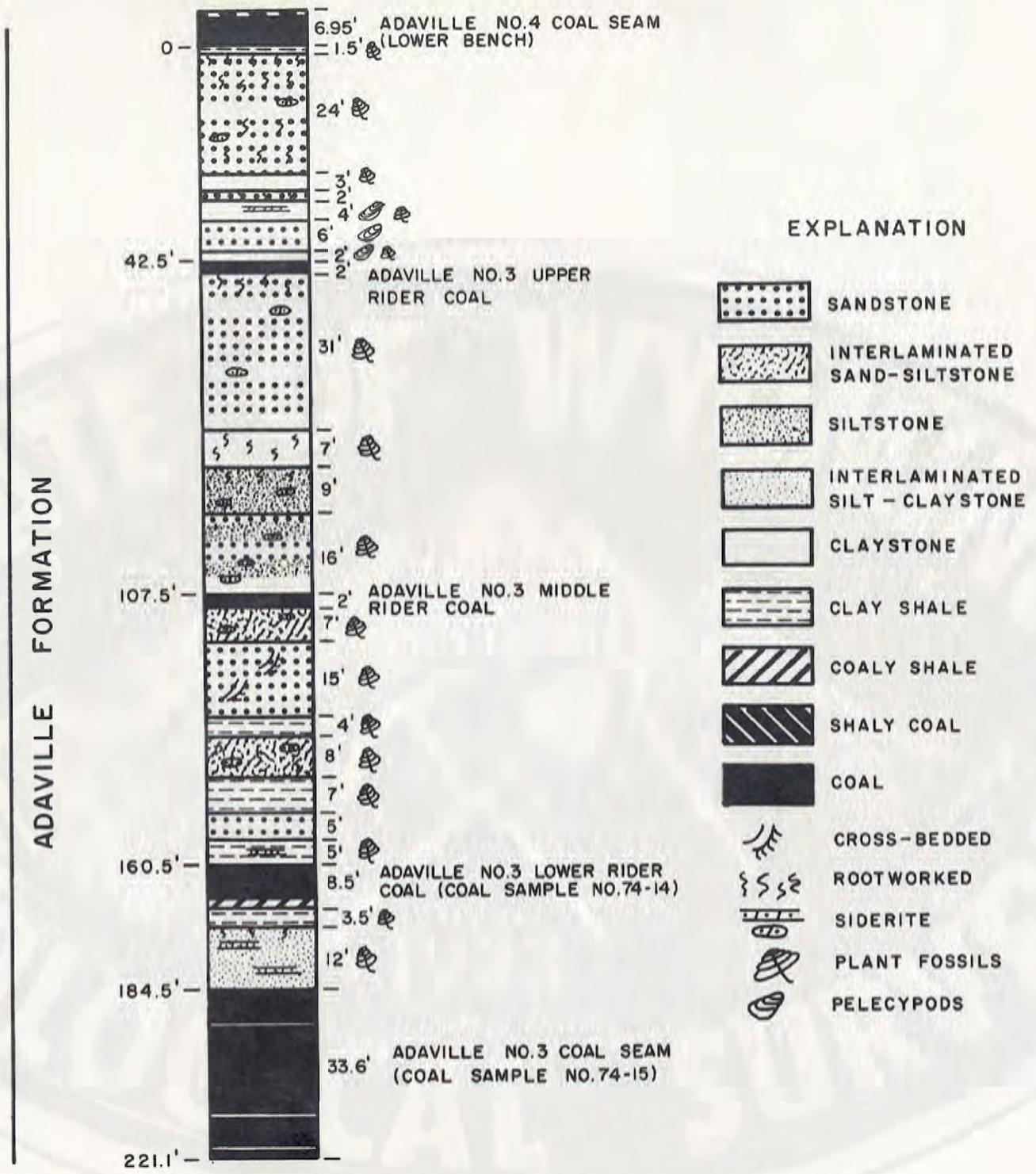


FIGURE 31: MEASURED SECTION AT THE ADAVILLE NO. 3 SAMPLE SITE IN THE SORENSEN MINE (COAL SAMPLE NOS. 74-14 AND 74-15)

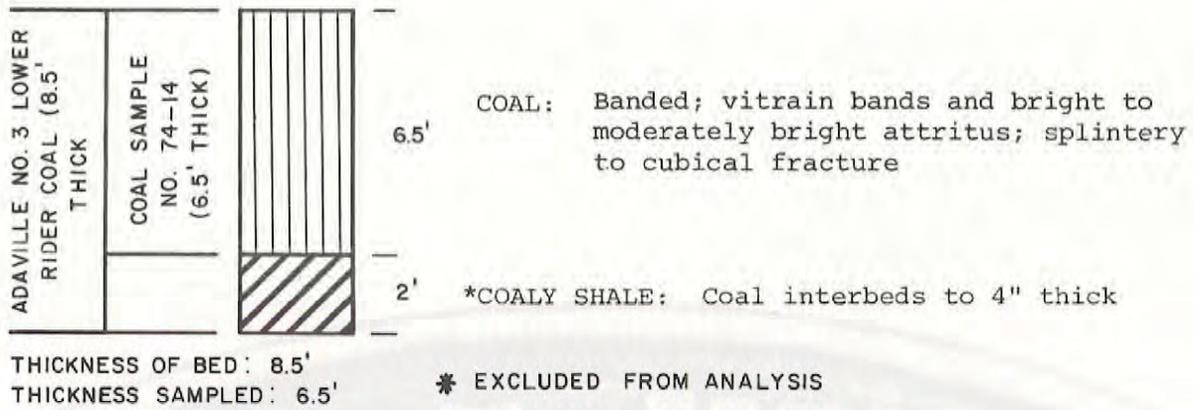


FIGURE 32: MEGASCOPIIC DESCRIPTION OF THE ADAVILLE NO. 3 LOWER RIDER COAL IN THE SORENSEN MINE (COAL SAMPLE NO. 74-14)

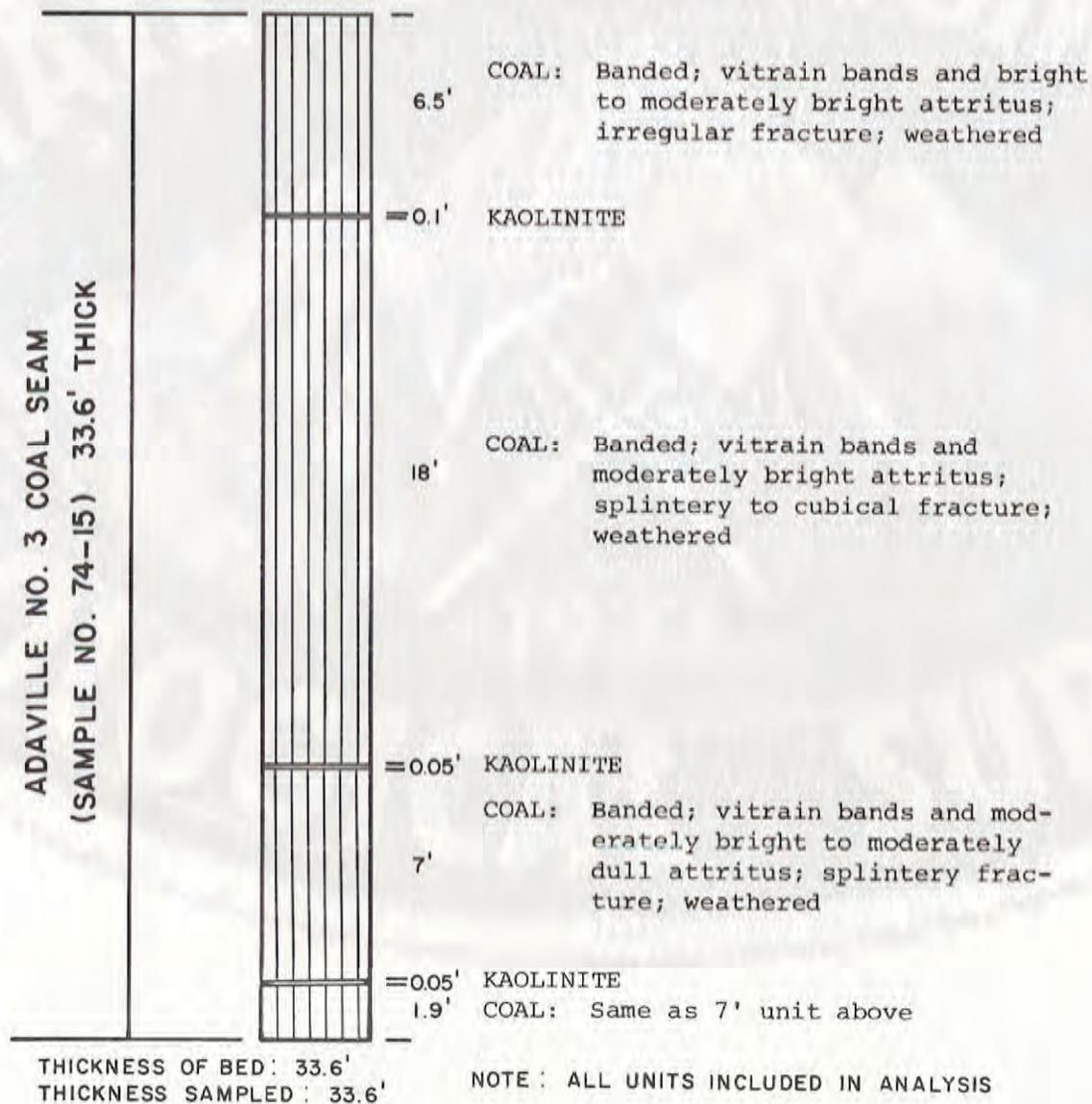


FIGURE 33: MEGASCOPIIC DESCRIPTION OF THE ADAVILLE NO. 3 COAL IN THE SORENSEN MINE (COAL SAMPLE NO. 74-15)

SAMPLE NO. 74-16: ADAVILLE NO. 2 UPPER RIDER

INDEX MAPS: *See Figures 7 and 8*

SAMPLE NO.: 74-16

COAL NAME(S): *Adaville No. 2
Upper Rider*
GEOLOGIC FORMATION: *Adaville*

AGE: *Upper Cretaceous*

COAL FIELD: *Kemmerer*

COAL-BEARING AREA: *Hams Fork Region*

MEASURED SECTION: *See Figure 35*

TOTAL SECTION MEASURED (FEET): *187.4*

COVER AT SAMPLING POINT (FEET): *30.0*

ELEVATION TOP OF SAMPLED COAL: *7200+*

STRIKE: *10-351°*

DIP: *16°W*

MAJOR JOINT ORIENTATIONS IN COAL:
See Sample No. 74-19

STATE: *Wyoming*

COUNTY: *Lincoln*

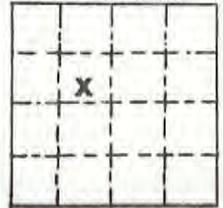
SECTION: *20*

TOWNSHIP: *T21N*

RANGE: *R116W*

QUADRANGLE: *Kemmerer 15'*

LOCATION
IN SECTION



COAL DESCRIPTION: *See Figure 36*

THICKNESS OF COAL (FEET): *4.25*

THICKNESS SAMPLED (FEET): *3.85*

TYPE OF SAMPLE: *Face-channel*

CONDITION OF SAMPLE: *Fresh*

TYPE OF EXPOSURE: *Strip mine*

MINE NAME: *Sorensen*

DATE OF SAMPLING: *8/21/74*

SAMPLE COLLECTOR: *Wyoming Geological Survey*

COMPLETION DATE OF ANALYSES

U. S. Bureau of Mines: *9/18/74*

Wyoming Geological Survey: *3/18/75*

U. S. Geological Survey: *6/13/75*

LABORATORY NUMBERS

K-47374

WGS-16

D171852

APPARENT RANK OF COAL: *Subbituminous B*

MISCELLANEOUS COMMENTS: *There are no company analyses for comparison.*

SAMPLE NO. 74-17: ADAVILLE NO. 2 LOWER RIDER

INDEX MAPS: *See Figures 7 and 8*

SAMPLE NO.: 74-17

COAL NAMES(S): *Adaville No. 2
Lower Rider*

GEOLOGIC FORMATION: *Adaville*

AGE: *Upper Cretaceous*

COAL FIELD: *Kemmerer*

COAL-BEARING AREA: *Hams Fork Region*

MEASURED SECTION: *See Figure 35*

TOTAL SECTION MEASURED (FEET): 187.4

COVER AT SAMPLING POINT (FEET): 80.0

ELEVATION TOP OF SAMPLED COAL: 7150+

STRIKE: 10-351°

DIP: 16°W

MAJOR JOINT ORIENTATIONS IN COAL:

See Sample No. 74-19

STATE: *Wyoming*

COUNTY: *Lincoln*

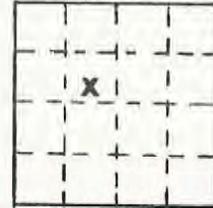
SECTION: 20

TOWNSHIP: *T21N*

RANGE: *R116W*

QUADRANGLE: *Kemmerer 15'*

LOCATION
IN SECTION



COAL DESCRIPTION: *See Figure 37*

THICKNESS OF COAL (FEET): 3.7

THICKNESS SAMPLED (FEET): 3.7

TYPE OF SAMPLE: *Face-channel*

CONDITION OF SAMPLE: *Fresh*

TYPE OF EXPOSURE: *Strip mine*

MINE NAME: *Sorensen*

DATE OF SAMPLING: 8/21/74

SAMPLE COLLECTOR: *Wyoming Geological Survey*

COMPLETION DATE OF ANALYSES

U. S. Bureau of Mines: 9/13/74

Wyoming Geological Survey: 3/18/75

U. S. Geological Survey: 6/13/75

LABORATORY NUMBERS

K-47196

WGS-17

D171851

APPARENT RANK OF COAL: *Subbituminous B*

MISCELLANEOUS COMMENTS: *There are no company analyses available for comparison.*

SAMPLE NO. 74-18: ADAVILLE NO. 2 COAL

INDEX MAPS: See Figures 7 and 8

SAMPLE NO.: 74-18

COAL NAME(S): Adaville No. 2

GEOLOGIC FORMATION: Adaville

AGE: Upper Cretaceous

COAL FIELD: Kemmerer

COAL-BEARING AREA: Hams Fork Region

MEASURED SECTION: See Figure 35

TOTAL SECTION MEASURED (FEET): 187.4

COVER AT SAMPLING POINT (FEET): 150.0

ELEVATION TOP OF SAMPLED COAL: 7100+

STRIKE: 10-351°

DIP: 16°W

MAJOR JOINT ORIENTATIONS IN COAL:
See Sample No. 74-19

STATE: Wyoming

COUNTY: Lincoln

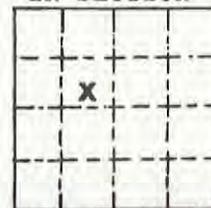
SECTION: 20

TOWNSHIP: T21N

RANGE: R116W

QUADRANGLE: Kemmerer 15'

LOCATION
IN SECTION



COAL DESCRIPTION: See Figure 38

THICKNESS OF COAL (FEET): 15.75

THICKNESS SAMPLED (FEET): 15.00

TYPE OF SAMPLE: Face-channel

CONDITION OF SAMPLE: Weathered

TYPE OF EXPOSURE: Strip mine

MINE NAME: Sorensen

DATE OF SAMPLING: 8/21/74

SAMPLE COLLECTOR: Wyoming Geological Survey

COMPLETION DATE OF ANALYSES

U. S. Bureau of Mines: 9/13/74

Wyoming Geological Survey: 3/18/75

U. S. Geological Survey: 2/12/75

LABORATORY NUMBERS

K-47200

WGS-17

D170262

APPARENT RANK OF COAL: Subbituminous B

MISCELLANEOUS COMMENTS: The heat value of this sample was 200-300 Btu/pound lower than the Kemmerer Coal Company's analyses -- probably because it was weathered. This seam averages 30 feet thick in other portions of the mine. Here it is thin because its lower bench has thinned to nothing but a 0.6' thick shaly coal.

AVERAGE ANALYSIS OF THE ADAVILLE NO. 2 COAL
PROVIDED BY KEMMERER COAL COMPANY

	<u>As Received</u>	<u>Dry Basis</u>
Moisture	20.24%	--
Ash	3.37%	--
Heat Value	--	12,528 Btu/lb.
Sulfur	0.42%	--



*FIGURE 34: KEMMERER COAL COMPANY'S SORENSEN MINE
(VIEW LOOKING NORTHWARD AT THE NORTH
END OF THE MINE. THE ADAVILLE NO. 2
CROPS OUT IN THE LOWER RIGHT FOREGROUND.
THE ADAVILLE NOS. 3 AND 4 WITH RIDERS
CROP OUT IN THE LEFT BACKGROUND.)*

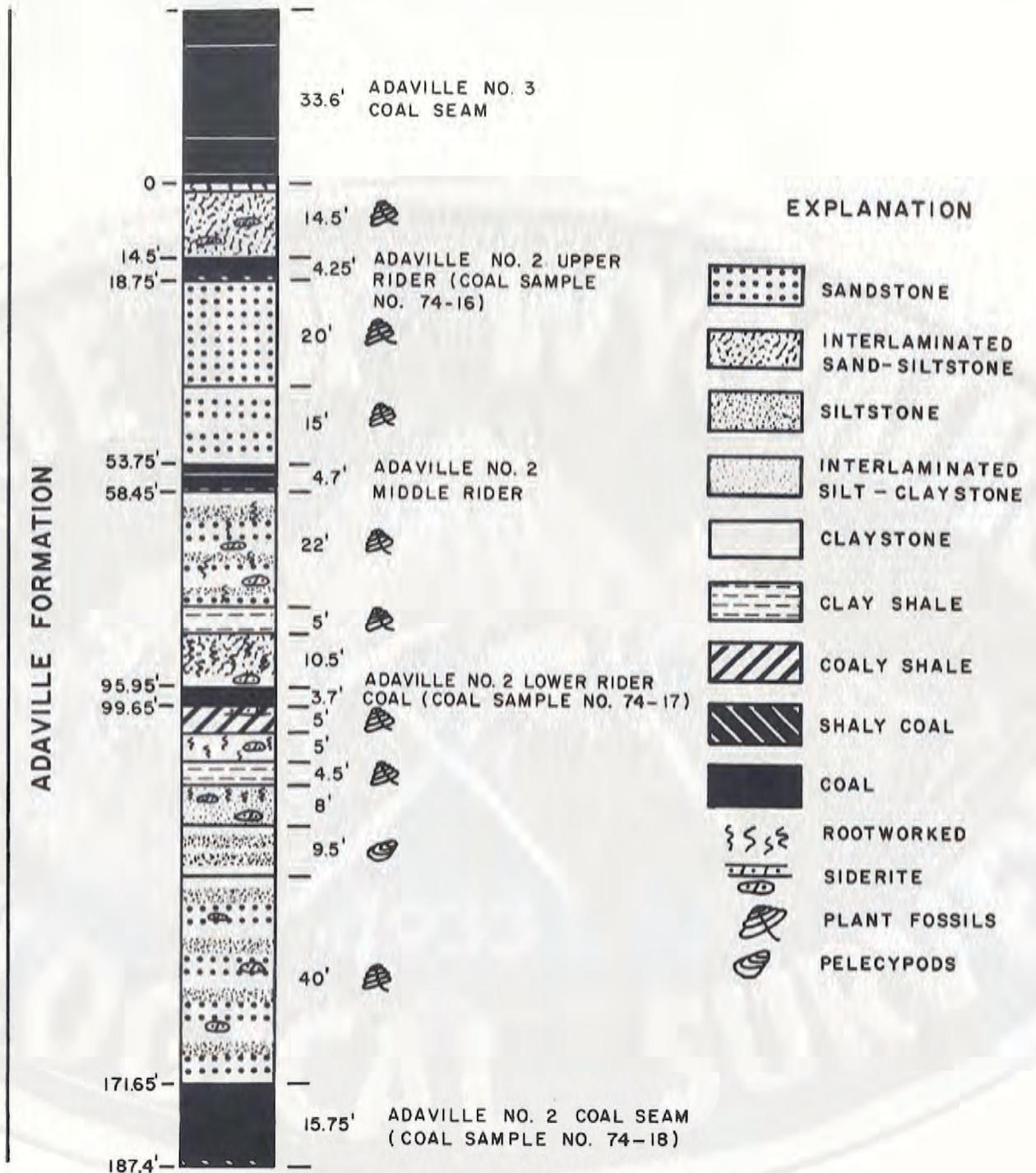


FIGURE 35: MEASURED SECTION AT THE ADAVILLE NO. 2 SAMPLE SITE IN THE SORENSEN MINE (COAL SAMPLE NOS. 74-16, 74-17, AND 74-18)

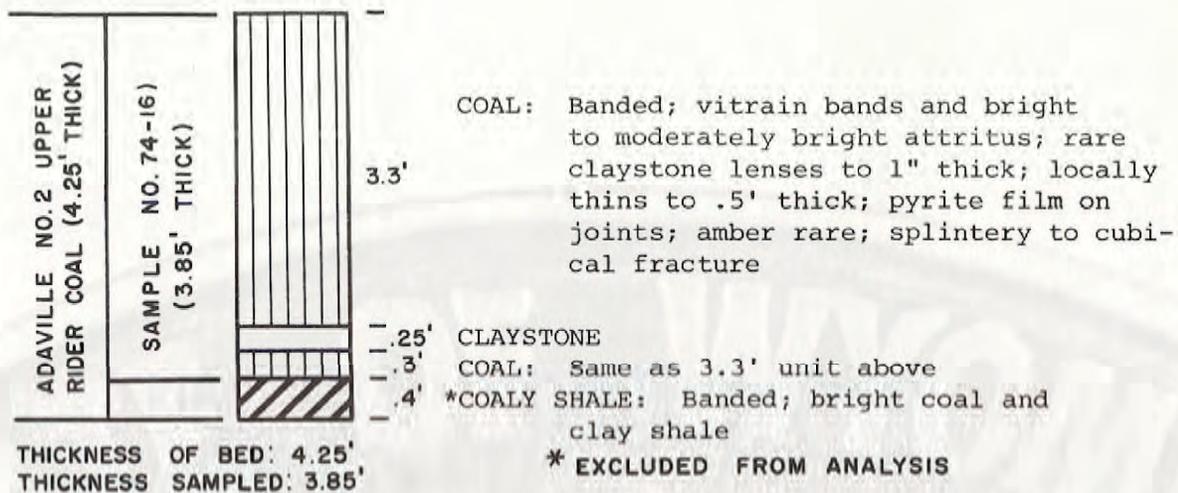


FIGURE 36: MEGASCOPIIC DESCRIPTION OF THE ADAVILLE NO. 2 UPPER RIDER COAL IN THE SORENSEN MINE (COAL SAMPLE NO. 74-16)

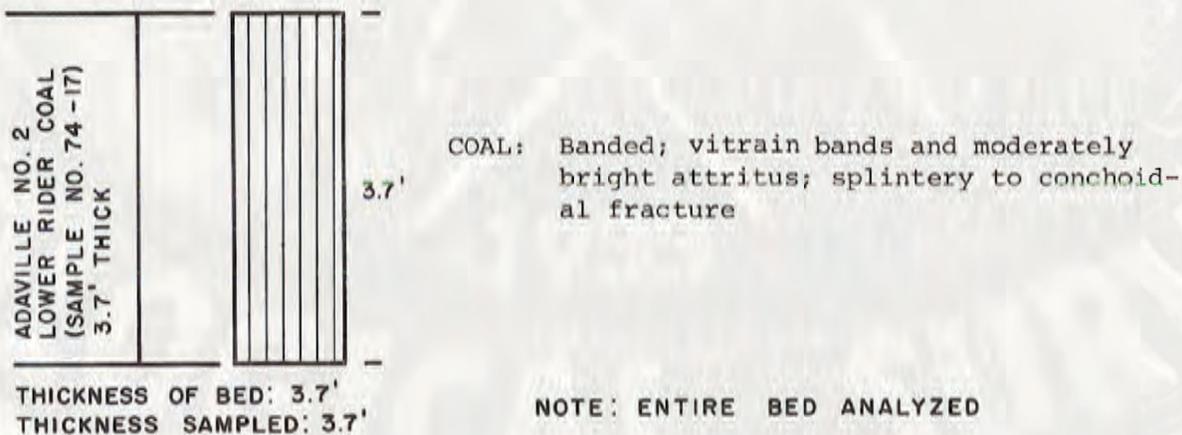
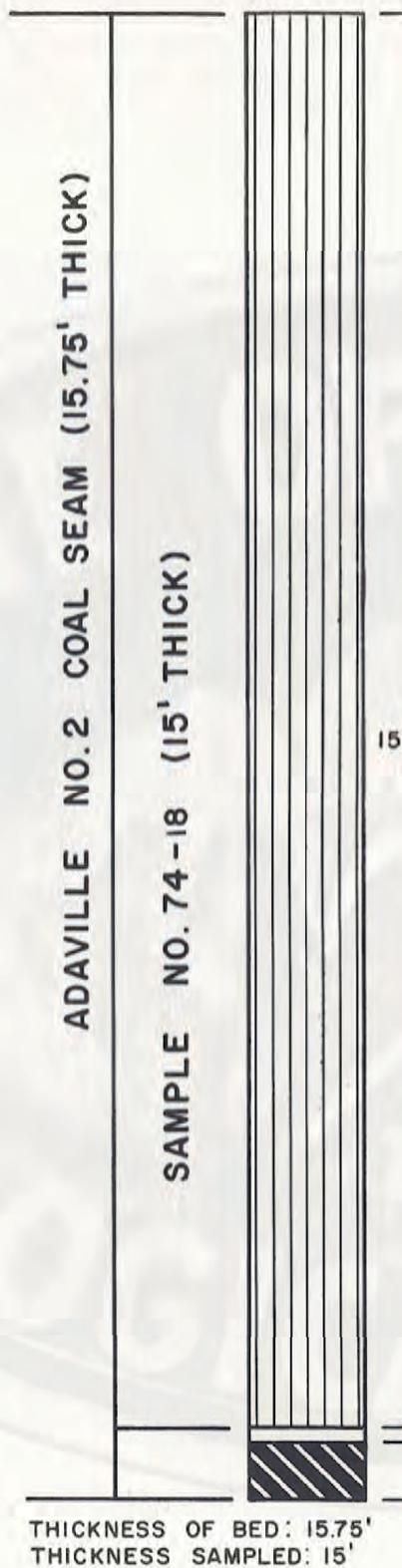


FIGURE 37: MEGASCOPIIC DESCRIPTION OF THE ADAVILLE NO. 2 LOWER RIDER COAL IN THE SORENSEN MINE (COAL SAMPLE NO. 74-17)



COAL: Banded; vitrain bands and moderately bright to moderately dull attritus; rare claystone partings to .125" thick; white stain on joints; iron stain common; irregular fracture; weathered

.15' *CLAYSTONE
 .6' *SHALY COAL: Banded; vitrain bands and dull to moderately dull attritus; amber common; shaly fracture; weathered

*EXCLUDED FROM ANALYSIS

FIGURE 38: MEGASCOPIC DESCRIPTION OF THE ADAVILLE NO. 2 COAL IN THE SORENSEN MINE (COAL SAMPLE NO. 74-18)

SAMPLE NO. 74-19: ADAVILLE NO. 1 COAL

INDEX MAPS: *See Figures 7 and 8*

SAMPLE NO.: 74-19

COAL NAMES(S): *Adaville No. 1*

GEOLOGIC FORMATION: *Adaville*

AGE: *Upper Cretaceous*

COAL FIELD: *Kemmerer*

COAL-BEARING AREA: *Hams Fork Region*

MEASURED SECTION: *See Figure 39*

TOTAL SECTION MEASURED (FEET): 240.9

COVER AT SAMPLING POINT (FEET): 50.0

ELEVATION TOP OF SAMPLED COAL: 7000+

STRIKE: 10-351°

DIP: 16°W

MAJOR JOINT ORIENTATIONS IN COAL:
65°, 330°

STATE: *Wyoming*

COUNTY: *Lincoln*

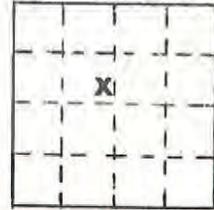
SECTION: 20

TOWNSHIP: *T21N*

RANGE: *R116W*

QUADRANGLE: *Kemmerer 15'*

LOCATION
IN SECTION



COAL DESCRIPTION: *See Figure 40*

THICKNESS OF COAL (FEET): 88.075

THICKNESS SAMPLED (FEET): 84.275

TYPE OF SAMPLE: *Face-channel*

CONDITION OF SAMPLE: *Weathered*

TYPE OF EXPOSURE: *Strip mine*

MINE NAME: *Elkol*

DATE OF SAMPLING: 8/20/74

SAMPLE COLLECTOR: *Wyoming Geological Survey*

COMPLETION DATE OF ANALYSES

U. S. Bureau of Mines: 9/18/74

Wyoming Geological Survey: 3/18/75

U. S. Geological Survey: 2/12/75

LABORATORY NUMBERS

K-47373

WGS-19

D170261

APPARENT RANK OF COAL: *Subbituminous A*

MISCELLANEOUS COMMENTS: *Some analyses by Kemmerer Coal Company show sulfur contents under 0.3%. This seam ranges from 86-108 feet thick, but averages closer to 96 feet.*

AVERAGE ANALYSIS OF THE ADAVILLE NO. 1 COAL
PROVIDED BY KEMMERER COAL COMPANY

	<u>As Received</u>	<u>Dry Basis</u>
Moisture	21.01%	--
Ash	2.59%	--
Heat Value	--	12,750 Btu/lb.
Sulfur	1.07%	--

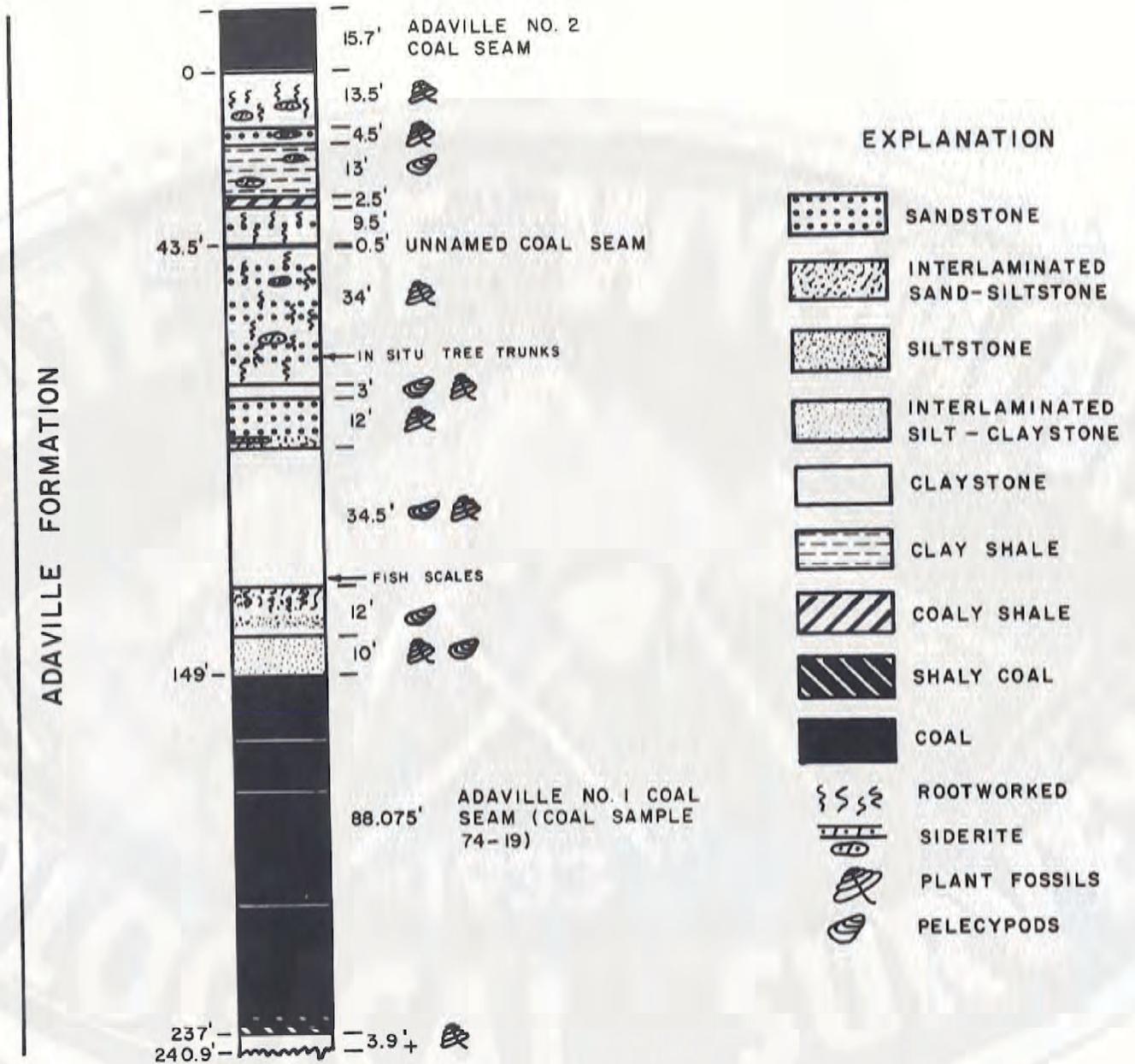


FIGURE 39: MEASURED SECTION AT THE ADAVILLE NO. 1 SAMPLE SITE IN THE ELKOL MINE (COAL SAMPLE NO. 74-19)

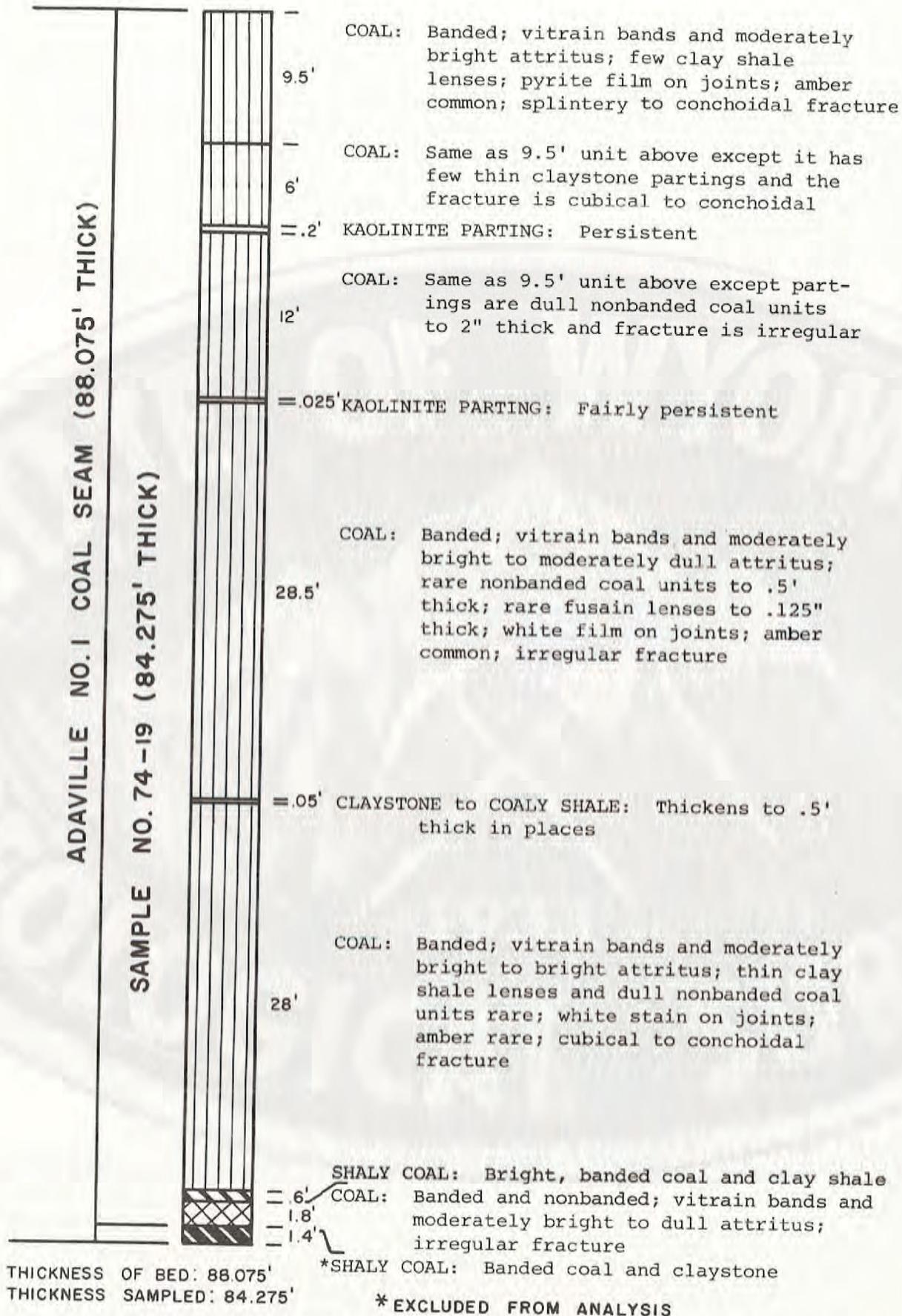


FIGURE 40: MEGASCOPIC DESCRIPTION OF THE ADAVILLE NO. 1 COAL IN THE ELKOL MINE (COAL SAMPLE NO. 74-19)

GREEN RIVER COAL REGION

Three samples were collected from the Green River Coal Region (Figure 41). Two were from the Bridger Coal Company's Jim Bridger strip mine (Coal Sample Nos. 74-20 and 74-21). These two samples consisted of the upper and lower benches of the Deadman coal from the Paleocene Fort Union Formation. Figure 42 shows the detailed location of the sample site for these two samples.

The third sample (Coal Sample No. 74-22) was a Rock Springs No. 7 coal sample, which was collected in the Columbine Mining Company's Rainbow No. 8 deep mine (formerly owned by Gunn-Quealy Coal Company). This is the only bituminous coal sampled for this report. See Figure 45 for a detailed map of this sample site.

Figure 41 also shows generalized sections of the sampled Rock Springs Formation as well as a portion of the Fort Union Formation. Both coal names and sample numbers are shown.

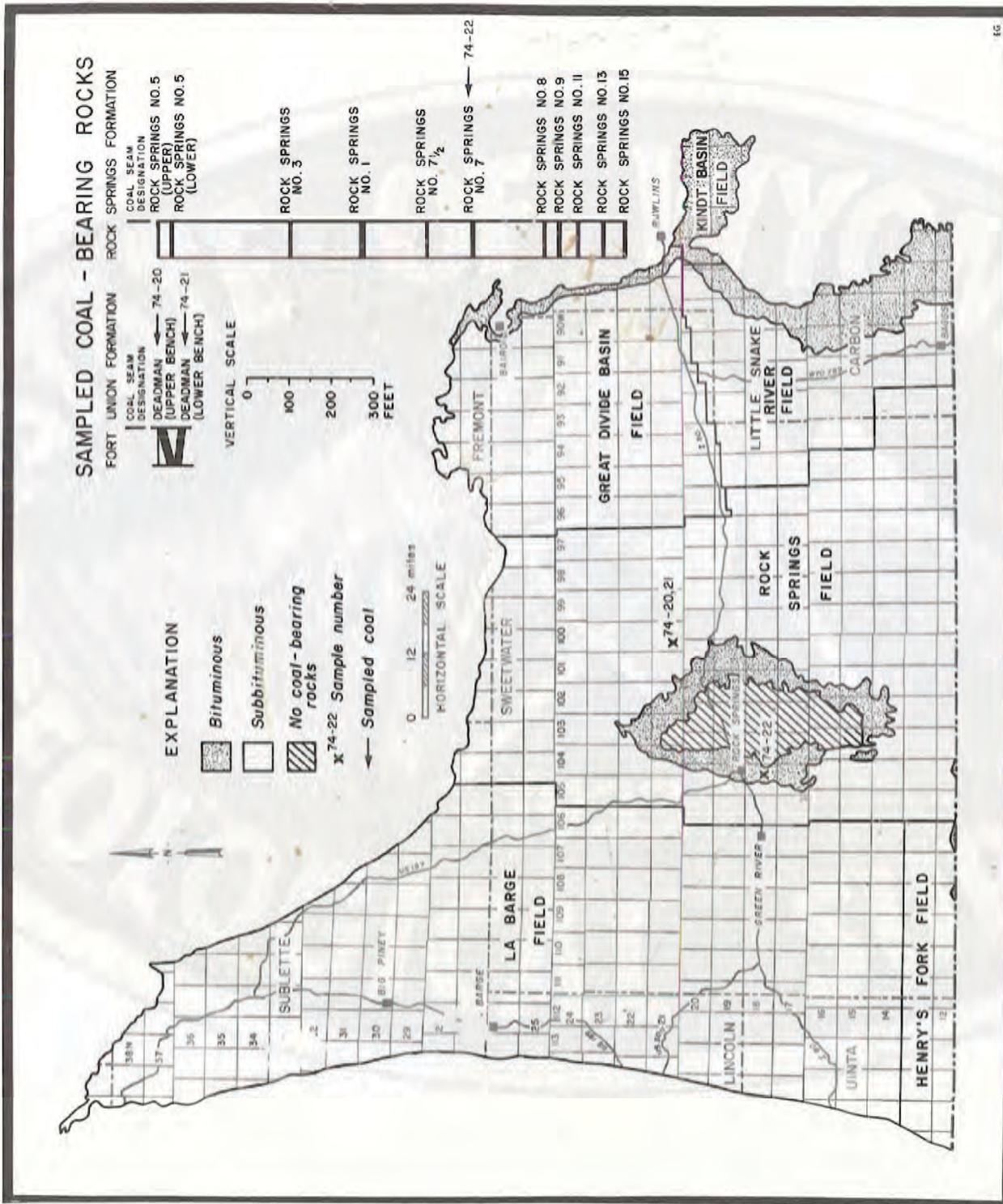


FIGURE 41: GENERALIZED SECTIONS AND INDEX MAP OF 3 SAMPLES (NOS. 74-20 TO 74-22) COLLECTED IN THE GREEN RIVER COAL REGION IN 1974

SAMPLE NO. 74-20: DEADMAN COAL (UPPER BENCH)

INDEX MAPS: See Figures 41 and 42

SAMPLE NO.: 74-20

COAL NAME(S): Deadman (Upper Bench)

GEOLOGIC FORMATION: Fort Union

AGE: Paleocene

COAL FIELD: Rock Springs

COAL-BEARING AREA: Green River Region

MEASURED SECTION: See Figure 43

TOTAL SECTION MEASURED (FEET): 58.9

COVER AT SAMPLING POINT (FEET): 27.0

ELEVATION TOP OF SAMPLED COAL: 6770

STRIKE: 0°

DIP: Less than 4°E

MAJOR JOINT ORIENTATIONS IN COAL:

55-60°, 324-336°

STATE: Wyoming

COUNTY: Sweetwater

SECTION: 20

TOWNSHIP: T21N

RANGE: R100W

QUADRANGLE: Superior 15'

LOCATION
IN SECTION



COAL DESCRIPTION: See Figure 44

THICKNESS OF COAL (FEET): 31.3

THICKNESS SAMPLED (FEET): 15.0

TYPE OF SAMPLE: Face-channel

CONDITION OF SAMPLE: Weathered

TYPE OF EXPOSURE: Strip mine

MINE NAME: Jim Bridger

DATE OF SAMPLING: 8/30/74

SAMPLE COLLECTOR: Wyoming Geological Survey

COMPLETION DATE OF ANALYSES

U. S. Bureau of Mines: 9/18/74

Wyoming Geological Survey: 3/18/75

U. S. Geological Survey: 6/13/75

LABORATORY NUMBERS

K-47372

WGS-20

D171834

APPARENT RANK OF COAL: Subbituminous B

MISCELLANEOUS COMMENTS: This sample's routine analysis compares favorable with a typical analysis provided by the Bridger Coal Company. Its heat value is less than 100 Btu/pound below the average. See the miscellaneous comments for Coal Sample No. 74-21 for a representative analysis of the Deadman coal provided by the company.

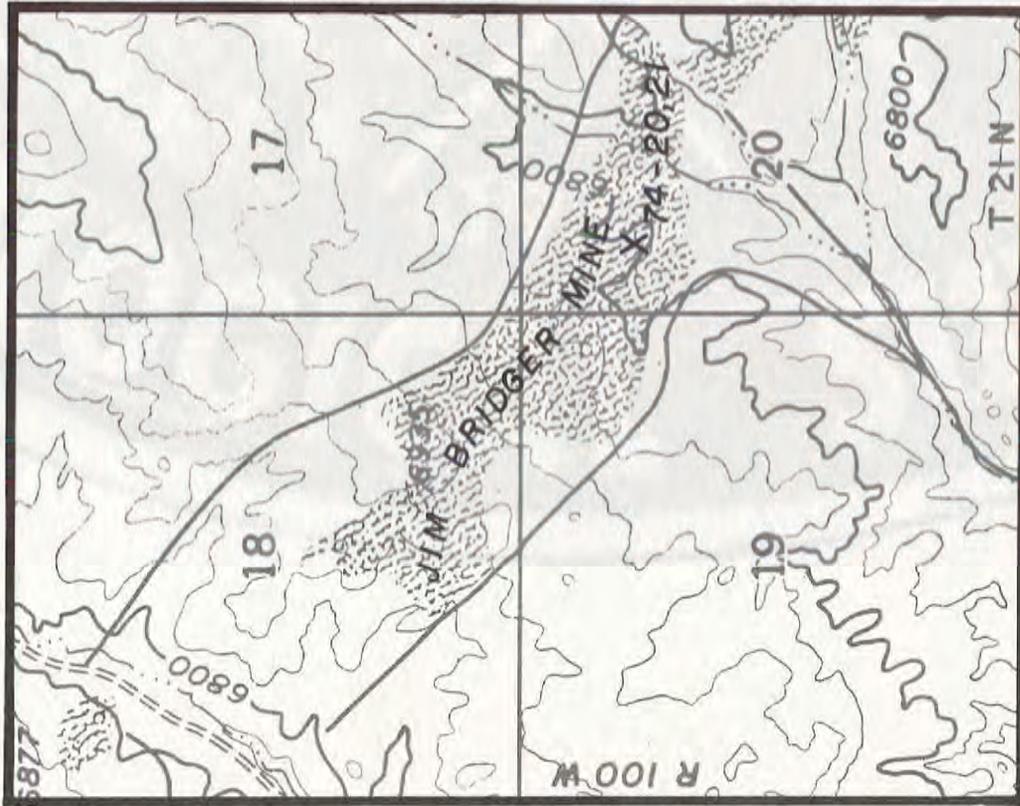
Additionally, Bridger Coal Company provided the following average concentrations for mercury (Hg), manganese (Mn), molybdenum (Mo), lead (Pb), and vanadium (V) for this bench of the Deadman coal:

AVERAGE TRACE ELEMENT CONTENT OF THE UPPER BENCH OF THE DEADMAN COAL
(PPM ON A WHOLE-COAL BASIS)¹

	<u>Hg</u> ²	<u>Mn</u>	<u>Mo</u>	<u>Pb</u> ²	<u>V</u>
Number of samples	17	Not given	Not given	14	Not given
Mean	0.14	9.7	1.5	3.30	9.7
Standard deviation	(0.16)	---	---	(2.15)	---

¹Data provided by the Bridger Coal Company

²This is an average for a composite sample of both benches



EXPLANATION



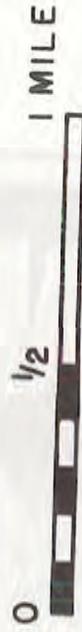
X
74-20

SAMPLE SITE
AND SAMPLE
NUMBER



STRIP MINE

Base map modified from U.S. Geological Survey's Superior 15' (1958) topographic map.



HORIZONTAL SCALE

FIGURE 42: DETAILED LOCATION MAP OF COAL SAMPLES 74-20 AND 74-21 COLLECTED IN 1974 FROM BRIDGER COAL COMPANY'S JIM BRIDGER STRIP MINE, SWEETWATER COUNTY, WYOMING

SAMPLE NO. 74-21: DEADMAN COAL (LOWER BENCH)

INDEX MAPS: See Figures 41 and 42

SAMPLE NO.: 74-21

COAL NAME(S): Deadman (Lower Bench)

GEOLOGIC FORMATION: Fort Union

AGE: Paleocene

COAL FIELD: Rock Springs

COAL-BEARING AREA: Green River Region

MEASURED SECTION: See Figure 43

TOTAL SECTION MEASURED (FEET): 58.9

COVER AT SAMPLING POINT (FEET): 70.0

ELEVATION TOP OF SAMPLED COAL: 6700

STRIKE: 0°

DIP: Less than 4°E

MAJOR JOINT ORIENTATIONS IN COAL:
See Sample No. 74-20

STATE: Wyoming

COUNTY: Sweetwater

SECTION: 20

TOWNSHIP: T21N

RANGE: R100W

QUADRANGLE: Superior 15'

LOCATION
IN SECTION



COAL DESCRIPTION: See Figure 44

THICKNESS OF COAL (FEET): 31.3

THICKNESS SAMPLED (FEET): 15.8

TYPE OF SAMPLE: Face-channel

CONDITION OF SAMPLE: Weathered

TYPE OF EXPOSURE: Strip mine

MINE NAME: Jim Bridger

DATE OF SAMPLING: 8/30/74

SAMPLE COLLECTOR: Wyoming Geological Survey

COMPLETION DATE OF ANALYSES

U. S. Bureau of Mines: 9/18/74

Wyoming Geological Survey: 3/18/75

U. S. Geological Survey: 6/13/75

LABORATORY NUMBERS

K-47371

WGS-21

D171833

APPARENT RANK OF COAL: Subbituminous C

MISCELLANEOUS COMMENTS: The nearness to outcrop has elevated the moisture and ash contents of this sample above company averages. As a result, the heat value is more than 1400 Btu/pound below average on an as received basis. For this reason, a representative composite analysis of both benches of the Deadman coal was provided by the Bridger Coal Company and is reproduced here:

REPRESENTATIVE ANALYSIS OF A DELIVERED DEADMAN COAL SAMPLE
PROVIDED BY THE BRIDGER COAL COMPANY (BOTH BENCHES COMBINED)

PROXIMATE ANALYSIS

	<u>As Received</u>	<u>Dry Basis</u>
Moisture	20.52%	--
Ash	9.68%	12.18%
Volatile Matter	29.09%	36.60%
Fixed Carbon	40.71%	51.22%

HEAT VALUE

	<u>As Received</u>	<u>Dry Basis</u>
Btu/lb.	9,350	11,759

ULTIMATE ANALYSIS

	<u>As Received</u>	<u>Dry Basis</u>
Carbon	54.48%	68.55%
Hydrogen	6.11%	4.46%
Nitrogen	0.95%	1.19%
Chlorine	0.02%	0.02%
Sulfur	0.47%	0.59%
Oxygen	28.30%	13.01%
Ash	9.68%	12.18%

SULFUR FORMS

	<u>As Received</u>	<u>Dry Basis</u>
Pyritic	0.20%	0.25%
Sulfate	0.01%	0.01%
Organic	0.26%	0.33%
Total	0.47%	0.59%

Additionally, Bridger Coal Company also provided the following average concentrations for mercury (Hg), manganese (Mn), molybdenum (Mo), lead (Pb), and vanadium (V) for the lower bench of the Deadman coal:

AVERAGE TRACE ELEMENT CONTENT OF THE LOWER BENCH OF THE DEADMAN COAL
(PPM ON A WHOLE-COAL BASIS)¹

	<u>Hg</u> ²	<u>Mn</u>	<u>Mo</u>	<u>Pb</u> ²	<u>V</u>
Number of samples	17	Not given	Not given	14	Not given
Mean	0.14	26	1.5	3.30	38
Standard deviation	(0.16)	--	---	(2.15)	--

¹Data provided by the Bridger Coal Company.

²This is an average for a composite sample of both benches.

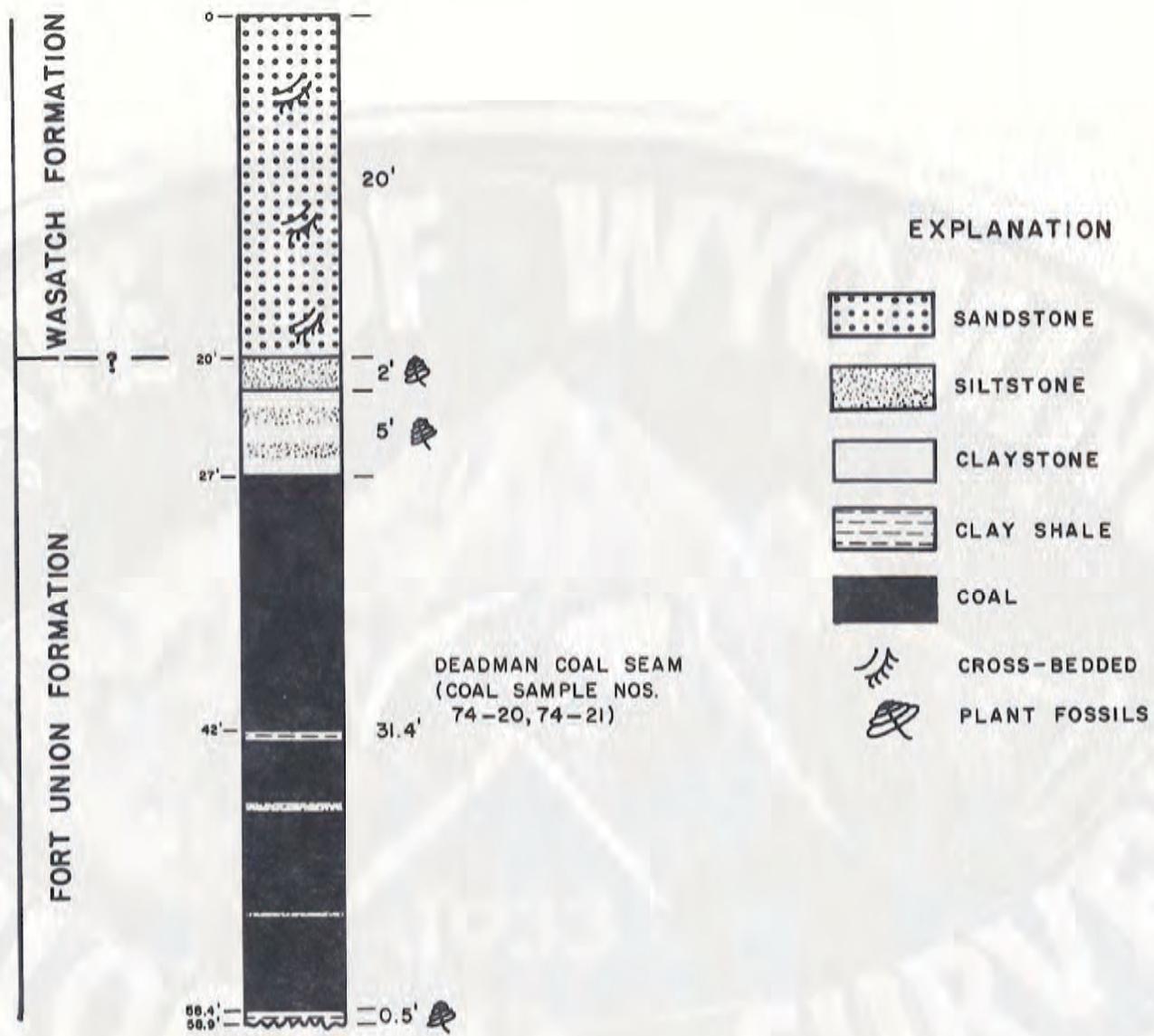


FIGURE 43: MEASURED SECTION AT THE DEADMAN COAL SAMPLE SITE IN THE JIM BRIDGER MINE (COAL SAMPLE NOS. 74-20 AND 74-21)

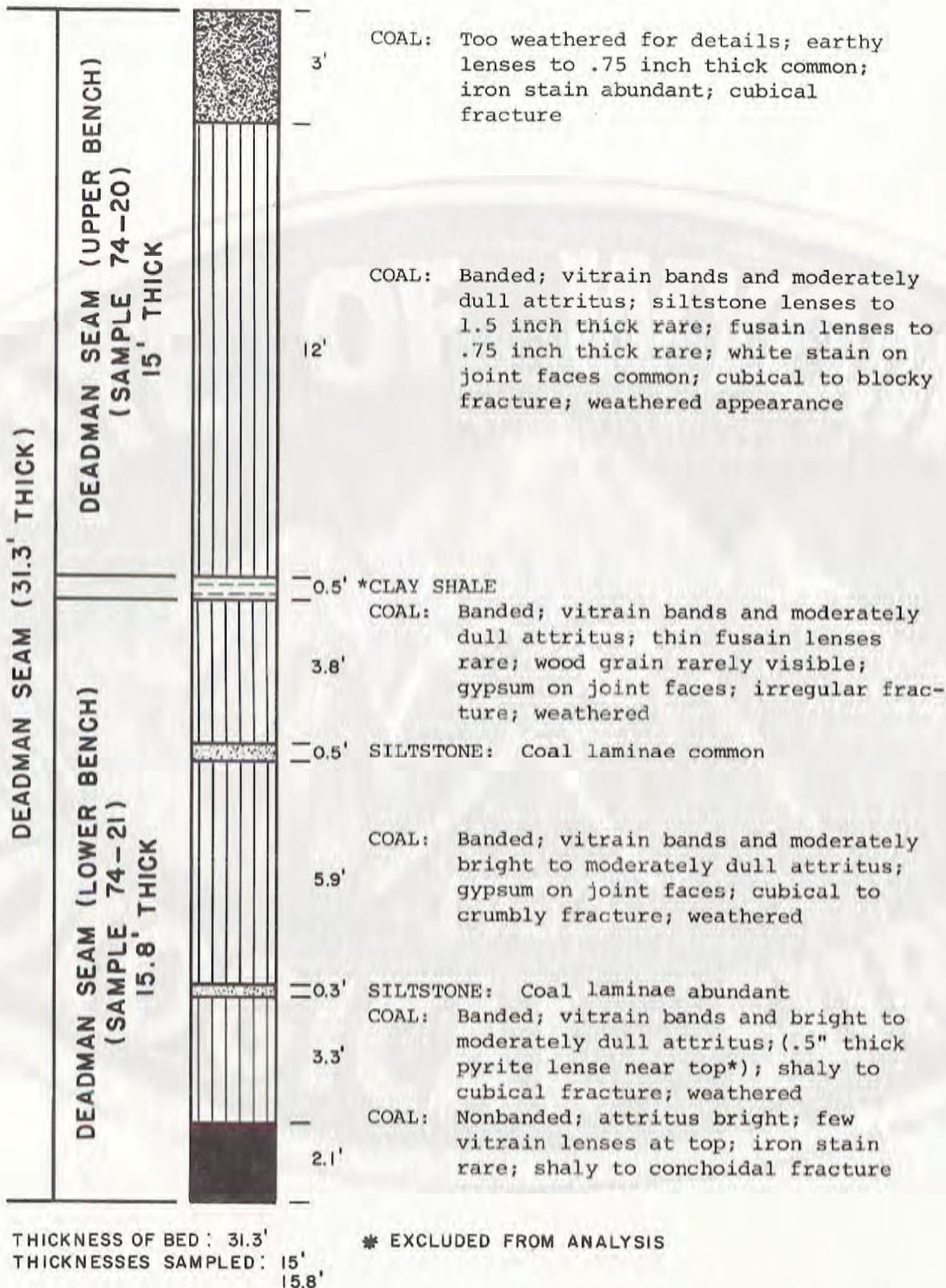


FIGURE 44: MEGASCOPIC DESCRIPTION OF THE UPPER AND LOWER BENCHES OF THE DEADMAN COAL IN THE JIM BRIDGER MINE (COAL SAMPLE NOS. 74-20 AND 74-21)

SAMPLE NO. 74-22: ROCK SPRINGS NO. 7 COAL

INDEX MAPS: *See Figures 41 and 45*

SAMPLE NO.: 74-22

COAL NAME(S): *Rock Springs No. 7*

GEOLOGIC FORMATION: *Rock Springs*

AGE: *Upper Cretaceous*

COAL FIELD: *Rock Springs*

COAL-BEARING AREA: *Green River Region*

MEASURED SECTION: *See Figure 46*

TOTAL SECTION MEASURED (FEET): 36.15

COVER AT SAMPLING POINT (FEET): 100+

ELEVATION TOP OF SAMPLED COAL: 6550+

STRIKE: *Approximately 340°*

DIP: 14°SW

MAJOR JOINT ORIENTATIONS IN COAL:

330-344°, 80-88°

STATE: *Wyoming*

COUNTY: *Sweetwater*

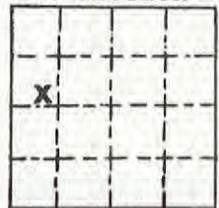
SECTION: 23

TOWNSHIP: *T18N*

RANGE: *R105W*

QUADRANGLE: *Rock Springs 7 1/2'*

LOCATION
IN SECTION



COAL DESCRIPTION: *See Figure 47*

THICKNESS OF COAL (FEET): 4.95

THICKNESS SAMPLED (FEET): 4.95

TYPE OF SAMPLE: *Face-channel*

CONDITION OF SAMPLE: *Fresh*

TYPE OF EXPOSURE: *Deep mine*

MINE NAME: *Rainbow No. 8*

DATE OF SAMPLING: 8/31/74

SAMPLE COLLECTOR: *Wyoming Geological Survey*

COMPLETION DATE OF ANALYSES

U. S. Bureau of Mines: 9/13/74

Wyoming Geological Survey: 3/18/75

U. S. Geological Survey: 2/12/75

LABORATORY NUMBERS

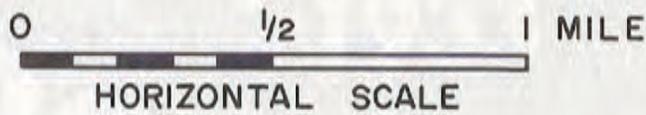
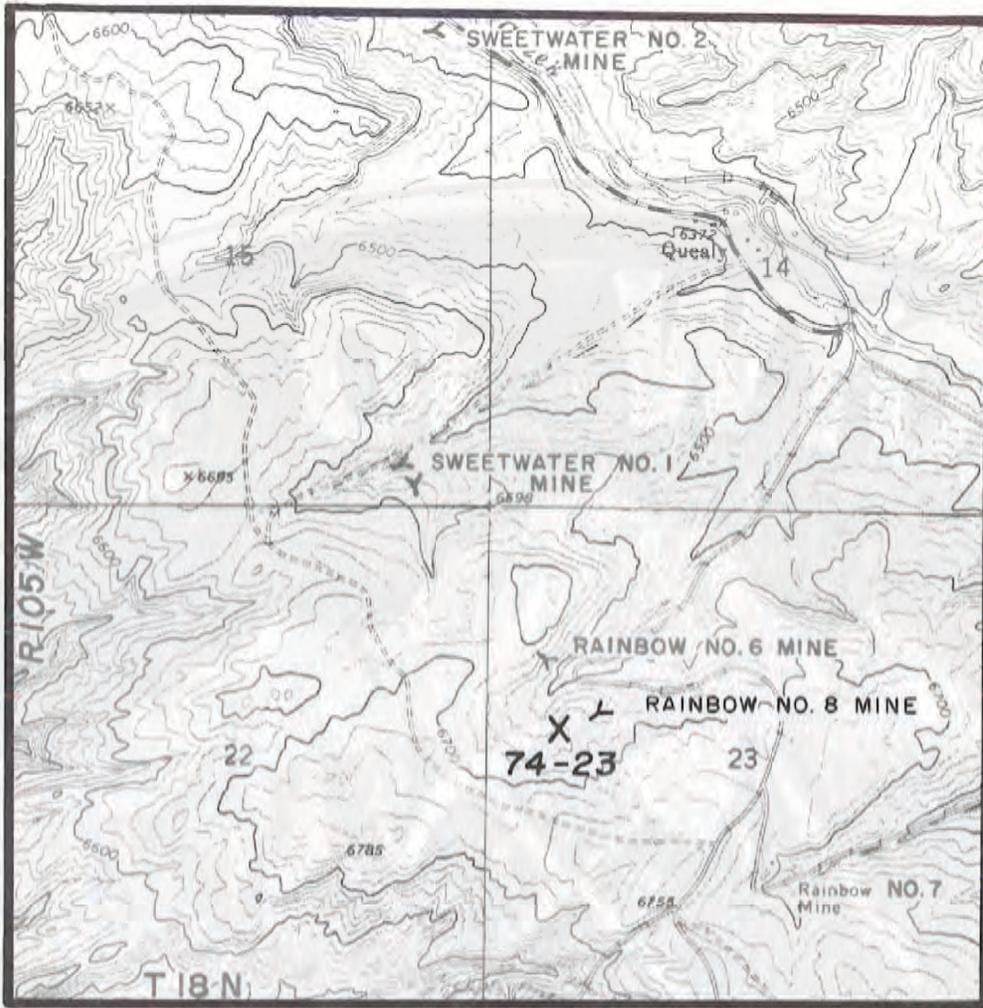
K-47201

WGS-22

D170264

APPARENT RANK OF COAL: *High Volatile C Bituminous*

MISCELLANEOUS COMMENTS: *This is the only bituminous coal sampled.*



EXPLANATION

X 74-23 SAMPLE SITE AND SAMPLE NUMBER

Base map modified from U.S. Geological Survey's Rock Springs 7 1/2' (1968) topographic map.

FIGURE 45: DETAILED LOCATION MAP OF COAL SAMPLE 74-22 COLLECTED IN 1974 FROM COLUMBINE MINING COMPANY'S RAINBOW NO. 8 DEEP MINE, SWEETWATER COUNTY, WYOMING

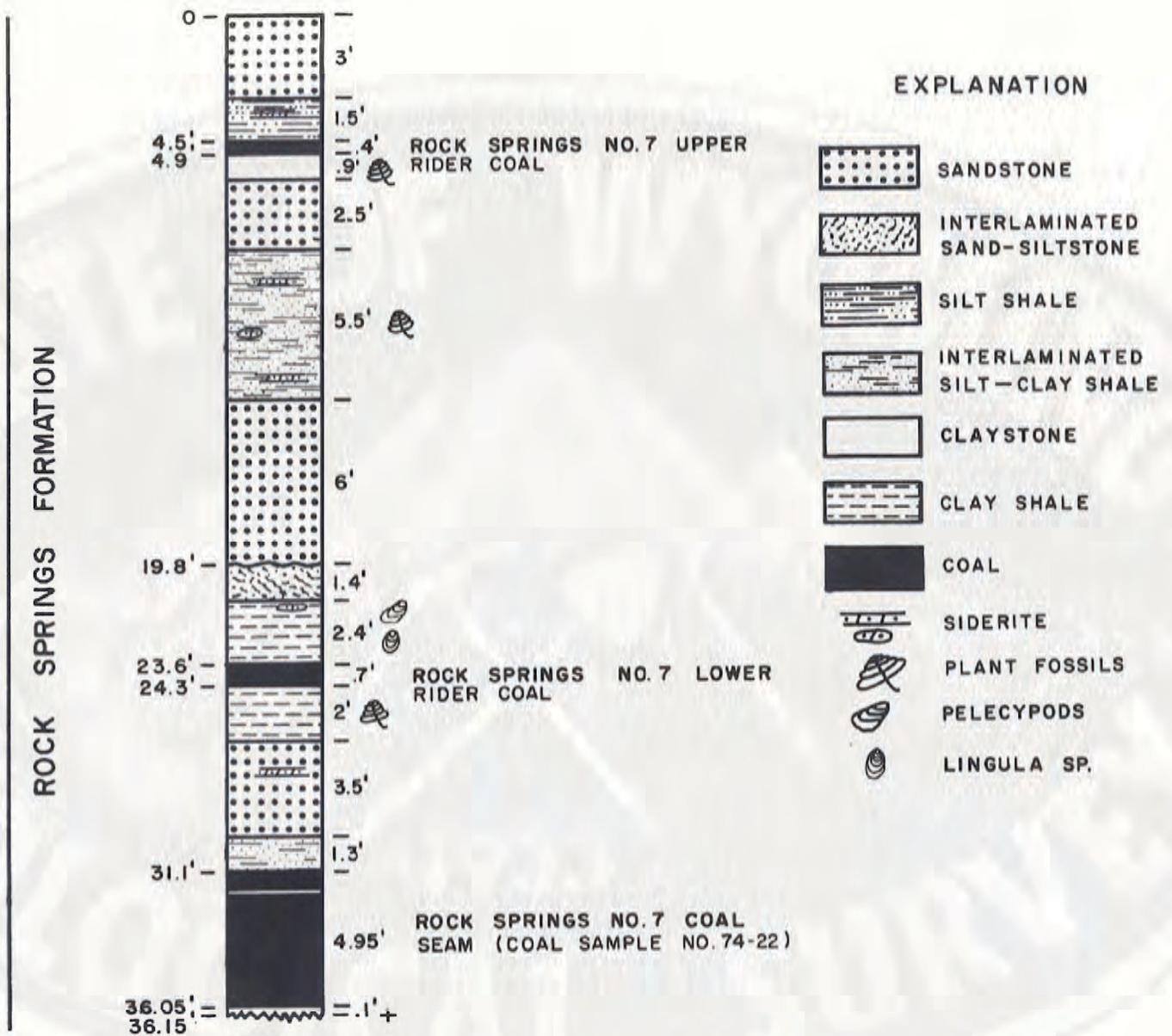


FIGURE 46: MEASURED SECTION AT THE ROCK SPRINGS NO. 7 COAL SAMPLE SITE IN THE RAINBOW NO. 8 MINE (COAL SAMPLE NO. 74-22)

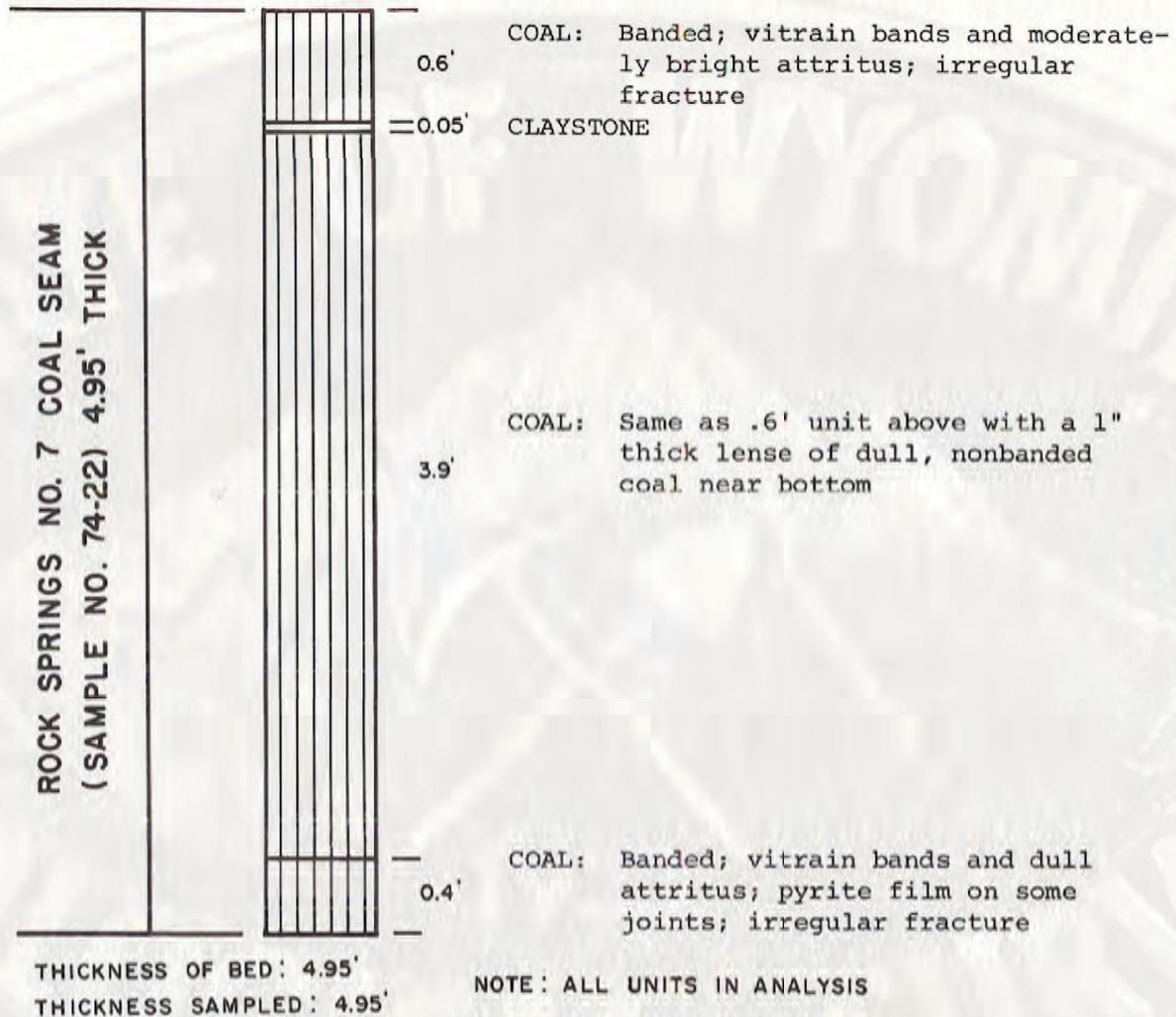


FIGURE 47: MEGASCOPIC DESCRIPTION OF THE ROCK SPRINGS NO. 7 COAL IN THE RAINBOW NO. 8 MINE (COAL SAMPLE NO. 74-22)

HANNA COAL FIELD

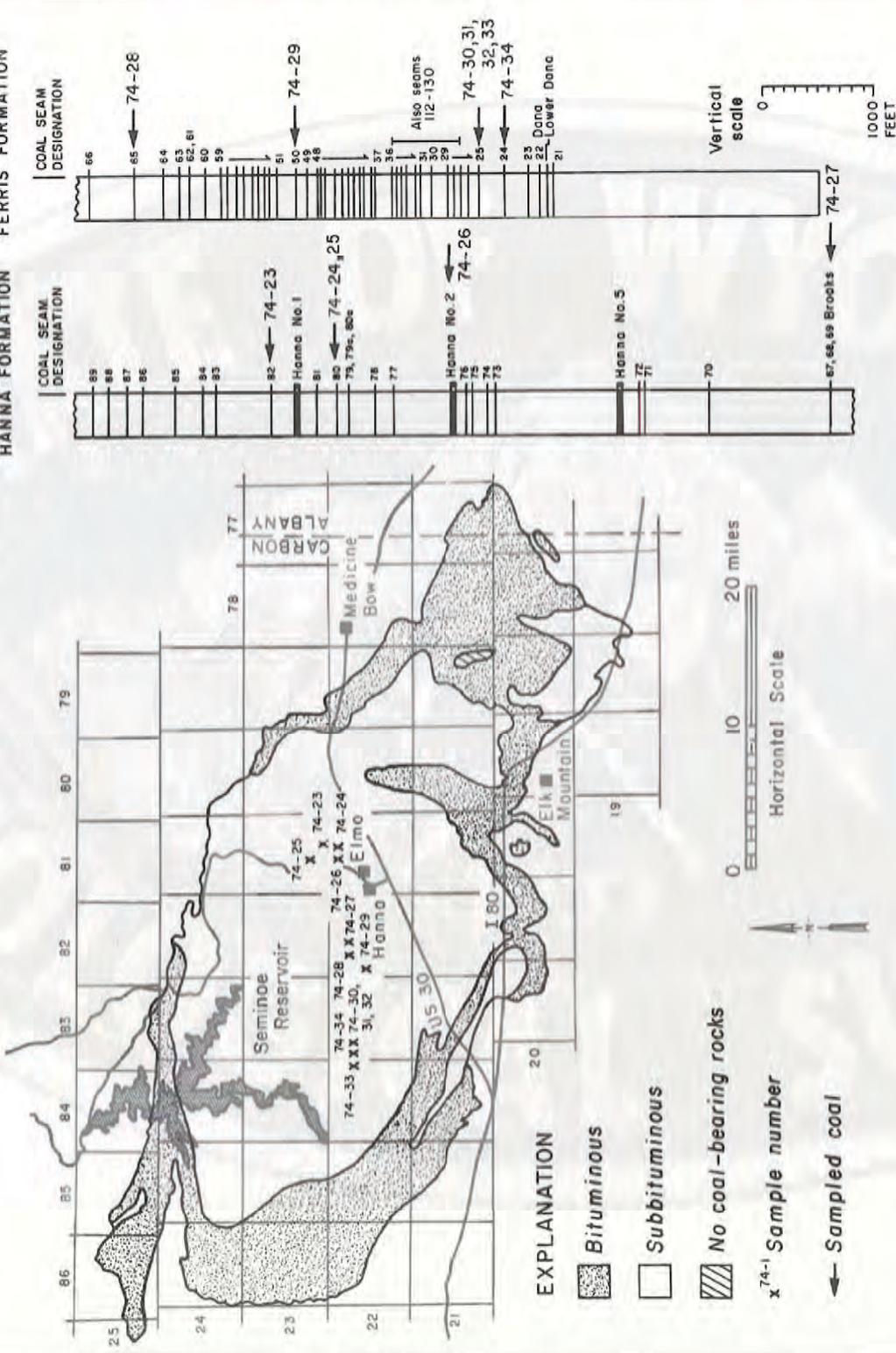
Twelve samples were collected in the Hanna Coal Field (Figure 48). Of these, five were coals from the Eocene-Paleocene Hanna Formation. The one sample of Bed No. 82 (74-23) and the two of Bed No. 80 (74-24 & 25) were collected from various strip mines of the Rosebud Coal Sales Company (Figure 49). The Hanna No. 2 sample (74-26) was collected in an abandoned Monolith strip mine (Figure 57). The lowermost Hanna Formation coal, the Brooks coal (74-27), was sampled in an Energy Development Company's strip mine (Figure 60).

The other 7 samples from the Hanna Coal Field were from the Ferris Formation. Bed No. 65 (74-28) was sampled in the Energy Development Company's Vanguard No. 1 deep mine (Figure 60). The Bed No. 50 sample (74-29) was also collected from an Energy Development Company deep mine, the Vanguard No. 2 (Figure 60). Four samples of various benches of Bed No. 25 were collected from outcrops as was a single sample of Bed No. 24. Figure 48 shows the sample sites for the Bed No. 25 and No. 24 samples (74-30 to 74-34).

Figure 48 also shows the sampled coals and the sample numbers on generalized sections of the Hanna and Ferris Formations.

SAMPLED COAL-BEARING FORMATION

HANNA FORMATION FERRIS FORMATION



EG PW

FIGURE 48: GENERALIZED SECTIONS AND INDEX MAP OF 12 SAMPLES (NOS. 74-23 TO 74-34) COLLECTED IN THE HANNA COAL FIELD IN 1974

SAMPLE NO. 74-23: BED NO. 82

INDEX MAPS: See Figures 48 and 49

SAMPLE NO.: 74-23

COAL NAME(S): Bed No. 82

GEOLOGIC FORMATION: Hanna

AGE: Eocene

COAL FIELD: Hanna

COAL-BEARING AREA: Hanna Coal Field

MEASURED SECTION: See Figure 50

TOTAL SECTION MEASURED (FEET): 85.05

COVER AT SAMPLING POINT (FEET): 73.6

ELEVATION TOP OF SAMPLED COAL: 7180

STRIKE: 355°

DIP: 10°NE

MAJOR JOINT ORIENTATIONS IN COAL:

300-330°, 20°, 70°

STATE: Wyoming

COUNTY: Carbon

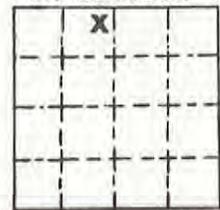
SECTION: 34

TOWNSHIP: T23N

RANGE: R81W

QUADRANGLE: Elmo 7 1/2'

LOCATION
IN SECTION



COAL DESCRIPTION: See Figure 51

THICKNESS OF COAL (FEET): 11.25

THICKNESS SAMPLED (FEET): 11.25

TYPE OF SAMPLE: Face-channel

CONDITION OF SAMPLE: Weathered

TYPE OF EXPOSURE: Strip mine

MINE NAME: Rosebud Pit No. 5

DATE OF SAMPLING: 9/10/74

SAMPLE COLLECTOR: Wyoming Geological Survey

COMPLETION DATE OF ANALYSES

U. S. Bureau of Mines: 9/27/74

Wyoming Geological Survey: 3/18/75

U. S. Geological Survey: 2/12/75

LABORATORY NUMBERS

K-47600

WGS-23

D170258

APPARENT RANK OF COAL: Subbituminous A

MISCELLANEOUS COMMENTS: The routine analysis of Sample No. 74-23 compares very favorably with representative analyses provided by Rosebud Coal Sales Company. The as received sulfur content is only 0.1-0.2% higher than the company analyses.

AVERAGE OF 6 ANALYSES OF BED NO. 82
PROVIDED BY ROSEBUD COAL SALES COMPANY (CORE SAMPLES)

Moisture (As Received)	12.38%
Ash (As Received)	9.14%
Sulfur (As Received)	0.81%
Heat Value (As Received)	10,500 Btu/lb.
Heat Value (Dry, Ash-free)	13,380 Btu/lb.

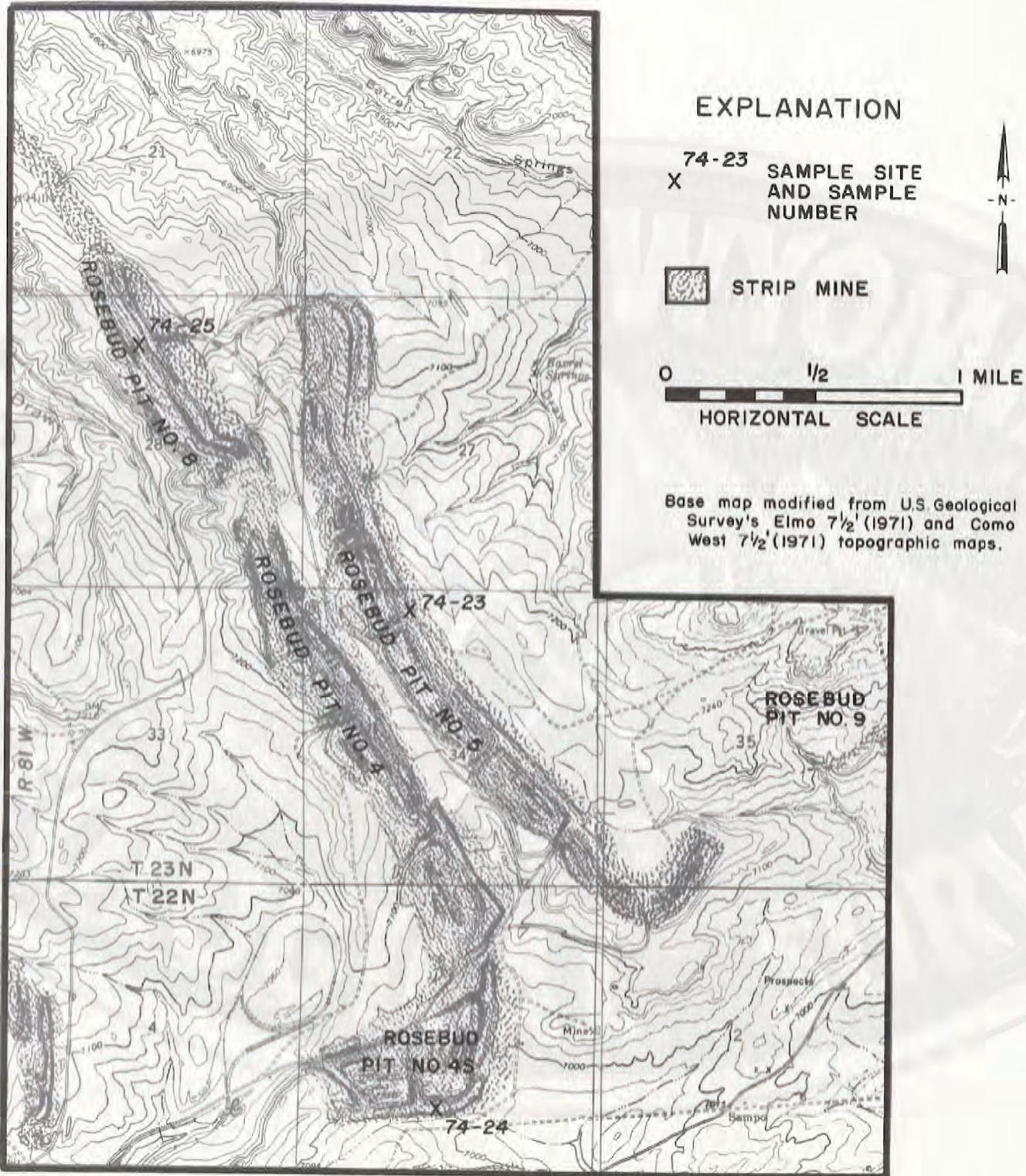


FIGURE 49: DETAILED LOCATION MAP OF COAL SAMPLES 74-23 THROUGH 74-25 COLLECTED IN 1974 FROM ROSEBUD COAL SALES' ROSEBUD PIT NOS. 4, 4S, 5 AND 8, CARBON COUNTY, WYOMING

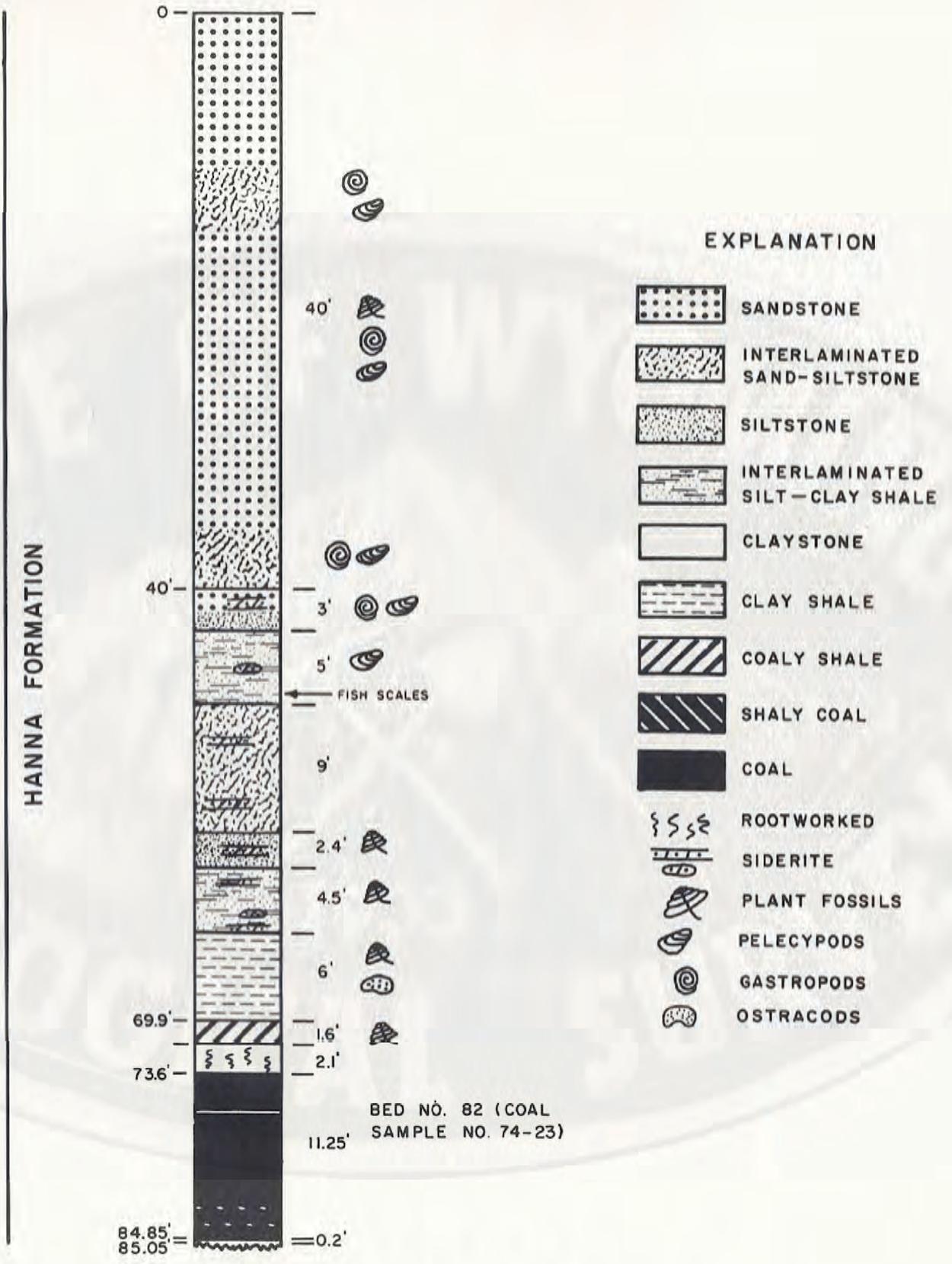
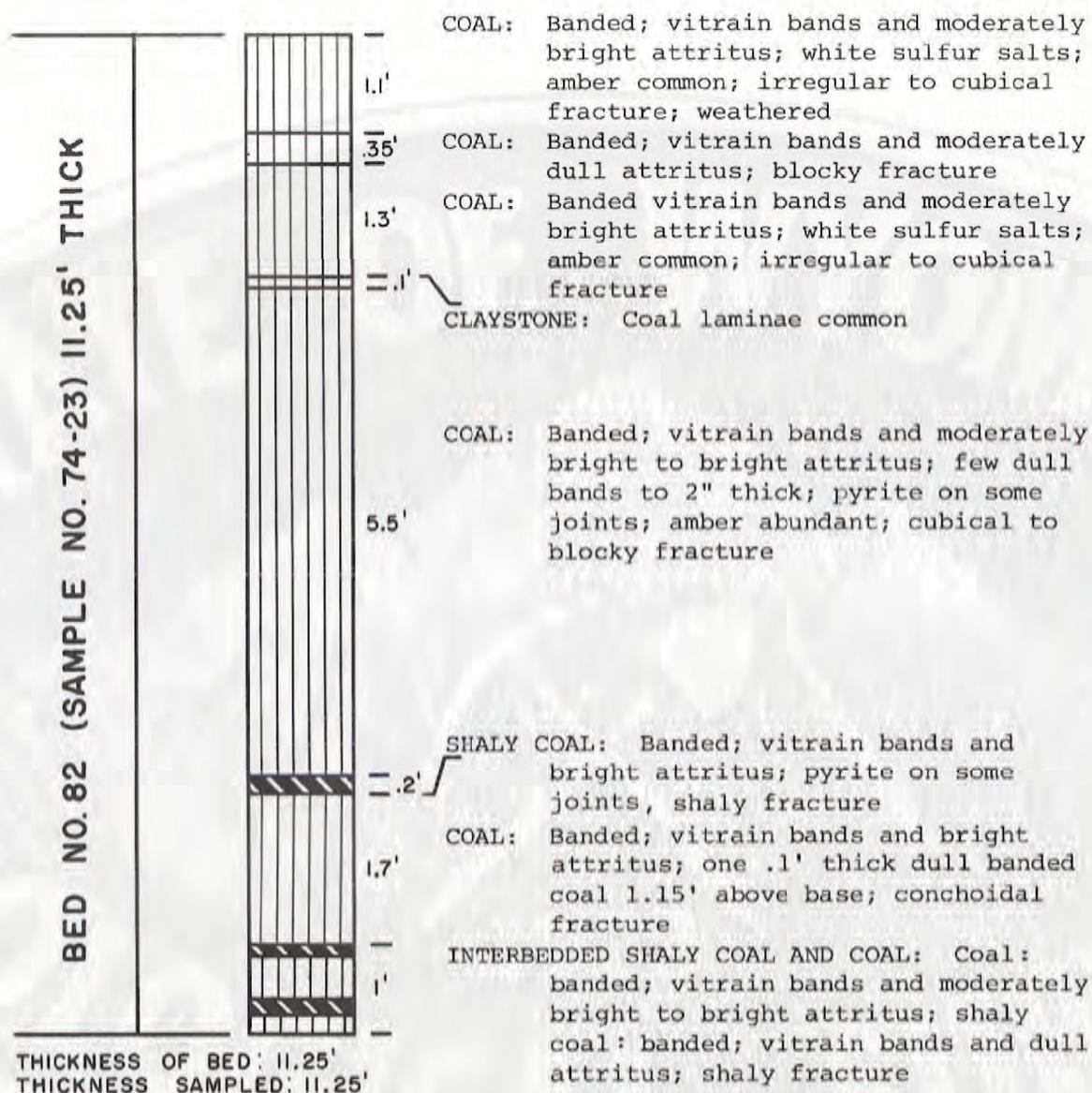


FIGURE 50: MEASURED SECTION AT THE BED NO. 82
SAMPLE SITE IN ROSEBUD PIT NO. 5
(COAL SAMPLE NO. 74-23)



NOTE: ALL UNITS IN ANALYSIS

FIGURE 51: MEGASCOPIC DESCRIPTION OF BED NO. 82
IN ROSEBUD PIT NO. 5
(COAL SAMPLE NO. 74-23)

SAMPLE NO. 74-24: BED NO. 80

INDEX MAPS: See Figures 48 and 49

SAMPLE NO.: 74-24

COAL NAME(S): Bed No. 80

GEOLOGIC FORMATION: Hanna

AGE: Paleocene

COAL FIELD: Hanna

COAL-BEARING AREA: Hanna Coal Field

MEASURED SECTION: See Figure 52

TOTAL SECTION MEASURED (FEET): 75.65

COVER AT SAMPLING POINT (FEET): 57.0

ELEVATION TOP OF SAMPLED COAL: 6950

STRIKE: 68°(?)

DIP: 8°SE

MAJOR JOINT ORIENTATIONS IN COAL:

314-325°, 40-55°

STATE: Wyoming

COUNTY: Carbon

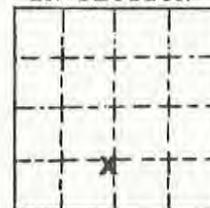
SECTION: 3

TOWNSHIP: T22N

RANGE: R81W

QUADRANGLE: Elmo 7 1/2'

LOCATION
IN SECTION



COAL DESCRIPTION: See Figure 53

THICKNESS OF COAL (FEET): 16.65

THICKNESS SAMPLED (FEET): 13.95

TYPE OF SAMPLE: Face-channel

CONDITION OF SAMPLE: Weathered

TYPE OF EXPOSURE: Strip mine

MINE NAME: Rosebud Pit No. 4S

DATE OF SAMPLING: 9/11/74

SAMPLE COLLECTOR: Wyoming Geological Survey

COMPLETION DATE OF ANALYSES

U. S. Bureau of Mines: 9/27/74

Wyoming Geological Survey: 3/18/75

U. S. Geological Survey: 2/12/75

LABORATORY NUMBERS

K-47599

WGS-24

D170259

APPARENT RANK OF COAL: Subbituminous A

MISCELLANEOUS COMMENTS: The analysis of Sample No. 74-24 compares very favorably with representative analyses provided by Rosebud Coal Sales Company. Again, the sulfur content (as received) is about 0.3% higher than it is in the less weathered company analyses. It should also be noted that the company analyses were performed on drill cuttings back in 1970.

AVERAGE OF 7 ANALYSES OF BED NO. 80
PROVIDED BY ROSEBUD COAL SALES COMPANY (DRILL CUTTING SAMPLES)

Moisture (As Received)	13.57%
Ash (As Received)	7.68%
Sulfur (As Received)	0.94%
Heat Value (As Received)	10,600 Btu/lb.

HANNA FORMATION

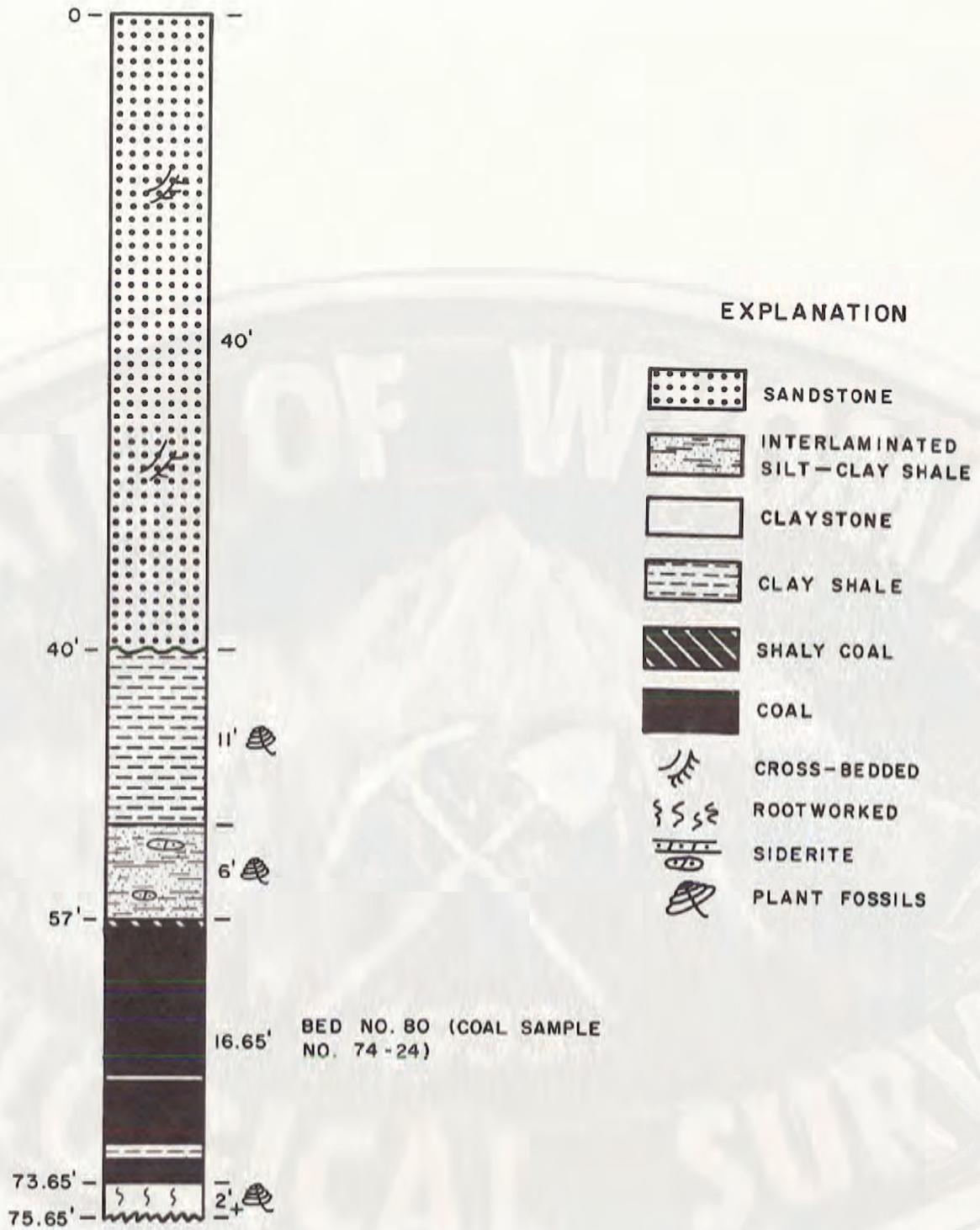


FIGURE 52: MEASURED SECTION AT THE BED NO. 80 SAMPLE SITE IN ROSEBUD PIT NO. 4S (COAL SAMPLE NO. 74-24)

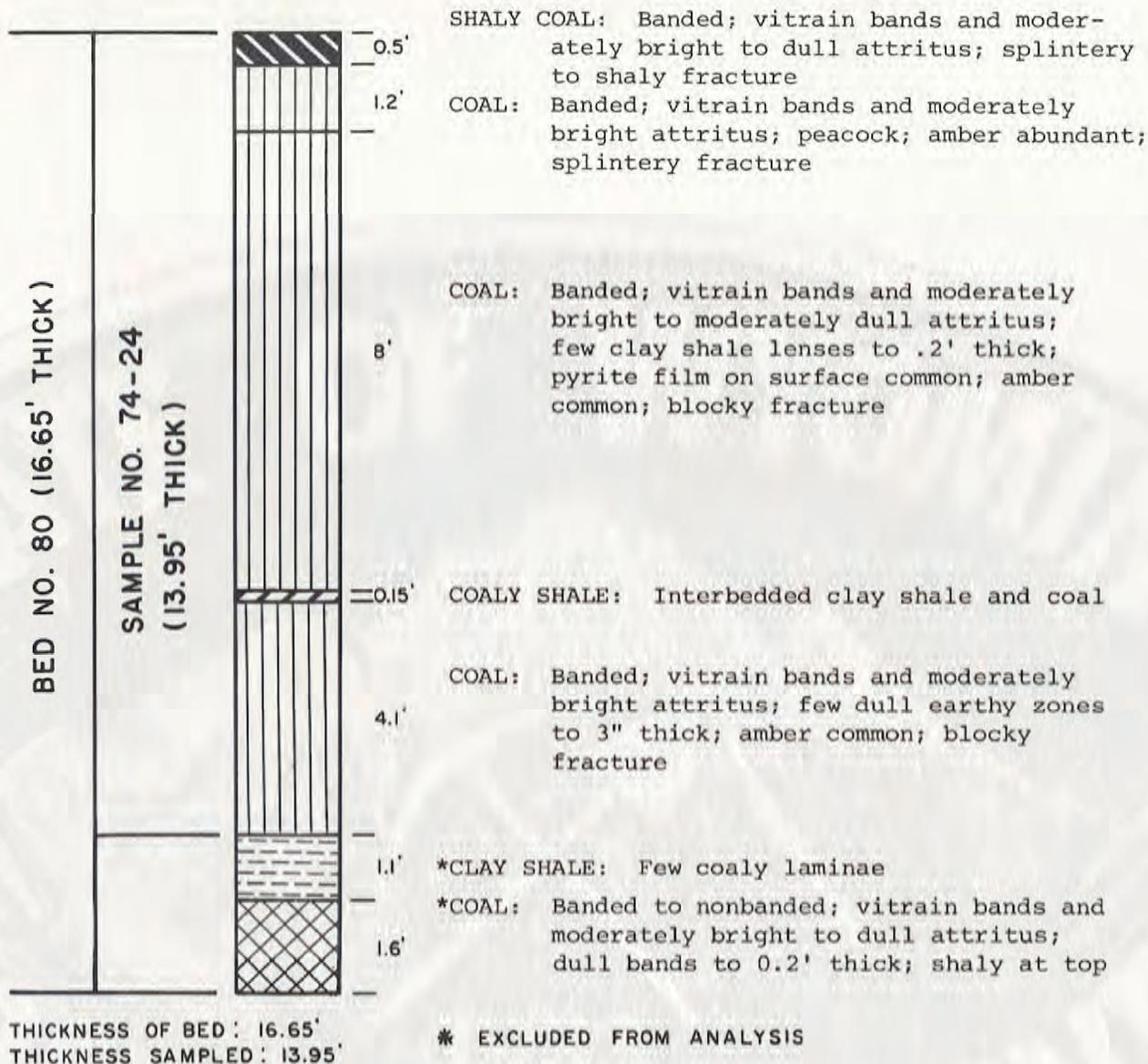


FIGURE 53: MEGASCOPIC DESCRIPTION OF BED NO. 80 IN ROSEBUD PIT NO. 45
(COAL SAMPLE NO. 74-24)

SAMPLE NO. 74-25: BED NO. 80

INDEX MAPS: See Figures 48 and 49

SAMPLE NO.: 74-25

COAL NAMES(S): Bed No. 80

GEOLOGIC FORMATION: Hanna

AGE: Paleocene

COAL FIELD: Hanna

COAL-BEARING AREA: Hanna Coal Field

MEASURED SECTION: See Figure 55

TOTAL SECTION MEASURED (FEET): 119.1

COVER AT SAMPLING POINT (FEET): 100.0

ELEVATION TOP OF SAMPLED COAL: 7120

STRIKE: 356°

DIP: 10°NE

MAJOR JOINT ORIENTATIONS IN COAL:

300-317°, 42-45°, 25°

STATE: Wyoming

COUNTY: Carbon

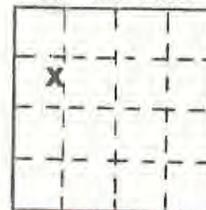
SECTION: 34

TOWNSHIP: T23N

RANGE: R81W

QUADRANGLE: Elmo 7 1/2'

LOCATION
IN SECTION



COAL DESCRIPTION: See Figure 56

THICKNESS OF COAL (FEET): 18.1

THICKNESS SAMPLED (FEET): 18.1

TYPE OF SAMPLE: Face-channel

CONDITION OF SAMPLE: Weathered

TYPE OF EXPOSURE: Strip mine

MINE NAME: Rosebud Pit No. 8

DATE OF SAMPLING: 9/11/74

SAMPLE COLLECTOR: Wyoming Geological Survey

COMPLETION DATE OF ANALYSES

U. S. Bureau of Mines: 9/27/74

Wyoming Geological Survey: 3/18/75

U. S. Geological Survey: 6/13/75

LABORATORY NUMBERS

K-47549

WGS-25

D171832

APPARENT RANK OF COAL: Subbituminous A

MISCELLANEOUS COMMENTS: The moisture content of Sample No. 74-25 is almost 4% lower than it is in a typical production analysis provided by Rosebud Coal Sales Company. Consequently the as received heat value is about 1000 Btu/pounds higher than expected. The ash content of Bed No. 80 is normally 3-5% higher than the 4.4% in Sample 74-25.

TYPICAL PRODUCTION ANALYSIS OF BED NO. 80
PROVIDED BY ROSEBUD COAL SALES COMPANY (? TIPPLE SAMPLE)

PROXIMATE ANALYSIS

	<u>As Received</u>	<u>Dry Basis</u>
Moisture	14.20%	--
Volatile Matter	35.03%	40.83%
Fixed Carbon	42.56%	49.60%
Ash	8.21%	9.57%

HEAT VALUE

<u>As Received</u>	<u>Dry Basis</u>
10,450 Btu/lb.	12,180 Btu/lb.

ULTIMATE ANALYSIS

	<u>As Received</u>	<u>Dry Basis</u>
Carbon	59.33%	69.15%
Hydrogen	6.16%	5.10%
Nitrogen	1.33%	1.55%
Chlorine	0.01%	0.01%
Sulfur	0.88%	1.02%
Oxygen	24.09%	13.60%
Ash	8.21%	9.57%

ASH COMPOSITION (OXIDES)

P ₂ O ₅	0.20%
SiO ₂	38.05%
Fe ₂ O ₃	7.65%
Al ₂ O ₃	20.30%
TiO ₂	1.25%
CaO	18.20%
MgO	4.15%
SO ₃	8.50%
K ₂ O	0.70%
Na ₂ O	0.15%
Undetermined	0.85%

FUSION TEMPERATURES OF ASH

Initial Deformation	2170°F
Softening (H=W)	2210°F
Fluid	2340°F

HARDGROVE GRINDABILITY INDEX

47.0



FIGURE 54: ROSEBUD COAL SALES' PIT NO. 8 (VIEW LOOKING NORTH AT SAMPLING SITE FOR BED NO. 82. ARROW POINTS TO POSITION OF CHANNEL SAMPLE).

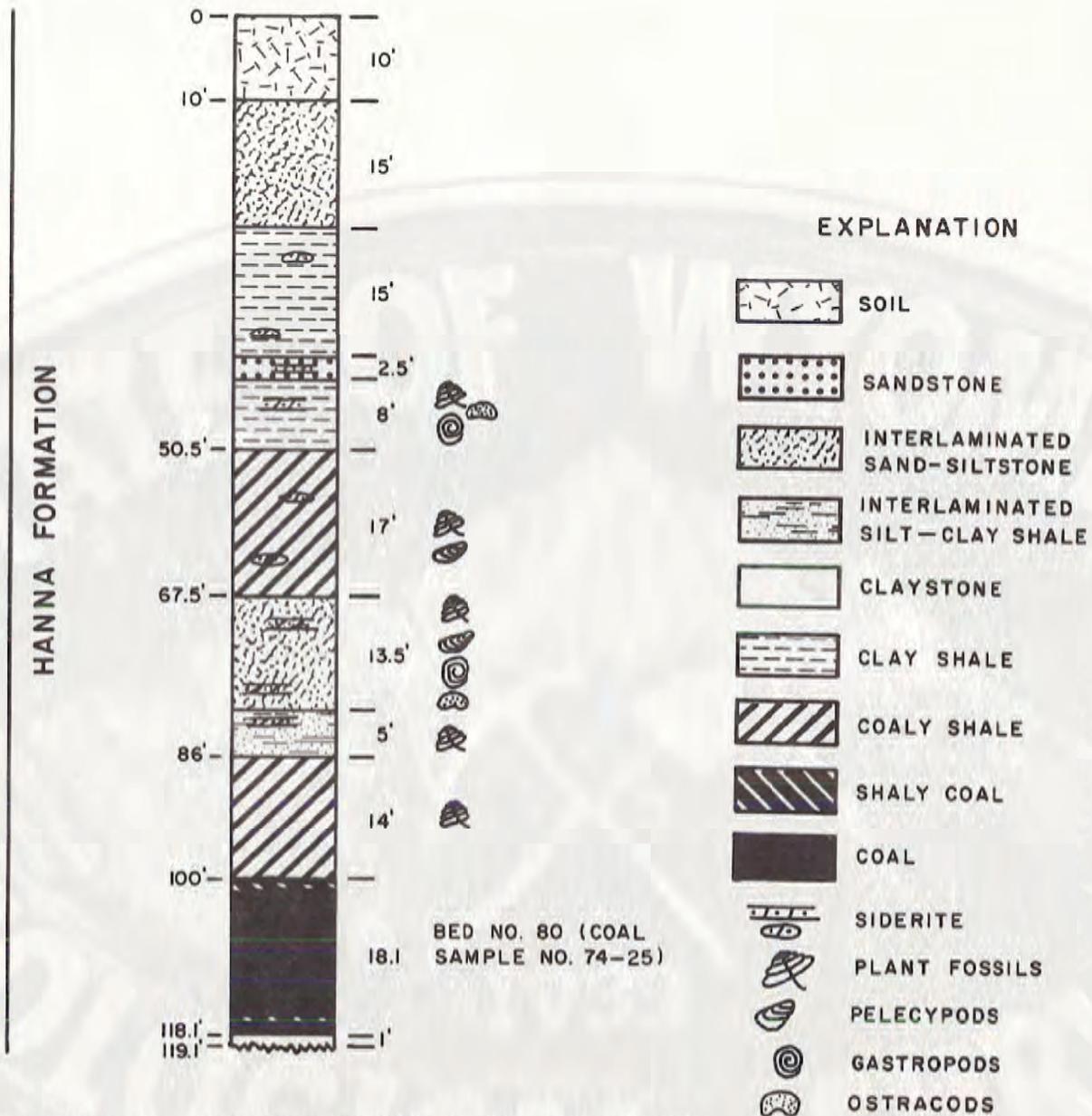


FIGURE 55: MEASURED SECTION AT THE BED NO. 80 SAMPLE SITE IN ROSEBUD PIT NO. 8 (COAL SAMPLE NO. 74-25)

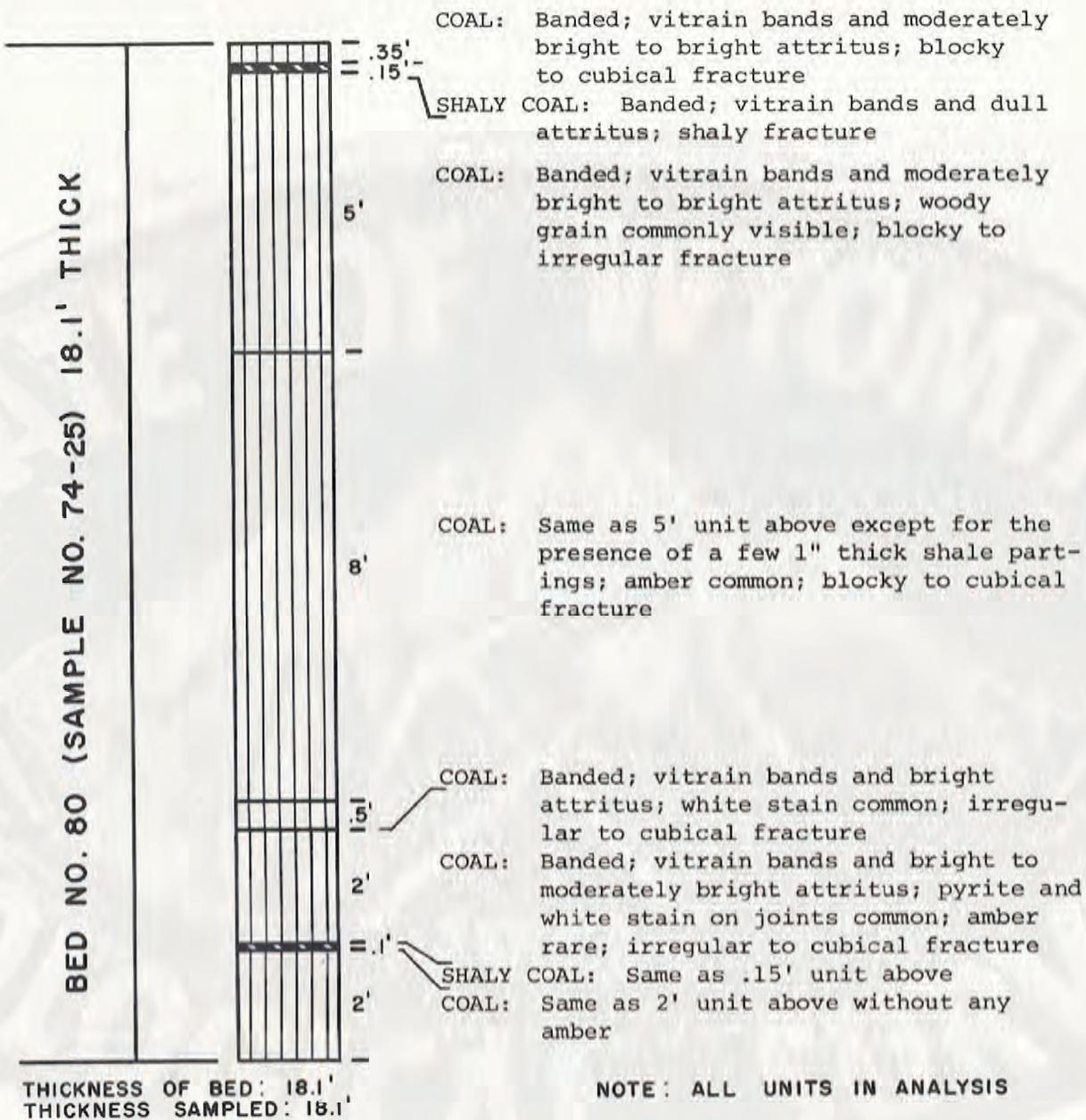


FIGURE 56: MEGASCOPIIC DESCRIPTION OF BED NO. 80 IN ROSEBUD PIT NO. 8 (COAL SAMPLE NO. 74-25)

SAMPLE NO. 74-26: HANNA NO. 2 COAL

INDEX MAPS: *See Figures 48 and 57*

SAMPLE NO.: 74-26

COAL NAMES(S): *Hanna No. 2*

GEOLOGIC FORMATION: *Hanna*

AGE: *Paleocene*

COAL FIELD: *Hanna*

COAL-BEARING AREA: *Hanna Coal Field*

MEASURED SECTION: *See Figure 58*

TOTAL SECTION MEASURED (FEET): 102.1

COVER AT SAMPLING POINT (FEET): 63.5

ELEVATION TOP OF SAMPLED COAL: 7140

STRIKE: 34°

DIP: 10°SE

MAJOR JOINT ORIENTATIONS IN COAL:

26-32°, 17°, 317-323°, 85-99°

STATE: *Wyoming*

COUNTY: *Carbon*

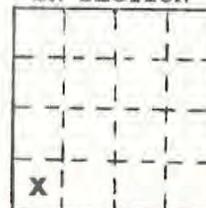
SECTION: 4

TOWNSHIP: *T22N*

RANGE: *R81W*

QUADRANGLE: *Elmo 7 1/2'*

LOCATION
IN SECTION



COAL DESCRIPTION: *See Figure 59*

THICKNESS OF COAL (FEET): 35.4

THICKNESS SAMPLED (FEET): 35.4

TYPE OF SAMPLE: *Face-channel*

CONDITION OF SAMPLE: *Weathered*

TYPE OF EXPOSURE: *Strip mine*

MINE NAME: *Old Monolith strip*

DATE OF SAMPLING: 9/18/74

SAMPLE COLLECTOR: *Wyoming Geological Survey*

COMPLETION DATE OF ANALYSES

U. S. Bureau of Mines: 10/11/74

Wyoming Geological Survey: 3/18/75

U. S. Geological Survey: 2/12/75

LABORATORY NUMBERS

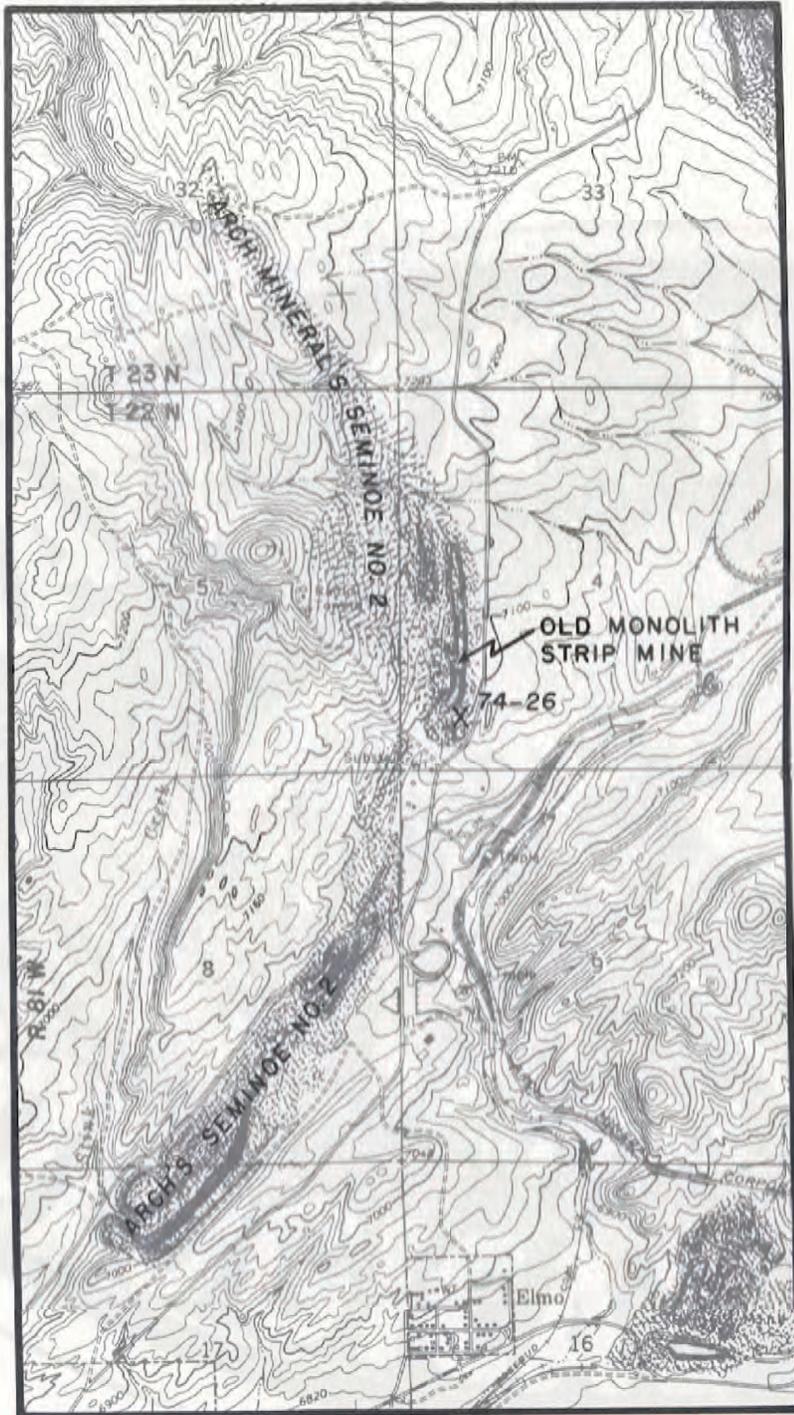
K-47845

WGS-26

D170253

APPARENT RANK OF COAL: *Subbituminous A*

MISCELLANEOUS COMMENTS: *Arch Mineral Corporation is presently strip mining both the Hanna No. 2 coal and a lower coal (Bed No. 76) in this area. Arch's mining has backfilled the old orphaned Monolith strip since Sample No. 74-26 was collected.*

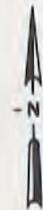


EXPLANATION

X 74-26 SAMPLE SITE AND SAMPLE NUMBER

STRIP MINE

0 1/2 1 MILE
HORIZONTAL SCALE



Base map modified from U.S. Geological Survey's Elmo 7 1/2' (1971) topographic map.

FIGURE 57: DETAILED LOCATION MAP OF COAL SAMPLE 74-26 COLLECTED IN 1974 FROM AN ABANDONED MONOLITH STRIP MINE, CARBON COUNTY, WYOMING

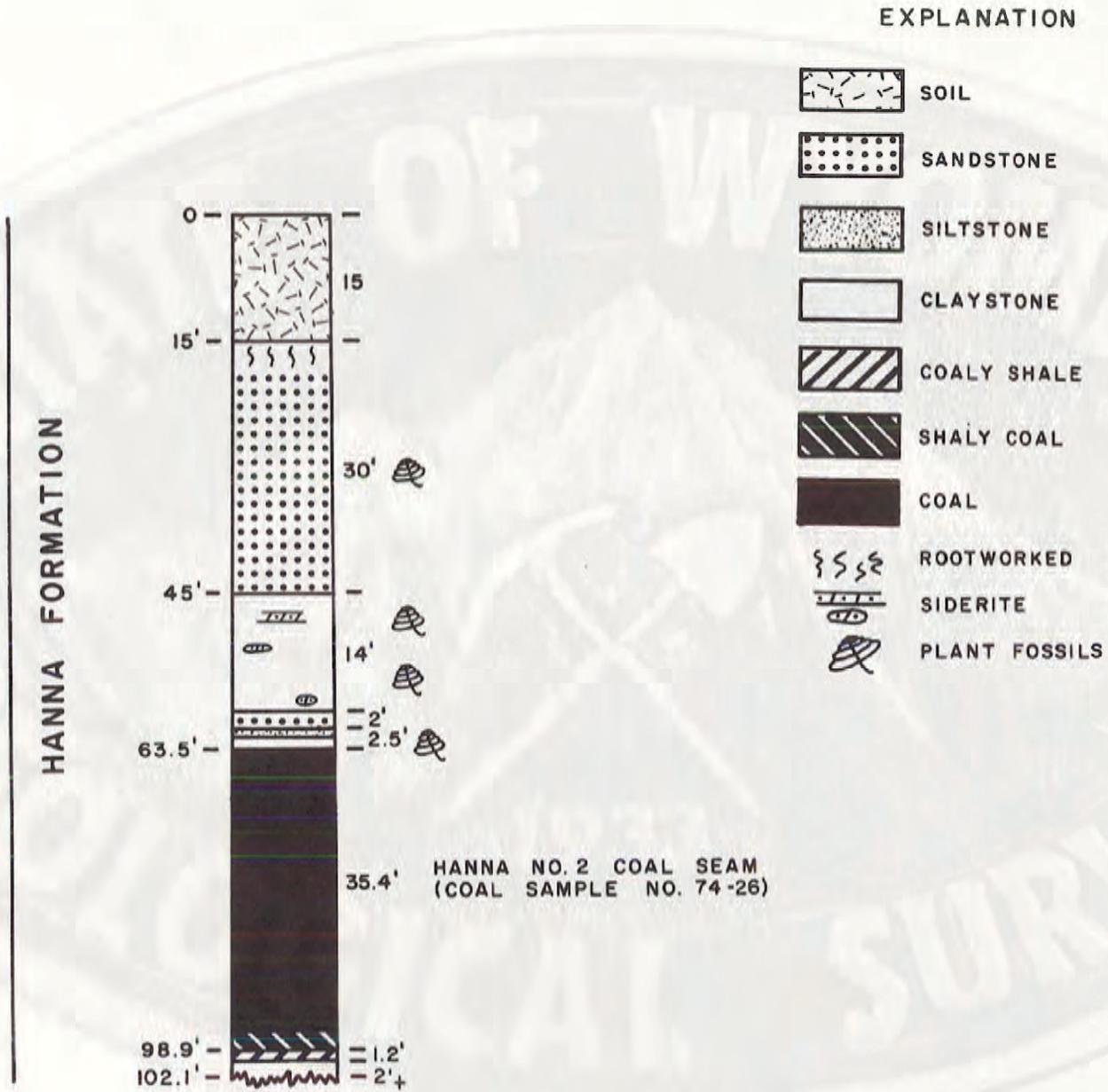


FIGURE 58: MEASURED SECTION AT THE HANNA NO. 2 COAL SAMPLE SITE IN AN ABANDONED MONOLITH STRIP MINE (COAL SAMPLE NO. 74-26)

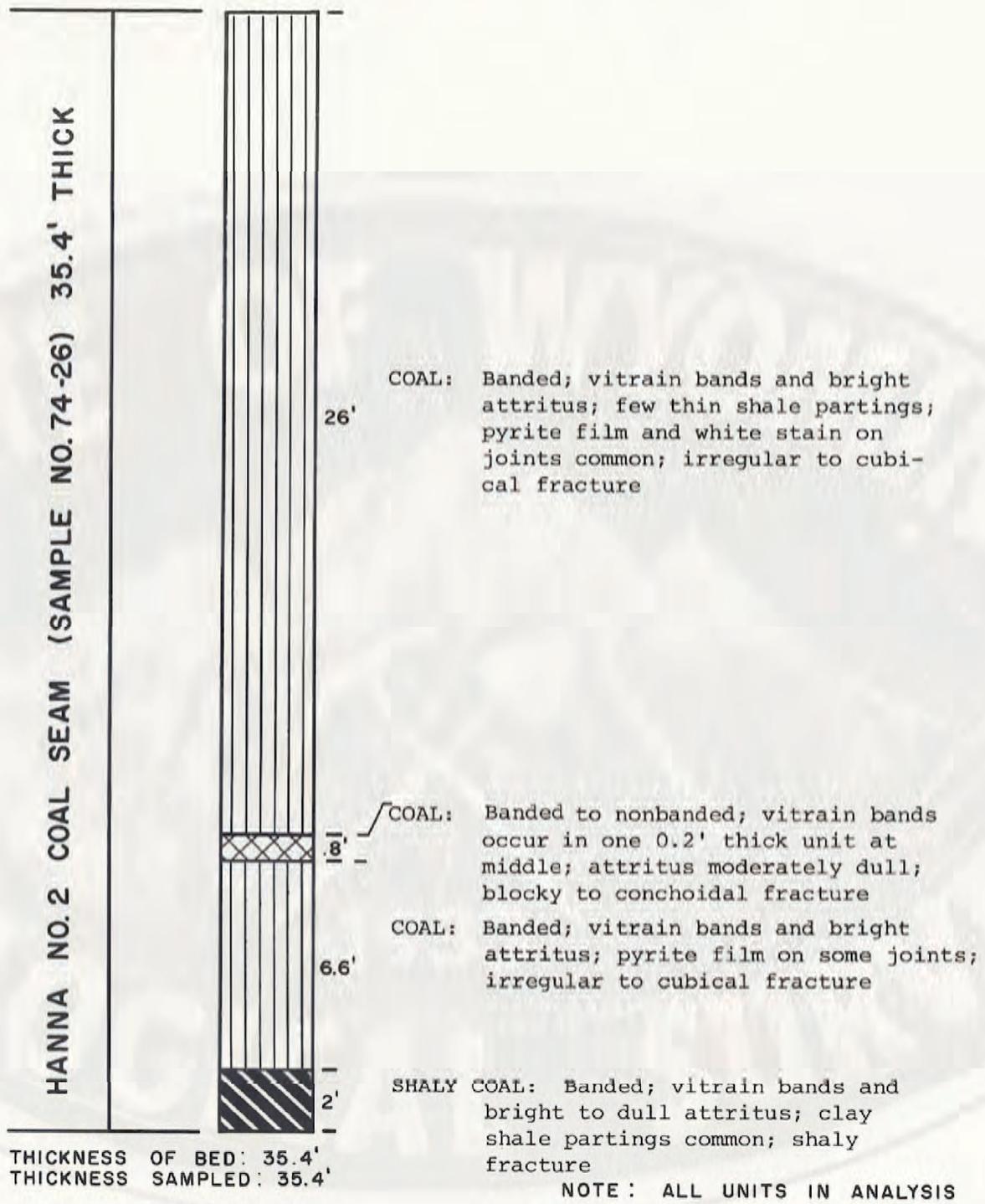


FIGURE 59: MEGASCOPIC DESCRIPTION OF THE HANNA NO. 2 COAL IN AN ABANDONED MONOLITH STRIP MINE (COAL SAMPLE NO. 74-26)

SAMPLE NO. 74-27: BROOKS COAL

INDEX MAPS: See Figures 48 and 60

SAMPLE NO.: 74-27

COAL NAMES(S): Brooks

GEOLOGIC FORMATION: Hanna

AGE: Paleocene

COAL FIELD: Hanna

COAL-BEARING AREA: Hanna Coal Field

MEASURED SECTION: See Figure 61

TOTAL SECTION MEASURED (FEET): 70.6

COVER AT SAMPLING POINT (FEET): 62.6

ELEVATION TOP OF SAMPLED COAL: 7120+

STRIKE: 290°

DIP: 6°SE

MAJOR JOINT ORIENTATIONS IN COAL:

20-25°, 290-320°

STATE: Wyoming

COUNTY: Carbon

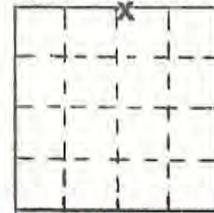
SECTION: 9

TOWNSHIP: T22N

RANGE: R82W

QUADRANGLE: Tenmile Spring 7 1/2'

LOCATION
IN SECTION



COAL DESCRIPTION: See Figure 62

THICKNESS OF COAL (FEET): 7.5

THICKNESS SAMPLED (FEET): 7.5

TYPE OF SAMPLE: Face-channel

CONDITION OF SAMPLE: Weathered

TYPE OF EXPOSURE: Strip mine

MINE NAME: Rimrock No. 3

DATE OF SAMPLING: 9/21/74

SAMPLE COLLECTOR: Wyoming Geological Survey

COMPLETION DATE OF ANALYSES

U. S. Bureau of Mines: 10/11/74

Wyoming Geological Survey: 3/18/75

U. S. Geological Survey: 2/12/75

LABORATORY NUMBERS

K-47847

WGS-27

D170260

APPARENT RANK OF COAL: Subbituminous A

MISCELLANEOUS COMMENTS: Probably because the moisture content of this sample is about 3% higher than the representative analysis provided by the Energy Development Company, its as received heat value is approximately 360 Btu/pound lower than the company's analysis.

REPRESENTATIVE ANALYSIS OF THE BROOKS COAL
PROVIDED BY ENERGY DEVELOPMENT COMPANY

PROXIMATE ANALYSIS

	<u>As Received</u>	<u>Dry Basis</u>
Moisture	8.89%	--
Volatile Matter	36.74%	40.32%
Fixed Carbon	47.53%	52.17%
Ash	6.84%	7.51%

HEAT VALUE

<u>As Received</u>	<u>Dry Basis</u>
11,179 Btu/lb.	12,270 Btu/lb.

ULTIMATE ANALYSIS

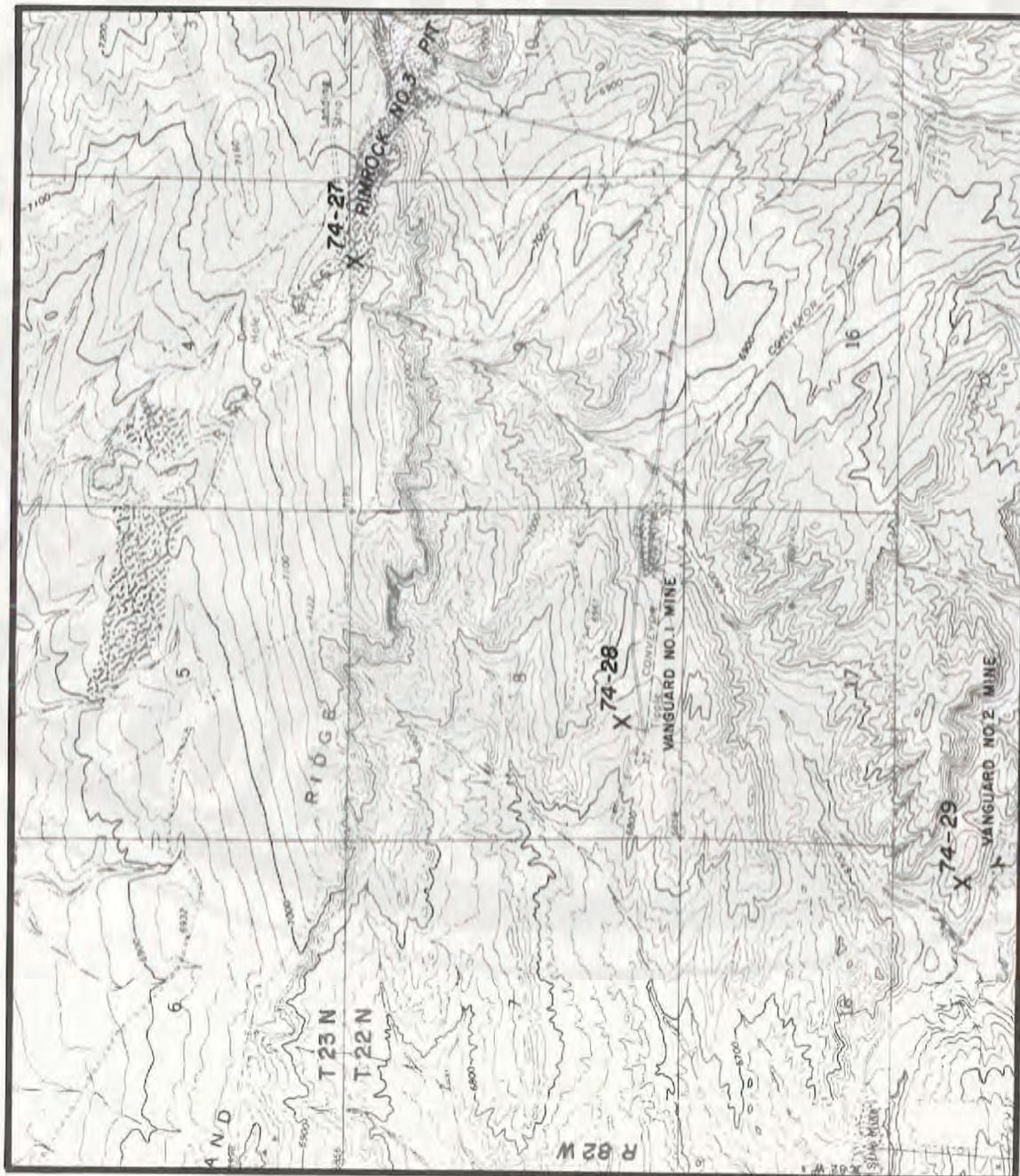
	<u>As Received</u>	<u>Dry Basis</u>
Carbon	64.68%	70.99%
Hydrogen	5.60%	4.93%
Nitrogen	0.71%	0.78%
Chlorine	0.02%	0.02%
Sulfur	0.70%	0.77%
Oxygen	21.45%	15.00%
Ash	6.84%	7.51%

ASH COMPOSITION (OXIDES)

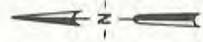
P ₂ O ₅	0.19%
SiO ₂	33.80%
Fe ₂ O ₃	9.60%
Al ₂ O ₃	11.70%
TiO ₂	0.56%
CaO	27.00%
MgO	2.37%
SO ₃	12.35%
K ₂ O	0.68%
Na ₂ O	0.86%
Undetermined	0.89%

FUSION TEMPERATURE OF ASH

Initial Deformation	2060°F
Softening (H=W)	2160°F
Fluid	2270°F



0 1/2 1
 HORIZONTAL SCALE: MILES



EXPLANATION

- X 74-27 SAMPLE SITE AND SAMPLE NUMBER
- [Stippled Box] STRIP MINE

Base map modified from U.S. Geological Survey's Tennille Spring 7 1/2' (1971) and Dana 7 1/2' (advance proof) topographic maps.

FIGURE 60: DETAILED LOCATION MAP OF COAL SAMPLES 74-27 THROUGH 74-29 COLLECTED IN 1974 FROM ENERGY DEVELOPMENT COMPANY'S RIMROCK NO. 3 STRIP MINE, VANGUARD NO. 1 DEEP MINE, AND VANGUARD NO. 2 DEEP MINE, RESPECTIVELY, CARBON COUNTY, WYOMING

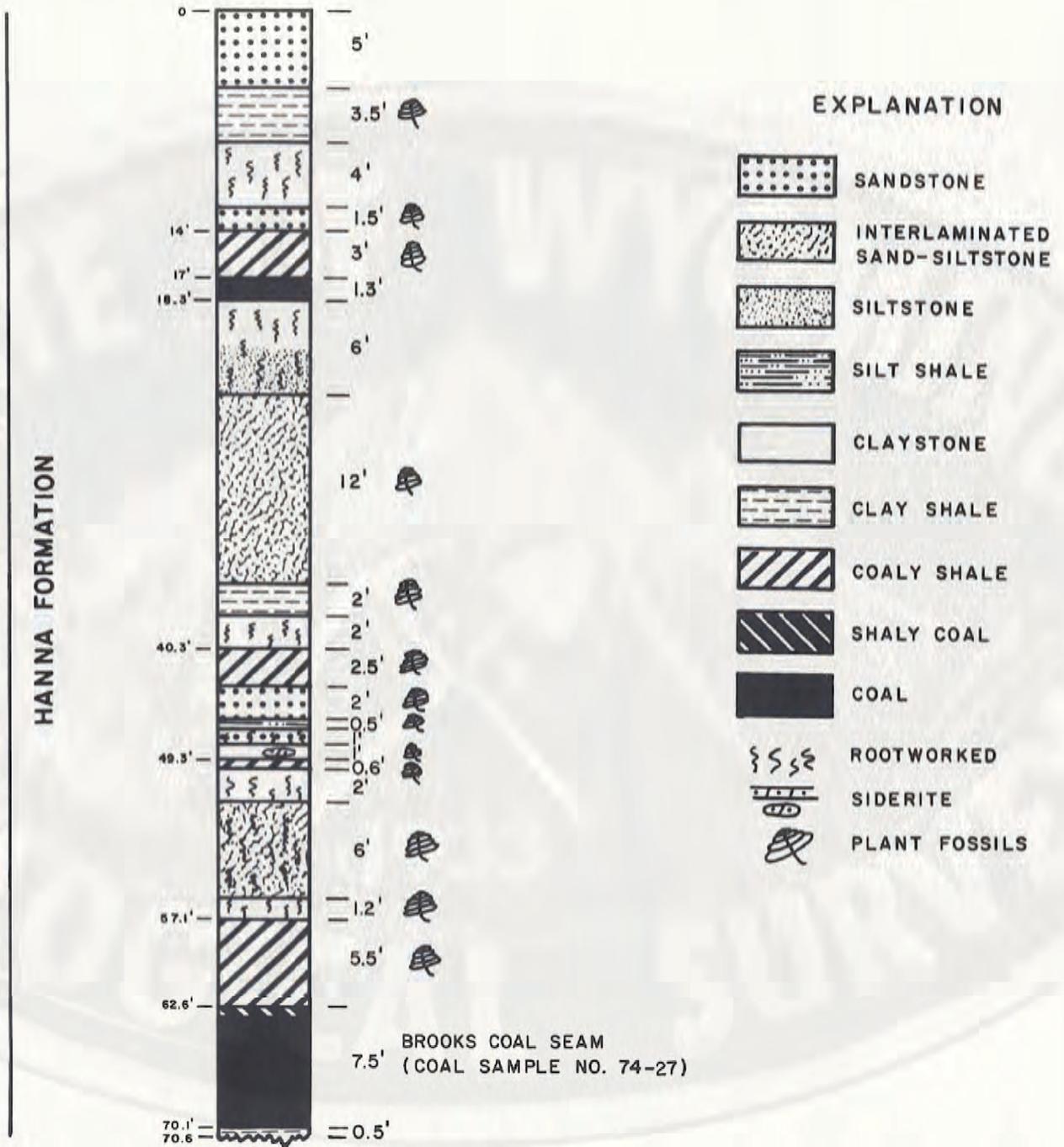


FIGURE 61: MEASURED SECTION AT THE BROOKS COAL SAMPLE SITE IN THE RIMROCK NO. 3 STRIP MINE (COAL SAMPLE NO. 74-27)

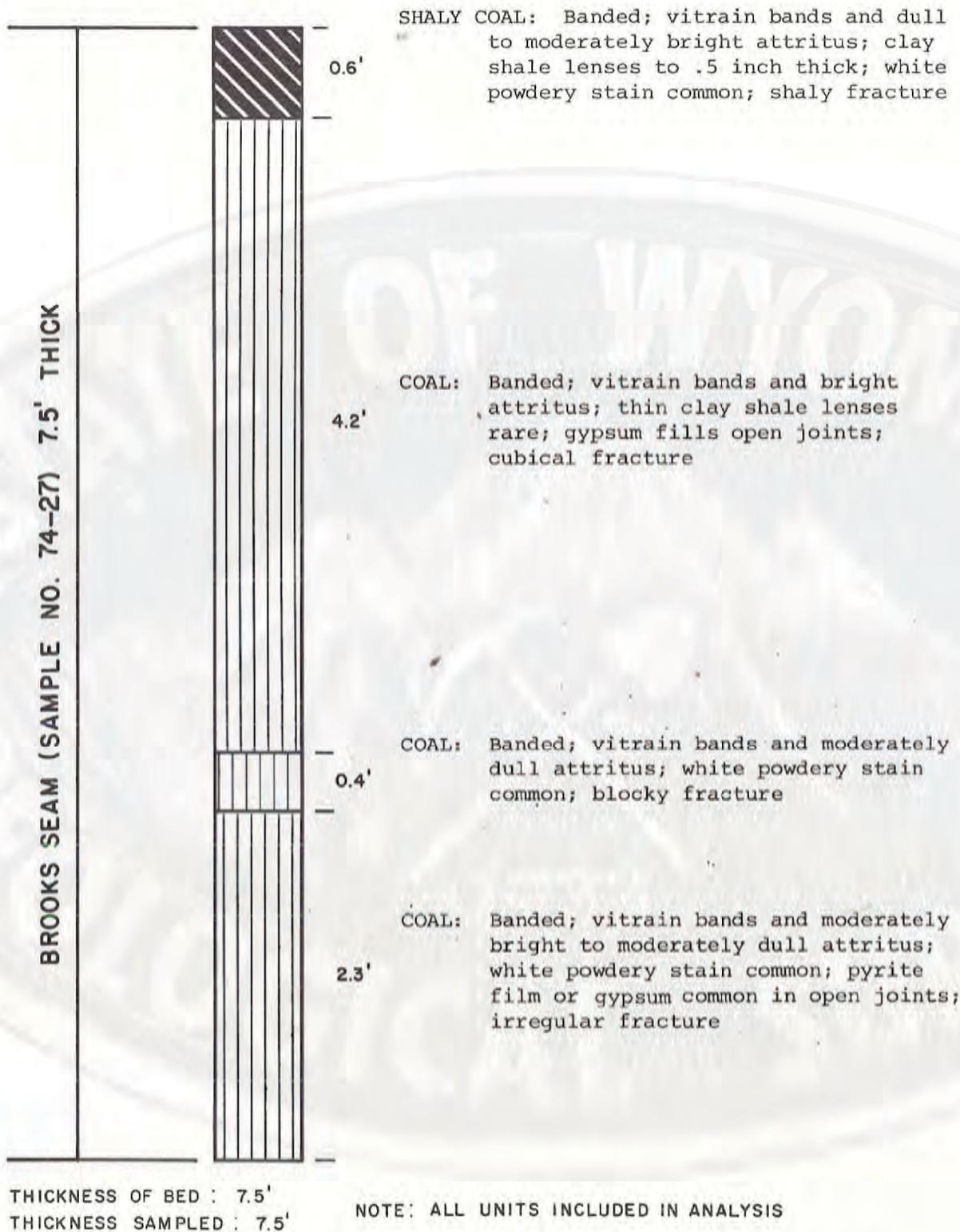


FIGURE 62: MEGASCOPIC DESCRIPTION OF THE BROOKS COAL SEAM IN THE RIMROCK NO. 3 STRIP MINE (COAL SAMPLE NO. 74-27)

SAMPLE NO. 74-28: BED NO. 65

INDEX MAPS: See Figures 48 and 60

SAMPLE NO.: 74-28

COAL NAME(S): Bed No. 65

GEOLOGIC FORMATION: Ferris

AGE: Paleocene

COAL FIELD: Hanna

COAL-BEARING AREA: Hanna Coal Field

MEASURED SECTION: See Figure 64

TOTAL SECTION MEASURED (FEET): 16.25

COVER AT SAMPLING POINT (FEET): 100.0⁺

ELEVATION TOP OF SAMPLED COAL: 6740⁺

STRIKE: Approximately 90°

DIP: 6-7°N

MAJOR JOINT ORIENTATIONS IN COAL:

292°, 26°

STATE: Wyoming

COUNTY: Carbon

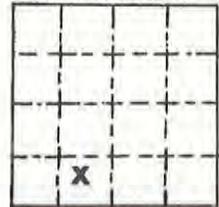
SECTION: 8

TOWNSHIP: T22N

RANGE: R82W

QUADRANGLE: Tenmile Spring 7 1/2'

LOCATION
IN SECTION



COAL DESCRIPTION: See Figure 65

THICKNESS OF COAL (FEET): 7.65

THICKNESS SAMPLED (FEET): 6.65

TYPE OF SAMPLE: Face-channel

CONDITION OF SAMPLE: Fresh

TYPE OF EXPOSURE: Deep mine

MINE NAME: Vanguard No. 1

DATE OF SAMPLING: 10/8/74

SAMPLE COLLECTOR: Wyoming Geological Survey

COMPLETION DATE OF ANALYSES

U. S. Bureau of Mines: 10/25/74

Wyoming Geological Survey: 3/18/75

U. S. Geological Survey: 6/13/75

LABORATORY NUMBERS

K-48218

WGS-28

D171835

APPARENT RANK OF COAL: Subbituminous A

MISCELLANEOUS COMMENTS: The proximate analysis of this sample compares very favorably with company analyses provided by Energy Development Company. This mine closed in late 1974.

REPRESENTATIVE ANALYSIS OF BED NO. 65
PROVIDED BY ENERGY DEVELOPMENT COMPANY

PROXIMATE ANALYSIS

	<u>As Received</u>	<u>Dry Basis</u>
Moisture	8.96%	--
Volatile Matter	36.79%	40.41%
Fixed Carbon	49.04%	53.87%
Ash	5.21%	5.72%

HEAT VALUE

	<u>As Received</u>	<u>Dry Basis</u>
	11,277 Btu/lb.	12,387 Btu/lb.

ULTIMATE ANALYSIS

	<u>As Received</u>	<u>Dry Basis</u>
Carbon	65.59%	72.05%
Hydrogen	5.71%	5.04%
Nitrogen	1.32%	1.45%
Chlorine	0.02%	0.02%
Sulfur	0.61%	0.67%
Oxygen	21.54%	15.05%
Ash	5.21%	5.72%

ASH COMPOSITION (OXIDES)

P_2O_5	0.15%
SiO_2	30.11%
Fe_2O_3	10.07%
Al_2O_3	14.30%
TiO_2	0.54%
CaO	25.30%
MgO	3.66%
SO_3	13.97%
K_2O	0.67%
Na_2O	0.31%
Undetermined	0.92%

FUSION TEMPERATURE OF ASH

Initial Deformation	2060°F
Softening (H=W)	2150°F
Fluid	2260°F

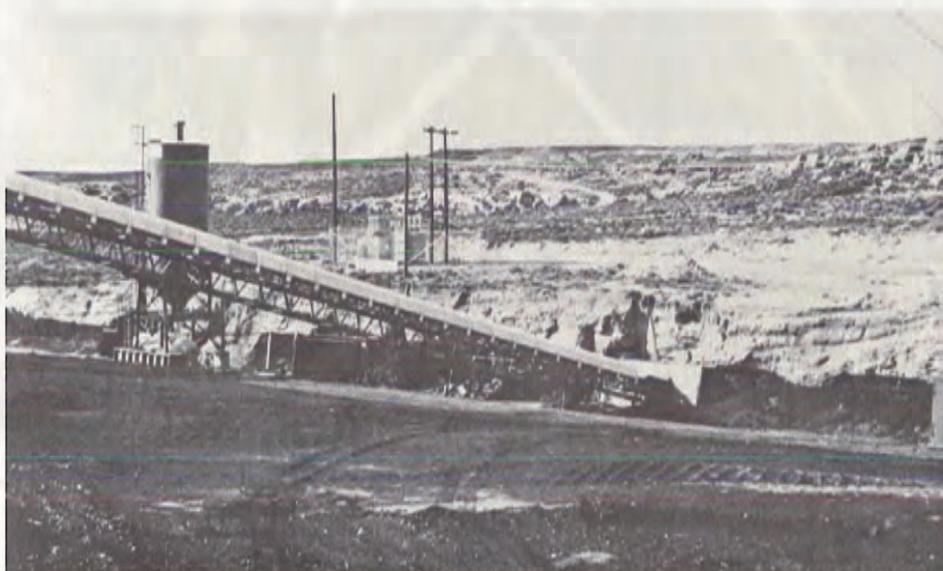


FIGURE 63: ENTRANCE TO THE VANGUARD NO. 1
UNDERGROUND MINE
(PHOTO TAKEN IN OCTOBER 1974)

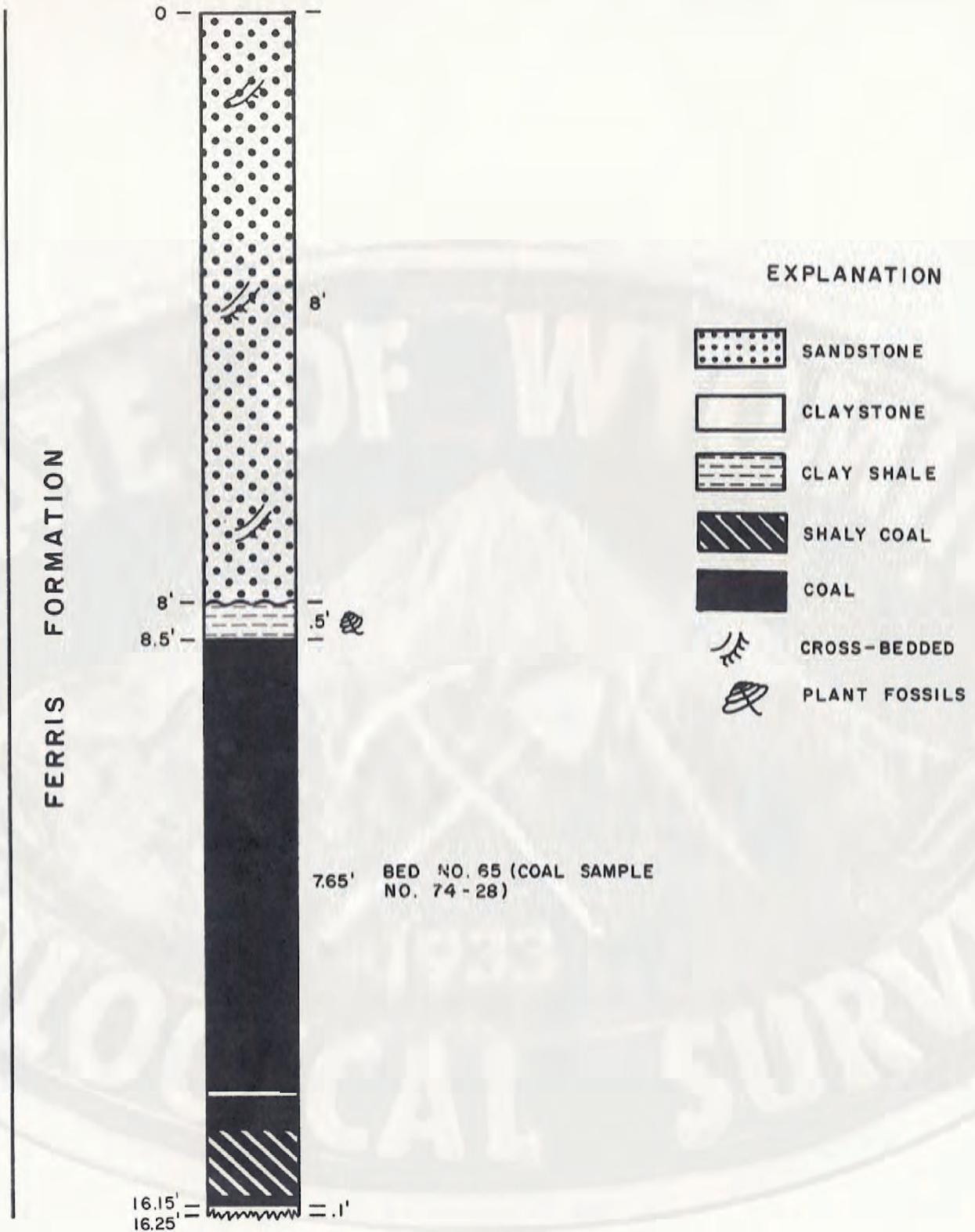


FIGURE 64: MEASURED SECTION AT THE BED NO. 65 SAMPLE SITE IN THE VANGUARD NO. 1 DEEP MINE (COAL SAMPLE NO. 74-28)

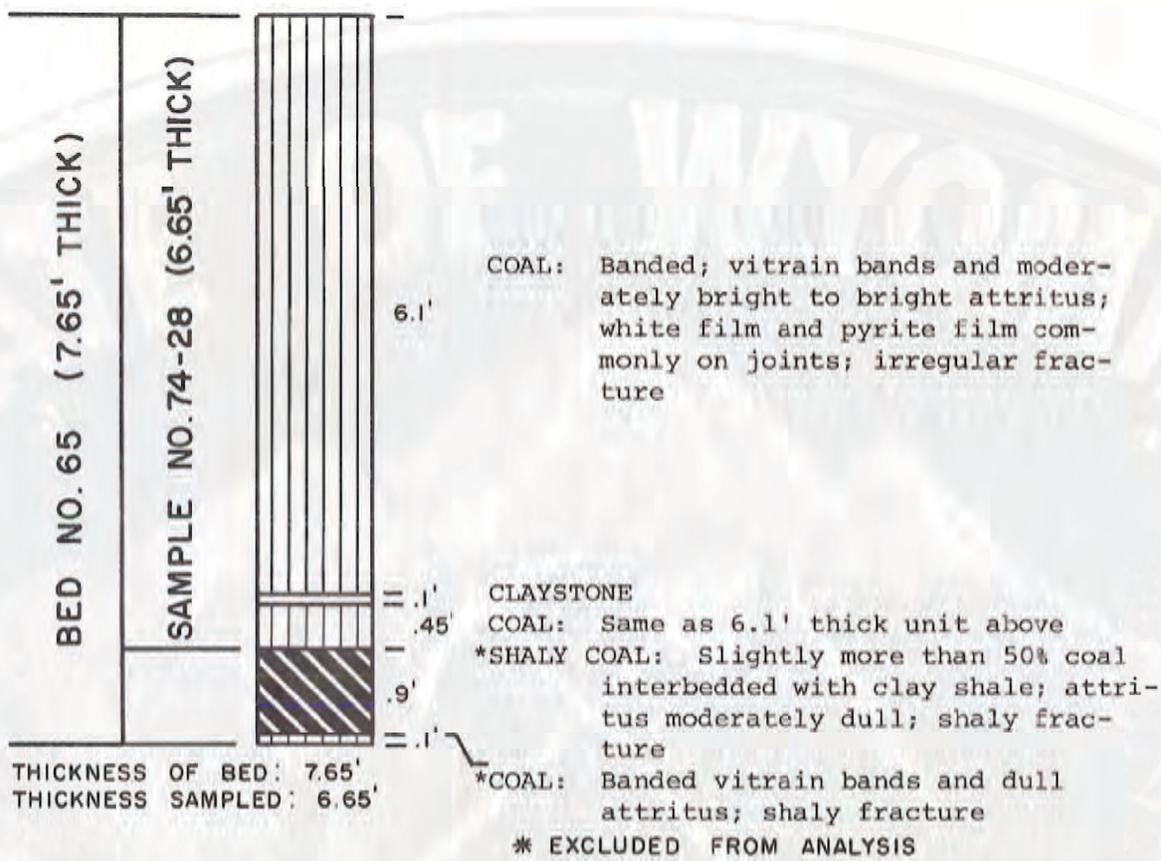


FIGURE 65: MEGASCOPIC DESCRIPTION OF BED NO. 65 IN THE VANGUARD NO. 1 DEEP MINE (COAL SAMPLE NO. 74-28)

SAMPLE NO. 74-29: BED NO. 50

INDEX MAPS: See Figures 48 and 60

SAMPLE NO.: 74-29

COAL NAME(S): Bed No. 50

GEOLOGIC FORMATION: Ferris

AGE: Paleocene

COAL FIELD: Hanna

COAL-BEARING AREA: Hanna Coal Field

MEASURED SECTION: See Figure 66

TOTAL SECTION MEASURED (FEET): 119.05

COVER AT SAMPLING POINT (FEET): 300+

ELEVATION TOP OF SAMPLED COAL: 6430+

STRIKE: 295-300°

DIP: 14°NE

MAJOR JOINT ORIENTATIONS IN COAL:

305-310°, 20-24°, 40°

STATE: Wyoming

COUNTY: Carbon

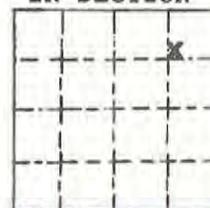
SECTION: 18

TOWNSHIP: T22N

RANGE: R82W

QUADRANGLE: Dana 7 1/2'

LOCATION
IN SECTION



COAL DESCRIPTION: See Figure 67
THICKNESS OF COAL (FEET): 18.25+
THICKNESS SAMPLED (FEET): 9.4
TYPE OF SAMPLE: Face-channel
CONDITION OF SAMPLE: Fresh
TYPE OF EXPOSURE: Deep mine
MINE NAME: Vanguard No. 2

DATE OF SAMPLING: 10/9/74

SAMPLE COLLECTOR: Wyoming Geological Survey

COMPLETION DATE OF ANALYSES

U. S. Bureau of Mines: 10/25/74

Wyoming Geological Survey: 3/18/75

U. S. Geological Survey: 6/13/75

LABORATORY NUMBERS

K-48217

WGS-29

D171836

APPARENT RANK OF COAL: Subbituminous A

MISCELLANEOUS COMMENTS: The proximate analysis of this sample favorably compares with an analysis provided by Energy Development Company. The company's sample was taken from a strip mine rather than the Vanguard No. 2 deep mine.

ANALYSIS OF BED NO. 50
PROVIDED BY ENERGY DEVELOPMENT COMPANY

PARTIAL PROXIMATE ANALYSIS

As Received

Moisture 14.3%
Ash 13.6%

HEAT VALUE

As Received Dry Basis
9,410 Btu/lb. 10,979 Btu/lb.

ULTIMATE ANALYSIS

Dry Basis

Carbon	64.63%
Hydrogen	4.48%
Nitrogen	1.30%
Sulfur	0.43%
Oxygen	13.74%
Ash	15.80%

ASH COMPOSITION (OXIDES)

P ₂ O ₅	0.7%
SiO ₂	52.0%
Fe ₂ O ₃	4.7%
Al ₂ O ₃	22.5%
TiO ₂	0.6%
CaO	11.8%
MgO	1.5%
SO ₃	4.5%
K ₂ O	2.1%
Na ₂ O	0.2%
Total	100.6%

FUSION TEMPERATURE OF ASH

Initial Deformation	2290°F
Softening (H=W)	2350°F
Fluid	2530°F

FREE-SWELLING INDEX

1/2

HARDGROVE GRINDABILITY
INDEX

45

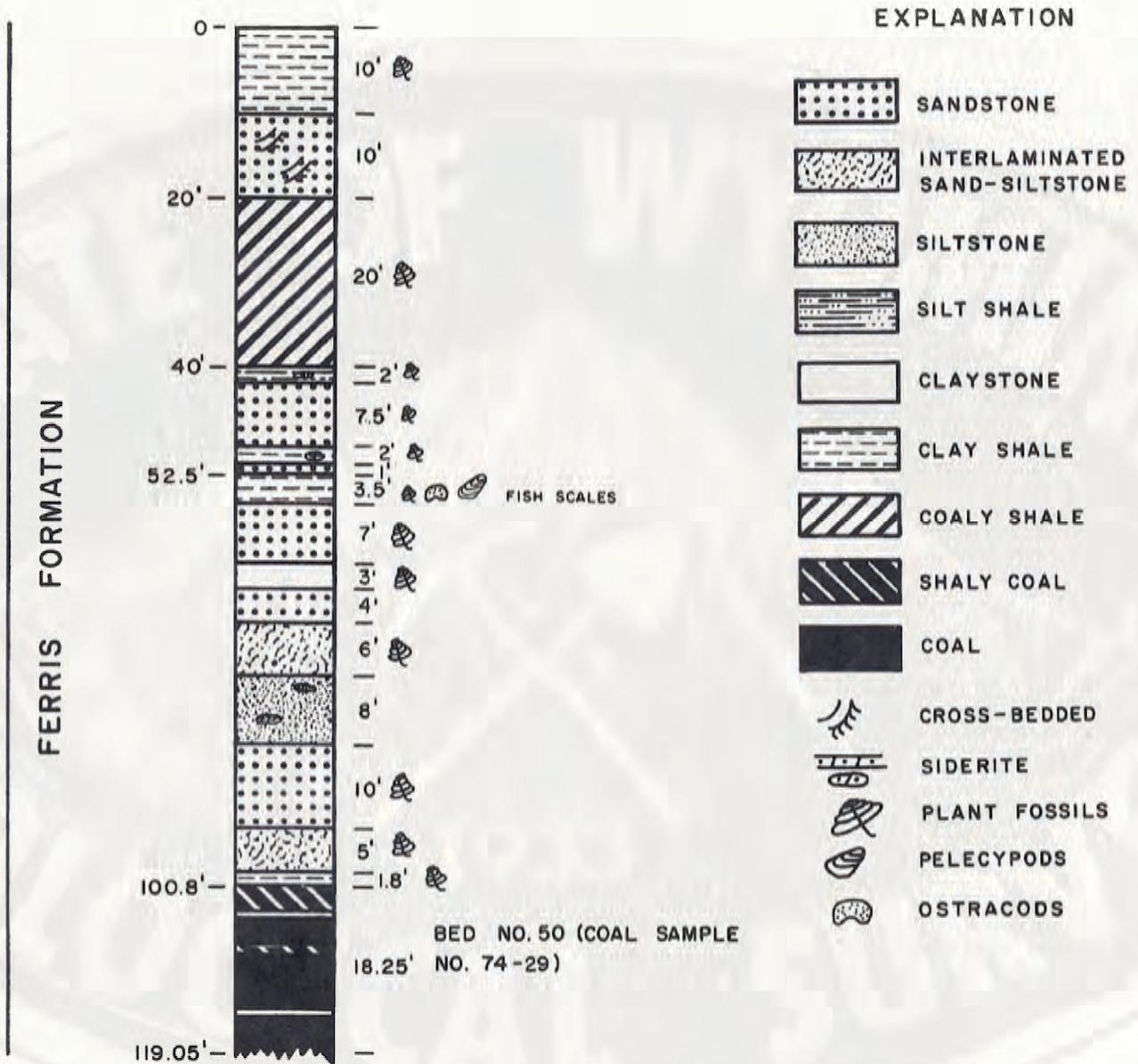


FIGURE 66: MEASURED SECTION AT THE BED NO. 50 SAMPLE SITE IN THE VANGUARD NO. 2 DEEP MINE (COAL SAMPLE NO. 74-29)

SAMPLE NO. 74-31: BED NO. 25 (MIDDLE BENCH)

INDEX MAPS: *See Figure 48*

SAMPLE NO.: 74-31

COAL NAMES(S): *Bed No. 25 (Middle Bench)*

GEOLOGIC FORMATION: *Ferris*

AGE: *Paleocene*

COAL FIELD: *Hanna*

COAL-BEARING AREA: *Hanna Coal Field*

MEASURED SECTION: *See Figure 68*

TOTAL SECTION MEASURED (FEET): 173.3

COVER AT SAMPLING POINT (FEET): 111.0

ELEVATION TOP OF SAMPLED COAL: 6590+

STRIKE: *Approximately 45°*

DIP: 10-15°NW

MAJOR JOINT ORIENTATIONS IN COAL:

See Sample No. 74-30

STATE: *Wyoming*

COUNTY: *Carbon*

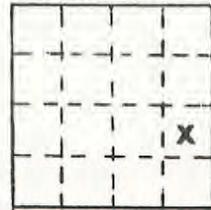
SECTION: 7

TOWNSHIP: *T22N*

RANGE: *R83W*

QUADRANGLE: *Pats Bottom 7 1/2'*

LOCATION
IN SECTION



COAL DESCRIPTION: *See Figure 70*

THICKNESS OF COAL (FEET): 5.5

THICKNESS SAMPLED (FEET): 5.5

TYPE OF SAMPLE: *Face-channel*

CONDITION OF SAMPLE: *Weathered*

TYPE OF EXPOSURE: *Outcrop*

MINE NAME: *Not applicable*

DATE OF SAMPLING: 9/21/74

SAMPLE COLLECTOR: *Wyoming Geological Survey*

COMPLETION DATE OF ANALYSES

U. S. Bureau of Mines: 10/11/74

Wyoming Geological Survey: 3/18/75

U. S. Geological Survey: 2/12/75

APPARENT RANK OF COAL: *Subbituminous A*

MISCELLANEOUS COMMENTS: *None.*

LABORATORY NUMBERS

K-47851

WGS-31

D170256

SAMPLE NO. 74-32: BED NO. 25 (LOWER BENCH)

INDEX MAPS: *See Figure 48*

SAMPLE NO.: 74-32

COAL NAME(S): *Bed No. 25 (Lower Bench)*

GEOLOGIC FORMATION: *Ferris*

AGE: *Paleocene*

COAL FIELD: *Hanna*

COAL-BEARING AREA: *Hanna Coal Field*

MEASURED SECTION: *See Figure 68*

TOTAL SECTION MEASURED (FEET): 173.3

COVER AT SAMPLING POINT (FEET): 157.5

ELEVATION TOP OF SAMPLED COAL: 6540+

STRIKE: *Approximately 45°*

DIP: *10-15°NW*

MAJOR JOINT ORIENTATIONS IN COAL:

See Sample No. 74-30

STATE: *Wyoming*

COUNTY: *Carbon*

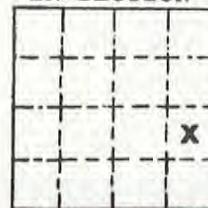
SECTION: 7

TOWNSHIP: *T22N*

RANGE: *R83W*

QUADRANGLE: *Pats Bottom 7 1/2'*

LOCATION
IN SECTION



COAL DESCRIPTION: *See Figure 71*

THICKNESS OF COAL (FEET): 8.3

THICKNESS SAMPLED (FEET): 8.3

TYPE OF SAMPLE: *Face-channel*

CONDITION OF SAMPLE: *Weathered*

TYPE OF EXPOSURE: *Outcrop*

MINE NAME: *Not applicable*

DATE OF SAMPLING: *9/21/74*

SAMPLE COLLECTOR: *Wyoming Geological Survey*

COMPLETION DATE OF ANALYSES

U. S. Bureau of Mines: *10/11/74*

Wyoming Geological Survey: *3/18/75*

U. S. Geological Survey: *2/12/75*

LABORATORY NUMBERS

K-47846

WGS-32

D170255

APPARENT RANK OF COAL: *Subbituminous B*

MISCELLANEOUS COMMENTS: *None.*

FERRIS FORMATION

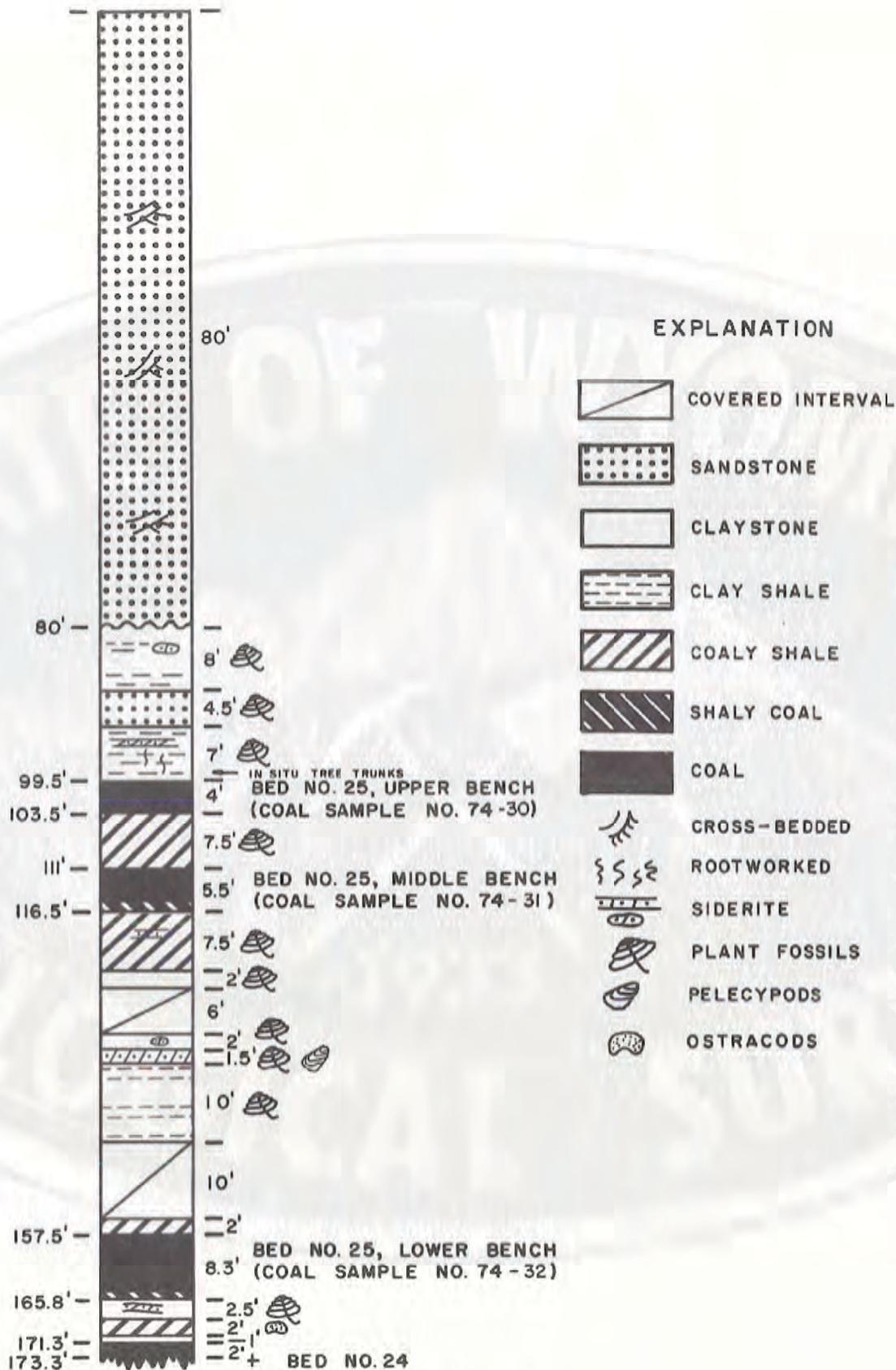


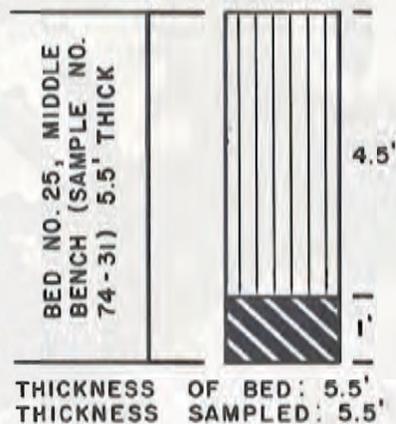
FIGURE 68: MEASURED SECTION AT A BED NO. 25
 SAMPLE SITE IN SECTION 7, T22N,
 R83W (COAL SAMPLE NOS. 74-30 THROUGH 74-32)



COAL: Banded; vitrain bands and moderately bright to moderately dull attritus; few thin shale lenses; white sulfur salts; irregular fracture; weathered

NOTE: ENTIRE SEAM ANALYZED

FIGURE 69: MEGASCOPIC DESCRIPTION OF THE UPPER BENCH OF BED NO. 25 AT A SAMPLE SITE IN SECTION 7, T22N, R83W (COAL SAMPLE NO. 74-30)



COAL: Banded; vitrain bands and moderately bright attritus; few thin clay shale lenses; few earthy zones to 2" thick; white sulfur salts; gypsum on some joints; irregular fracture; weathered

SHALY COAL: Banded; vitrain bands and dull attritus; white sulfur salts; shaly fracture; weathered

NOTE: BOTH UNITS IN ANALYSIS

FIGURE 70: MEGASCOPIC DESCRIPTION OF THE MIDDLE BENCH OF BED NO. 25 AT A SAMPLE SITE IN SECTION 7, T22N, R83W (COAL SAMPLE NO. 74-31)



COAL: Banded; vitrain bands and moderately bright to bright attritus; few thin clay shale lenses; white sulfur salts; gypsum on some joints; irregular fracture

SHALY COAL: Banded; vitrain bands and moderately dull to dull attritus; .5" thick shale lenses common; white sulfur salts; irregular fracture

NOTE: ENTIRE SEAM ANALYZED

FIGURE 71: MEGASCOPIC DESCRIPTION OF THE LOWER BENCH OF BED NO. 25 AT A SAMPLE SITE IN SECTION 7, T22N, R83W (COAL SAMPLE NO. 74-32)

SAMPLE NO. 74-33: BED NO. 25 (LOWER BENCH)

INDEX MAPS: *See Figure 48*

SAMPLE NO.: 74-33

COAL NAMES(S): *Bed No. 25 (Lower Bench)*

GEOLOGIC FORMATION: *Ferris*

AGE: *Paleocene*

COAL FIELD: *Hanna*

COAL-BEARING AREA: *Hanna Coal Field*

MEASURED SECTION: *See Figure 72*

TOTAL SECTION MEASURED (FEET): 240.7

COVER AT SAMPLING POINT (FEET): 140.0

ELEVATION TOP OF SAMPLED COAL: 6480+

STRIKE: *Approximately 95°*

DIP: 12°NE

MAJOR JOINT ORIENTATIONS IN COAL:

25-30°, 320°, 345°, 0°

STATE: *Wyoming*

COUNTY: *Carbon*

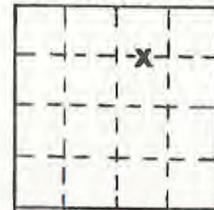
SECTION: 12

TOWNSHIP: T22N

RANGE: R84W

QUADRANGLE: *Pats Bottom 7 1/2'*

LOCATION
IN SECTION



COAL DESCRIPTION: *See Figure 73*

THICKNESS OF COAL (FEET): 7.2

THICKNESS SAMPLED (FEET): 7.2

TYPE OF SAMPLE: *Face-channel*

CONDITION OF SAMPLE: *Weathered*

TYPE OF EXPOSURE: *Outcrop*

MINE NAME: *Not applicable*

DATE OF SAMPLING: 9/19/74

SAMPLE COLLECTOR: *Wyoming Geological Survey*

COMPLETION DATE OF ANALYSES

U. S. Bureau of Mines: 10/11/74

Wyoming Geological Survey: 3/18/75

U. S. Geological Survey:

LABORATORY NUMBERS

K-47848

WGS-33

None

APPARENT RANK OF COAL: *Subbituminous C*

MISCELLANEOUS COMMENTS: *Although this coal sample was collected at this location, the measured section was made in Section 7, T22N, R83W (see Sample No. 74-34).*

Weathering has probably lowered the heat value of this sample by as much as 1600 Btu/pound on an as received basis.

SAMPLE NO. 74-34: BED NO. 24

INDEX MAPS: See Figure 48

SAMPLE NO.: 74-34

COAL NAME(S): Bed No. 24

GEOLOGIC FORMATION: Ferris

AGE: Paleocene

COAL FIELD: Hanna

COAL-BEARING AREA: Hanna Coal Field

MEASURED SECTION: See Figure 72

TOTAL SECTION MEASURED (FEET): 240.7

COVER AT SAMPLING POINT (FEET): 221.5

ELEVATION TOP OF SAMPLED COAL: 6420+

STRIKE: Approximately 95°

DIP: 12°NE

MAJOR JOINT ORIENTATIONS IN COAL:

20-38°, 301-320°, 347°, 5-15°

STATE: Wyoming

COUNTY: Carbon

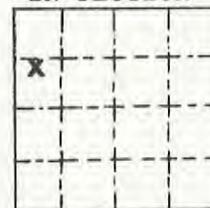
SECTION: 7

TOWNSHIP: T22N

RANGE: R83W

QUADRANGLE: Pats Bottom 7 1/2'

LOCATION
IN SECTION



COAL DESCRIPTION: See Figure 74

THICKNESS OF COAL (FEET): 19.0

THICKNESS SAMPLED (FEET): 19.0

TYPE OF SAMPLE: Face-channel

CONDITION OF SAMPLE: Weathered

TYPE OF EXPOSURE: Outcrop

MINE NAME: Not applicable

DATE OF SAMPLING: 9/19/74

SAMPLE COLLECTOR: Wyoming Geological Survey

COMPLETION DATE OF ANALYSES

U. S. Bureau of Mines: 10/11/74

Wyoming Geological Survey: 3/18/75

U. S. Geological Survey: 2/12/75

LABORATORY NUMBERS

K-47849

WGS-34

D170254

APPARENT RANK OF COAL: Subbituminous B

MISCELLANEOUS COMMENTS: None.

FERRIS FORMATION

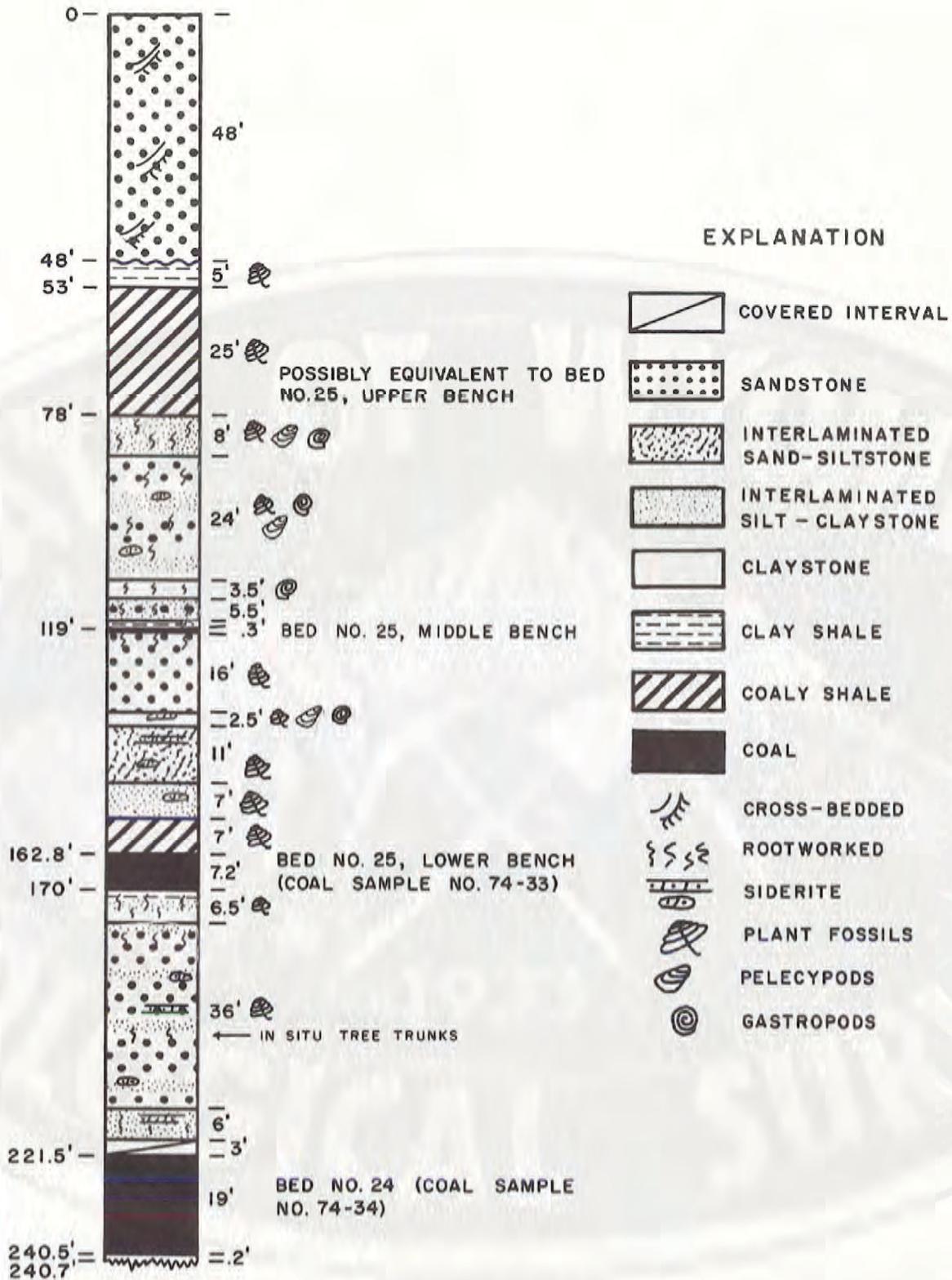
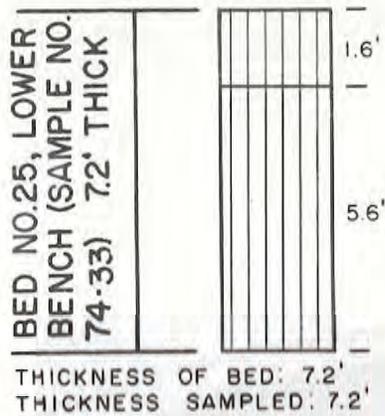


FIGURE 72: MEASURED SECTION AT A BED NO. 24 AND BED NO. 25 SAMPLE SITE IN SECTION 7, T22N, R83W (COAL SAMPLE NOS. 74-33 AND 74-34)

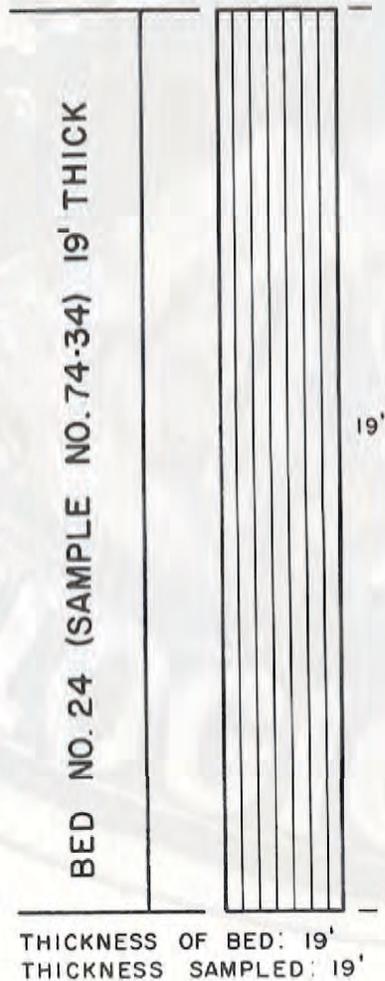


COAL: Banded; attritus moderately bright; amber common; too weathered for more details

COAL: Banded; vitrain bands and moderately bright attritus; joints filled with gypsum; white powdery stain common; irregular fracture; badly weathered

NOTE: BOTH UNITS IN ANALYSIS

FIGURE 73: MEGASCOPIC DESCRIPTION OF THE LOWER BENCH OF BED NO. 25 AT AN OUTCROP IN SECTION 12, T22N, R84W (COAL SAMPLE NO. 74-33)



COAL: Banded; vitrain bands and moderately bright attritus; joints commonly filled with gypsum; white powdery stain common; blocky to conchoidal fracture; weathered

NOTE: ENTIRE SEAM ANALYZED

FIGURE 74: MEGASCOPIC DESCRIPTION OF BED NO. 24 AT AN OUTCROP IN SECTION 7, T22N, R83W (COAL SAMPLE NO. 74-34)

POWDER RIVER COAL BASIN

Twenty samples of coal (74-35 through 74-54) were collected from the Paleocene Fort Union Formation in the Powder River Coal Basin (Figure 75). Of these, a Badger coal sample (74-35) and two School coal samples (74-36 & 37) were sampled in the Dave Johnston strip mine in Converse County (Figure 76).

Three samples of the Anderson-Canyon (Wyodak) coal (74-38 to 74-40) were collected from the Belle Ayr strip mine in Campbell County (Figure 84). Another three samples of that coal (74-41 to 74-43) were taken from the Wyodak strip mines, also in Campbell County (Figure 88).

Single samples of the Dietz No. 2, an unnamed Dietz coal, the Four-foot Bed, the Dietz No. 3, and the Monarch coal (74-44 to 74-48) were collected from the Big Horn No. 1 strip mine in Sheridan County (Figure 93). Figure 100 shows the location of one rider coal and five Monarch coal samples (74-49 to 74-54) taken in the Welch strip mine in Sheridan County.

Figure 75 shows all these 20 sampled coals and their sample numbers on generalized sections of the Fort Union Formation.

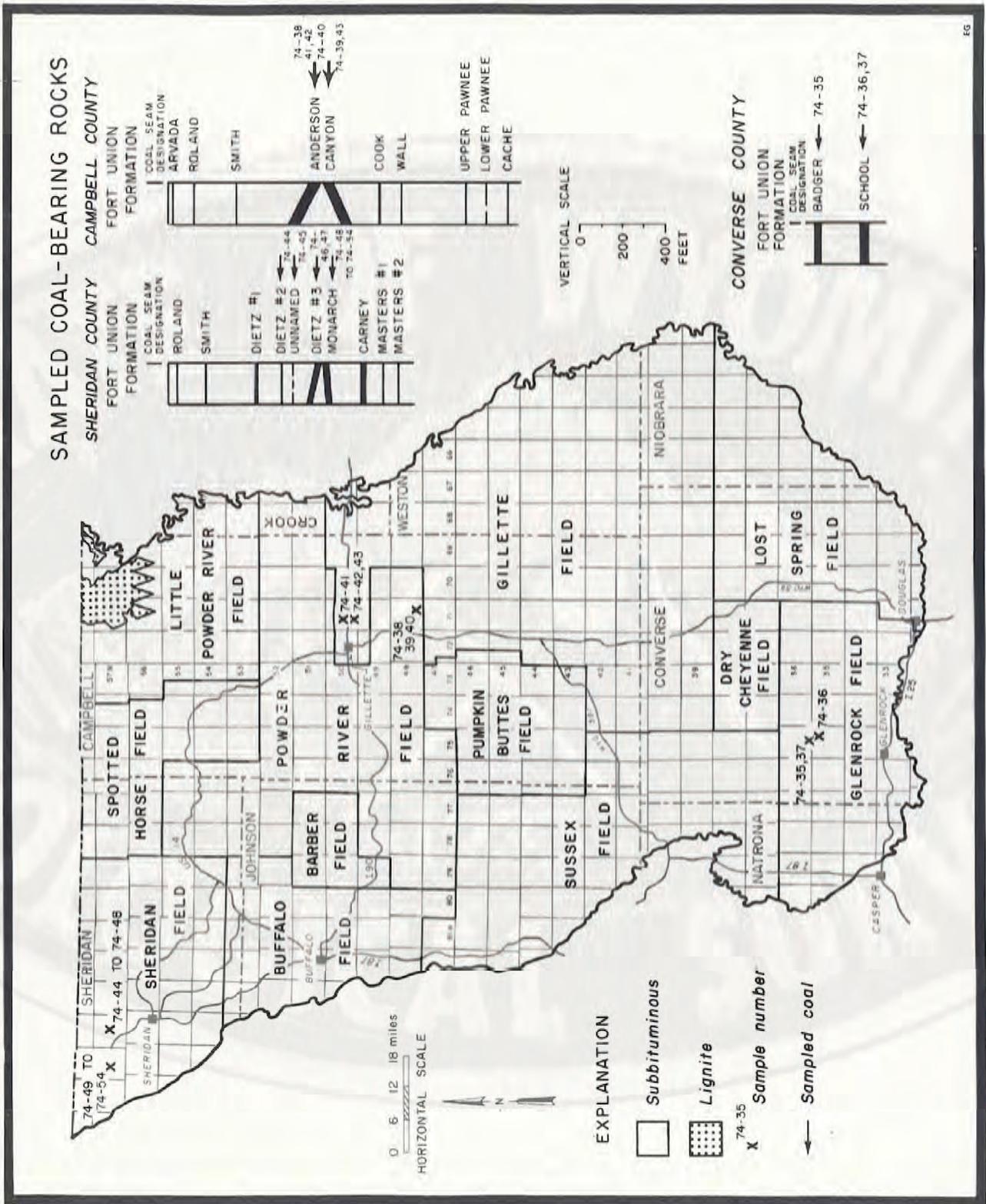


FIGURE 75: GENERALIZED SECTIONS AND INDEX MAP OF 20 SAMPLES (NOS. 74-35 TO 74-54) COLLECTED IN THE POWDER RIVER COAL BASIN IN 1974

SAMPLE NO. 74-35: BADGER COAL

INDEX MAPS: See Figures 75 and 76

SAMPLE NO.: 74-35

COAL NAMES(S): Badger

GEOLOGIC FORMATION: Fort Union

AGE: Paleocene

COAL FIELD: Glenrock

COAL-BEARING AREA: Powder River Coal Basin QUADRANGLE: Fifty-five Ranch 15'

STATE: Wyoming

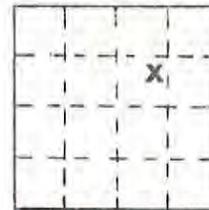
COUNTY: Converse

SECTION: 34

TOWNSHIP: T36N

RANGE: R75W

LOCATION
IN SECTION



MEASURED SECTION: See Figure 77

TOTAL SECTION MEASURED (FEET): 93.0

COVER AT SAMPLING POINT (FEET): 75.7

ELEVATION TOP OF SAMPLED COAL: 5725

STRIKE: NW-SE

DIP: Less than 4°NE

MAJOR JOINT ORIENTATIONS IN COAL:
85-95°, 74-78°, 65-68°, 320-327°,
353-341°

COAL DESCRIPTION: See Figure 78

THICKNESS OF COAL (FEET): 16.8

THICKNESS SAMPLED (FEET): 16.8

TYPE OF SAMPLE: Face-channel

CONDITION OF SAMPLE: Fresh

TYPE OF EXPOSURE: Strip mine

MINE NAME: Dave Johnston, Badger
Pit

DATE OF SAMPLING: 7/19/74

SAMPLE COLLECTOR: Wyoming Geological Survey

COMPLETION DATE OF ANALYSES

U. S. Bureau of Mines: 8/12/74

Wyoming Geological Survey: 3/18/75

U. S. Geological Survey: 6/13/75

LABORATORY NUMBERS

K-45927

WGS-35

D171838

APPARENT RANK OF COAL: Subbituminous C

MISCELLANEOUS COMMENTS: On an as received basis, the heat value of this sample is about 700 Btu/pound higher than in a typical analysis provided by Pacific Power and Light Company. This is probably the result of this sample's lower moisture content. On a dry basis the heat values are nearly identical.

TYPICAL ANALYSIS OF THE BADGER COAL
PROVIDED BY PACIFIC POWER AND LIGHT COMPANY (CORE SAMPLE)

PROXIMATE ANALYSIS

	<u>As Received</u>	<u>Dry Basis</u>
Moisture	29.02%	--
Volatile Matter	34.03%	47.95%
Fixed Carbon	28.47%	40.10%
Ash	8.48%	11.95%

HEAT VALUE

<u>As Received</u>	<u>Dry Basis</u>
7,606 Btu/lb.	10,716 Btu/lb.

ULTIMATE ANALYSIS

	<u>As Received</u>	<u>Dry Basis</u>
Carbon	44.47%	62.65%
Hydrogen	6.93%	4.65%
Nitrogen	0.48%	0.68%
Chlorine	0.00%	0.00%
Sulfur	0.41%	0.58%
Oxygen	39.22%	19.49%
Ash	8.48%	11.95%

ASH COMPOSITION (OXIDES)

P ₂ O ₅	1.29%
SiO ₂	39.30%
Fe ₂ O ₃	3.58%
Al ₂ O ₃	15.73%
TiO ₂	0.41%
CaO	22.58%
MgO	3.27%
SO ₃	12.99%
K ₂ O	0.49%
Na ₂ O	0.14%
Undetermined	0.22%

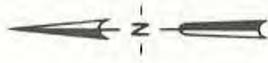
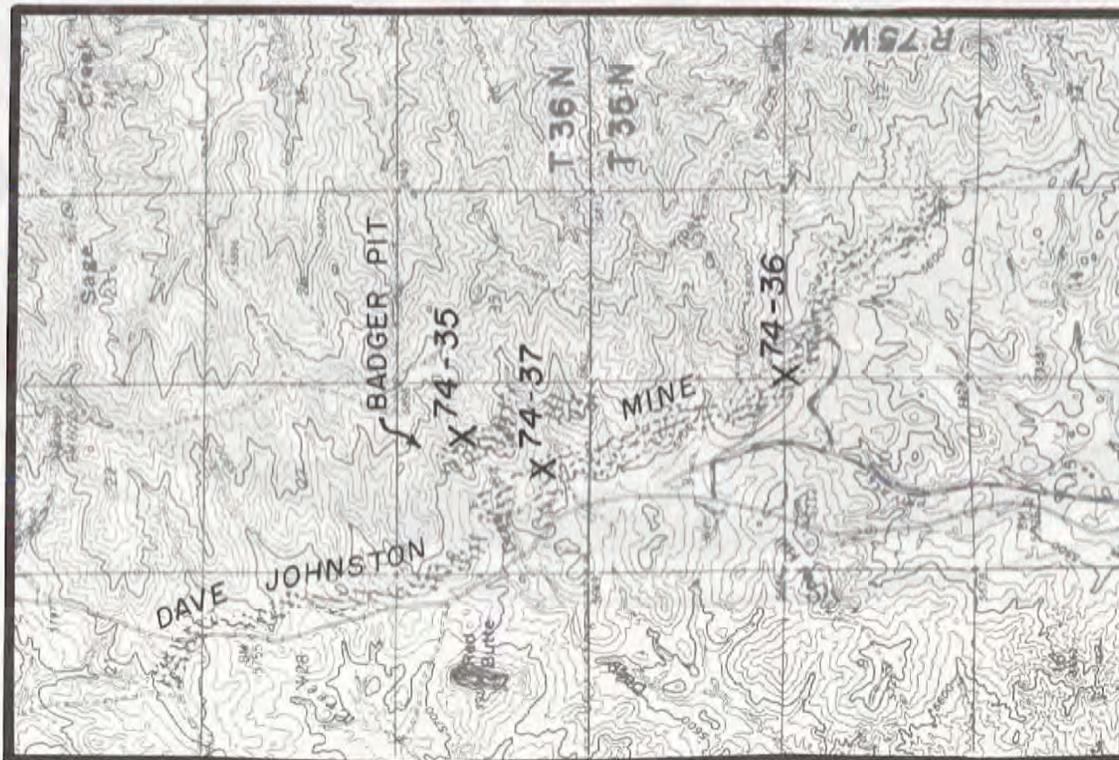
FUSION TEMPERATURE OF ASH

Initial Deformation	2235°F
Softening (H=W)	2240°F
Fluid	2255°F

HARDGROVE GRINDABILITY INDEX: 29.3

FORMS OF SULFUR

	<u>As Received</u>	<u>Dry Basis</u>
Pyritic	0.02	0.03
Sulfate	0.00	0.00
Organic	0.39	0.55



EXPLANATION

X 74-35 SAMPLE SITE AND SAMPLE NUMBER



STRIP MINE

Base map modified from U.S. Geological Survey's Fifty-five Ranch 15' (1959) topographic map.

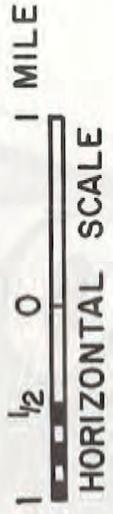


FIGURE 76: DETAILED LOCATION MAP OF COAL SAMPLES 74-35 THROUGH 74-37 COLLECTED IN 1974 FROM PACIFIC POWER AND LIGHT COMPANY'S DAVE JOHNSTON STRIP MINE, CONVERSE COUNTY, WYOMING

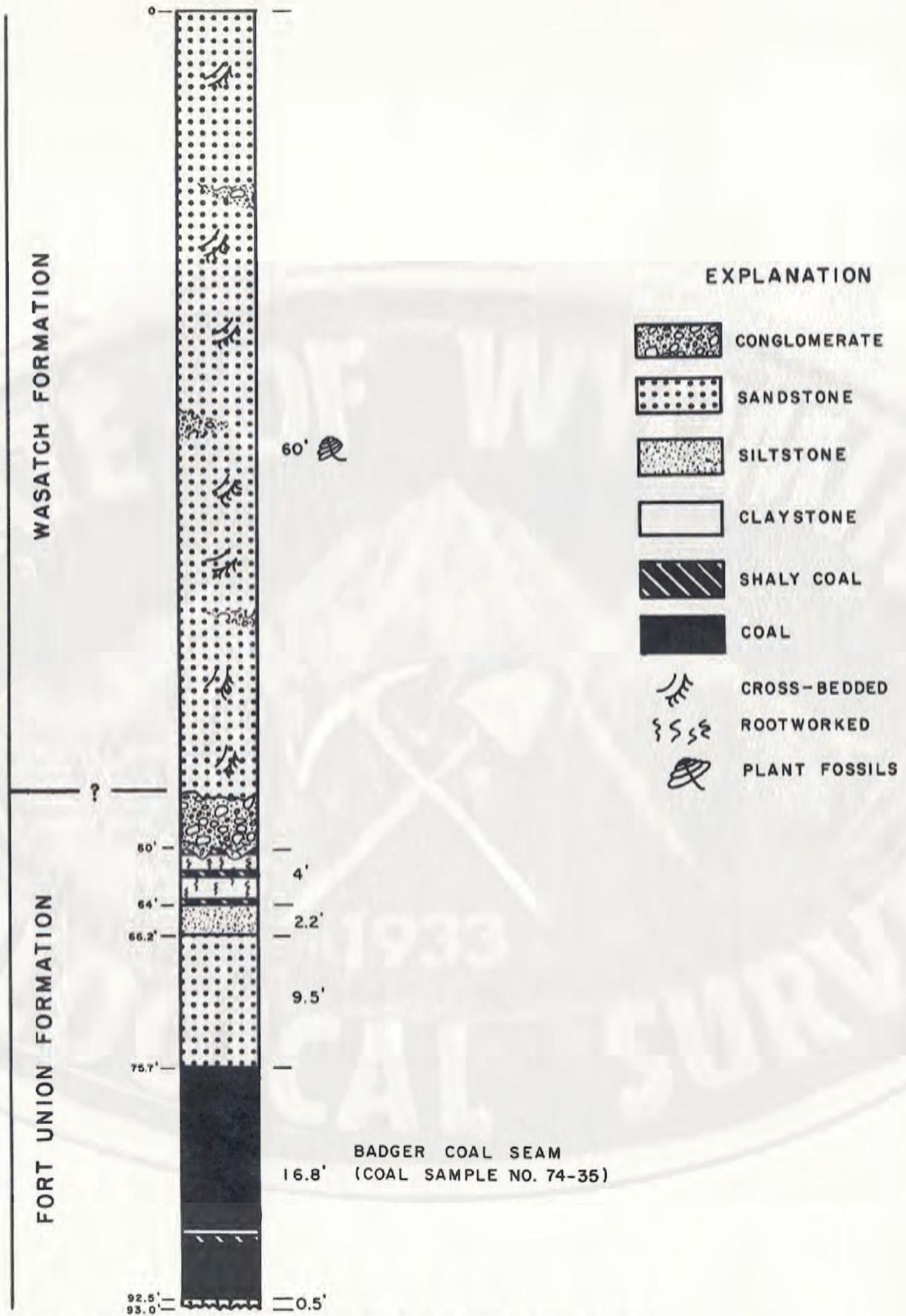
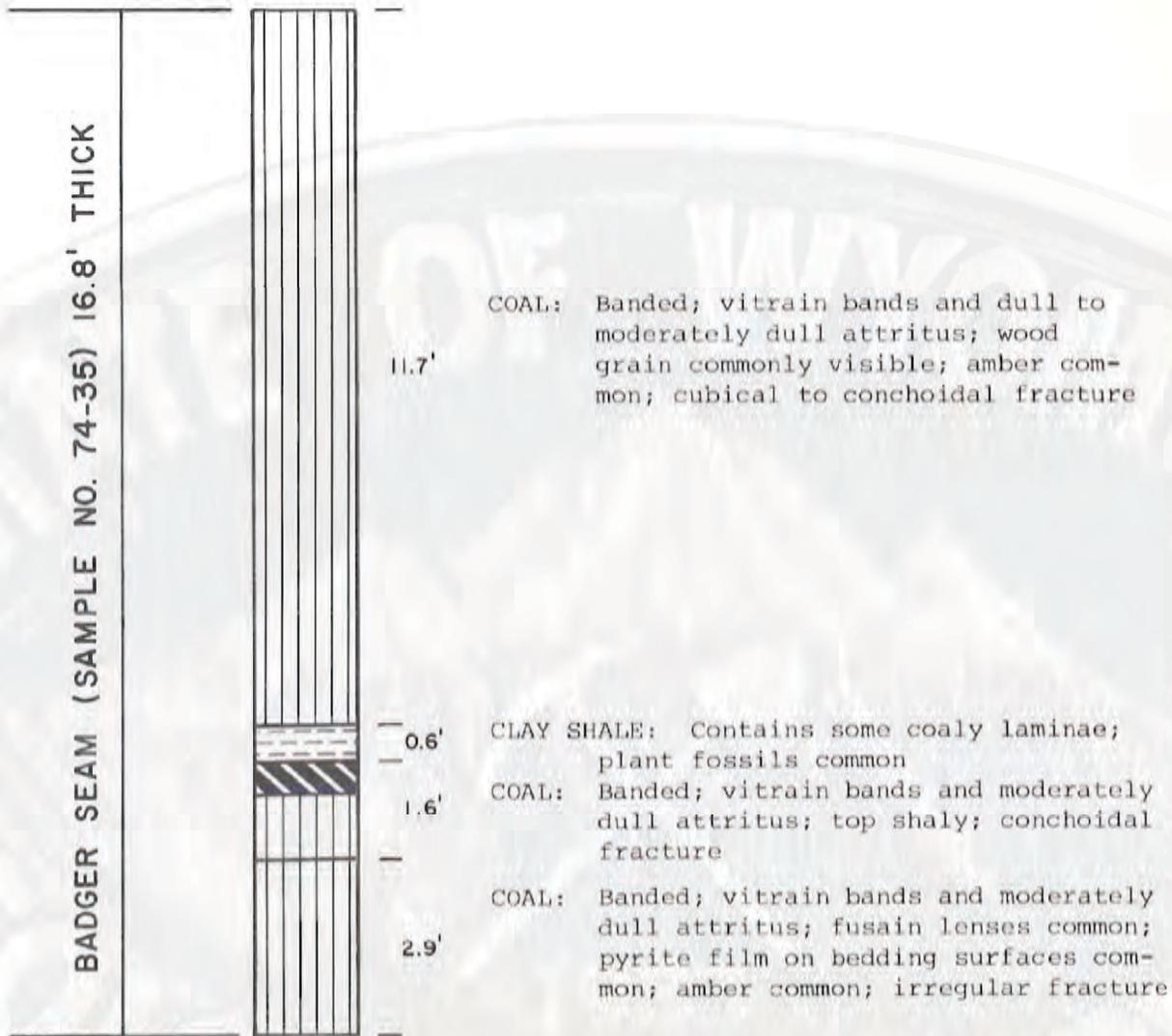


FIGURE 77: MEASURED SECTION AT THE BADGER COAL SAMPLE SITE IN THE DAVE JOHNSTON STRIP MINE (COAL SAMPLE NO. 74-35)



THICKNESS OF BED: 16.8'
 THICKNESS SAMPLED: 16.8'

NOTE: ALL UNITS INCLUDED IN ANALYSIS

FIGURE 78: MEGASCOPIIC DESCRIPTION OF THE BADGER COAL SEAM
 IN THE DAVE JOHNSTON STRIP MINE
 (COAL SAMPLE NO. 74-35)

SAMPLE NO. 74-36: SCHOOL COAL

INDEX MAPS: See Figures 75 and 76

SAMPLE NO.: 74-36

COAL NAME(S): School

GEOLOGIC FORMATION: Fort Union

AGE: Paleocene

COAL FIELD: Glenrock

COAL-BEARING AREA: Powder River Coal Basin

MEASURED SECTION: See Figure 79

TOTAL SECTION MEASURED (FEET): 111.7

COVER AT SAMPLING POINT (FEET): 73.0

ELEVATION TOP OF SAMPLED COAL: 5650

STRIKE: NW-SE

DIP: 3.5-4°NE

MAJOR JOINT ORIENTATIONS IN COAL:

81-85°, 345-352°

STATE: Wyoming

COUNTY: Converse

SECTION: 2

TOWNSHIP: T35N

RANGE: R75W

QUADRANGLE: Fifty-five Ranch 15'

LOCATION
IN SECTION



COAL DESCRIPTION: See Figure 80

THICKNESS OF COAL (FEET): 38.1

THICKNESS SAMPLED (FEET): 38.1

TYPE OF SAMPLE: Face-channel

CONDITION OF SAMPLE: Weathered

TYPE OF EXPOSURE: Strip mine

MINE NAME: Dave Johnston

DATE OF SAMPLING: 7/26/74

SAMPLE COLLECTOR: Wyoming Geological Survey

COMPLETION DATE OF ANALYSES

U. S. Bureau of Mines: 8/12/74

Wyoming Geological Survey: 3/18/75

U. S. Geological Survey: 6/13/75

LABORATORY NUMBERS

K-45926

WGS-36

D171837

APPARENT RANK OF COAL: Subbituminous C

MISCELLANEOUS COMMENTS: No partings were removed from this sample. A Company representative said that it had not yet been decided if these partings would be removed during mining. The as received ash content of this sample is nearly double the value found in a more northerly sample of the School seam (74-37), but not quite double that exhibited in a typical company analysis (see analysis in miscellaneous comments for Sample No. 74-37).

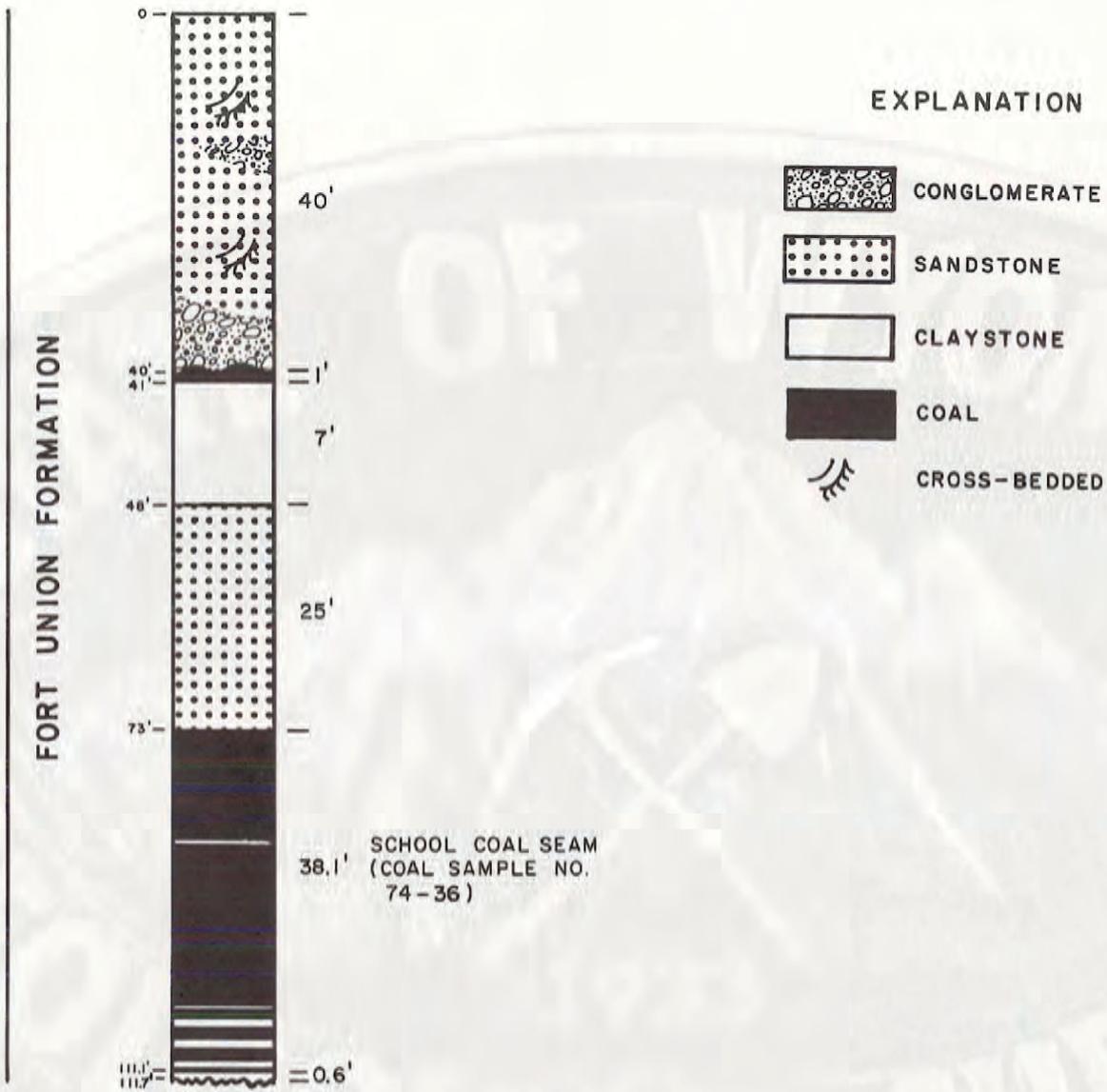
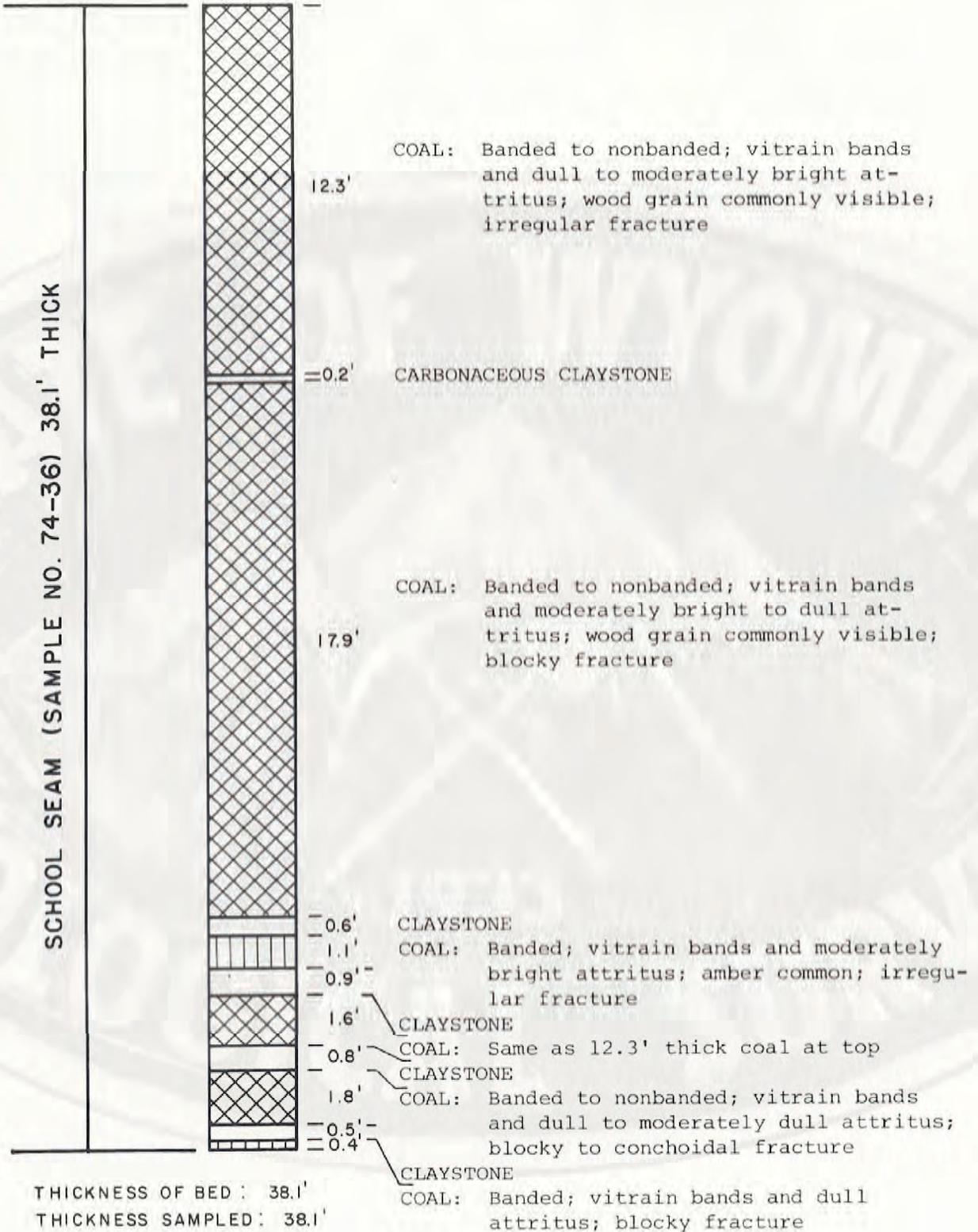


FIGURE 79: MEASURED SECTION AT A SCHOOL COAL SAMPLE SITE IN THE SOUTHERN END OF THE DAVE JOHNSTON STRIP MINE (COAL SAMPLE NO. 74-36)



NOTE: ALL UNITS INCLUDED IN ANALYSIS

FIGURE 80: MEGASCOPIC DESCRIPTION OF THE SCHOOL COAL SEAM IN THE SOUTHERN END OF THE DAVE JOHNSTON STRIP MINE (COAL SAMPLE NO. 74-36)

SAMPLE NO. 74-37: SCHOOL COAL

INDEX MAPS: See Figures 75 and 76

SAMPLE NO.: 74-37

COAL NAMES(S): School

GEOLOGIC FORMATION: Fort Union

AGE: Paleocene

COAL FIELD: Glenrock

COAL-BEARING AREA: Powder River Coal Basin QUADRANGLE: Fifty-five Ranch 15'

MEASURED SECTION: See Figure 81

TOTAL SECTION MEASURED (FEET): 165.1

COVER AT SAMPLING POINT (FEET): 127.9

ELEVATION TOP OF SAMPLED COAL: 5600+

STRIKE: NW-SE

DIP: Less than 4° NE

MAJOR JOINT ORIENTATIONS IN COAL:
70-77°, 85°, 345-356°

STATE: Wyoming

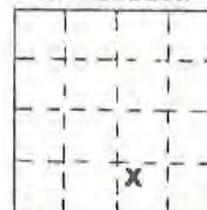
COUNTY: Converse

SECTION: 34

TOWNSHIP: T36N

RANGE: R75W

LOCATION
IN SECTION



COAL DESCRIPTION: See Figure 82

THICKNESS OF COAL (FEET): 37.0

THICKNESS SAMPLED (FEET): 36.2

TYPE OF SAMPLE: Face-channel

CONDITION OF SAMPLE: Fresh

TYPE OF EXPOSURE: Strip mine

MINE NAME: Dave Johnston

DATE OF SAMPLING: 7/17/74

SAMPLE COLLECTOR: Wyoming Geological Survey

COMPLETION DATE OF ANALYSES

U. S. Bureau of Mines: 8/12/74

Wyoming Geological Survey: 3/18/75

U. S. Geological Survey: 6/13/75

LABORATORY NUMBERS

K-45928

WGS-37

D171839

APPARENT RANK OF COAL: Subbituminous B

MISCELLANEOUS COMMENTS: The partings in Sample No. 74-36 thin in this direction and are not mined here. For this reason the partings were not included in Sample No. 74-37. The routine analysis of Sample No. 74-37 compares favorably with company analyses except in as received moisture and heat values. Like Sample No. 74-35, the moisture is lower than in company analyses while the heat value is over 1000 Btu/pound higher. On a dry basis, however, the heat value is less than 400 Btu/pound higher than the typical company analysis.

In addition to the typical analysis provided below, Pacific Power and Light Company also provided the following trace element values for the School seam to compare with data in this report:

	<u>Mn</u>	<u>Mo</u>	<u>V</u>
PARTS PER MILLION ON A WHOLE-COAL BASIS	32.0	Not detected	4.3

TYPICAL ANALYSIS OF THE SCHOOL COAL
 PROVIDED BY PACIFIC POWER AND LIGHT COMPANY (CORE SAMPLE)

PROXIMATE ANALYSIS

	<u>As Received</u>	<u>Dry Basis</u>
Moisture	26.41%	--
Volatile Matter	34.43%	46.78%
Fixed Carbon	29.48%	40.06%
Ash	9.68%	13.16%

HEAT VALUE

<u>As Received</u>	<u>Dry Basis</u>
7,830 Btu/lb.	10,640 Btu/lb.

ULTIMATE ANALYSIS

	<u>As Received</u>	<u>Dry Basis</u>
Carbon	45.77%	62.20%
Hydrogen	6.72%	4.65%
Nitrogen	0.48%	0.65%
Chlorine	0.00%	0.00%
Sulfur	0.52%	0.70%
Oxygen	36.83%	18.64%
Ash	9.68%	13.16%

ASH COMPOSITION (OXIDES)

P ₂ O ₅	1.21%
SiO ₂	42.50%
Fe ₂ O ₃	3.89%
Al ₂ O ₃	15.62%
TiO ₂	0.42%
CaO	18.00%
MgO	2.62%
SO ₃	12.05%
K ₂ O	0.95%
Na ₂ O	2.62%
Undetermined	0.12%

FUSION TEMPERATURE OF ASH

Initial Deformation	2130°F
Softening (H=W)	2175°
Fluid	2205°F

HARDGROVE GRINDABILITY INDEX: 35.5

FORMS OF SULFUR

	<u>As Received</u>	<u>Dry Basis</u>
Pyritic	0.13	0.18
Sulfate	0.00	0.00
Organic	0.39	0.52

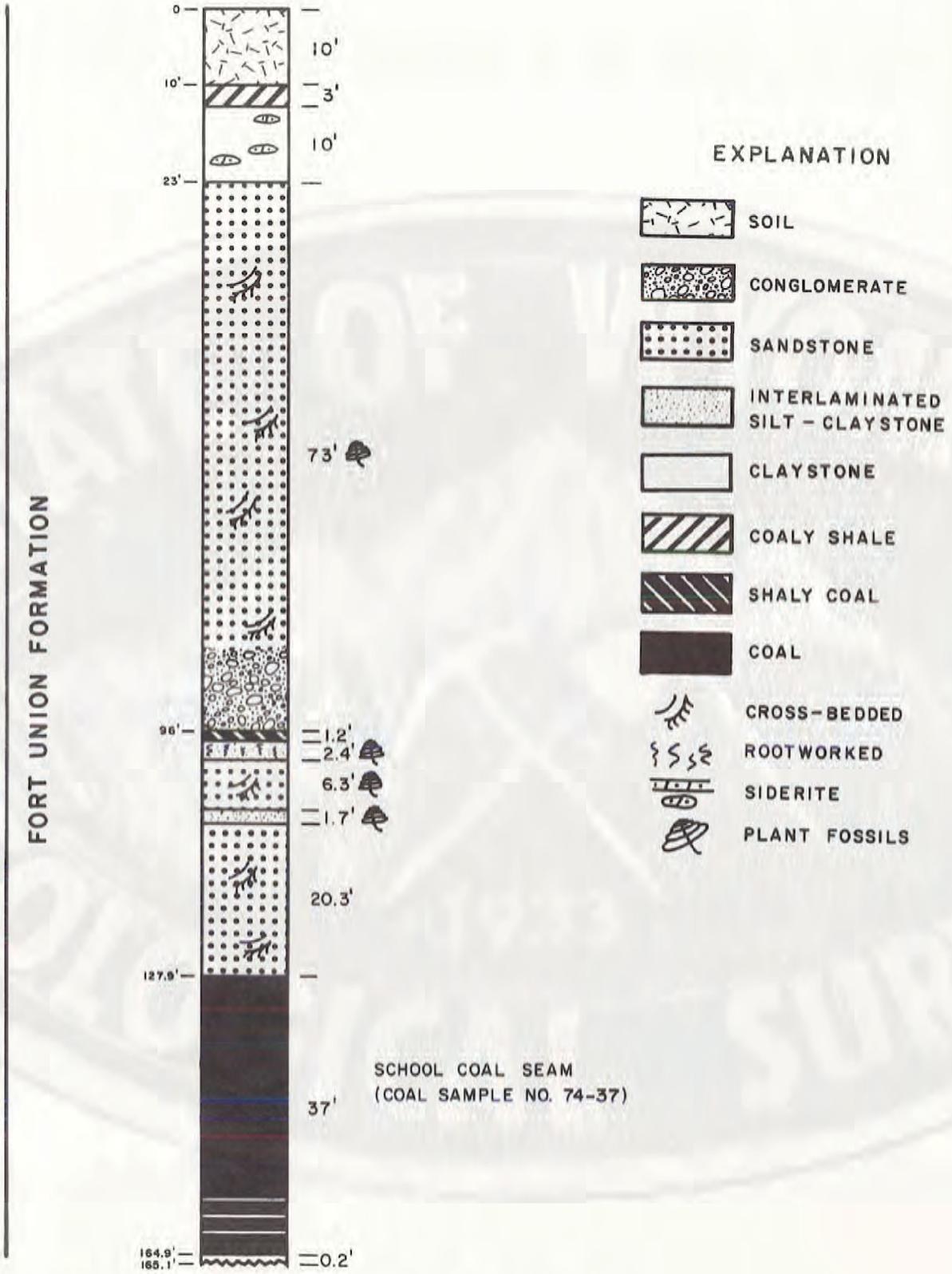


FIGURE 81: MEASURED SECTION AT A SCHOOL COAL SAMPLE SITE IN THE MIDDLE OF THE DAVE JOHNSTON STRIP MINE (COAL SAMPLE NO. 74-37)

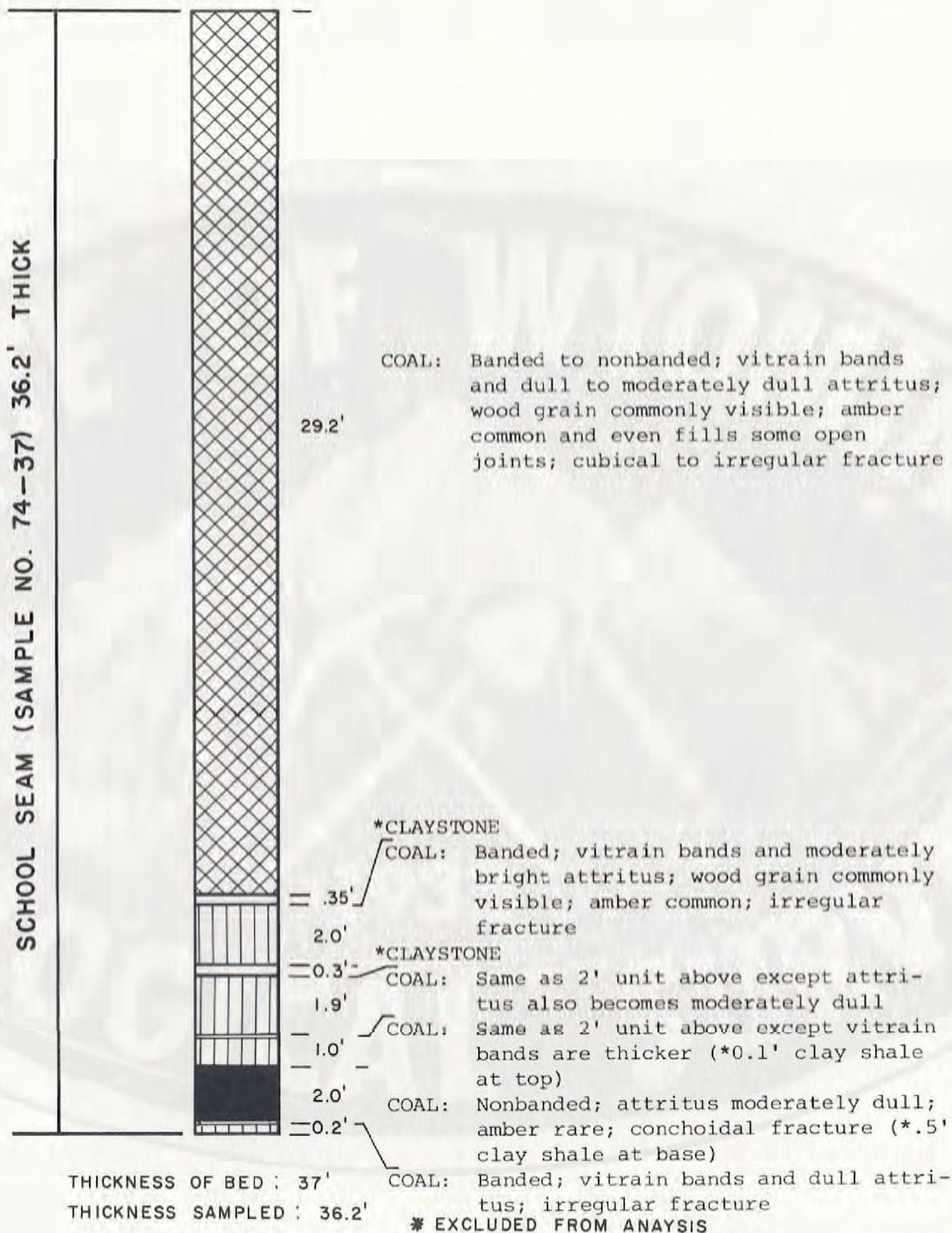


FIGURE 82: MEGASCOPIC DESCRIPTION OF THE SCHOOL COAL IN THE MIDDLE OF THE DAVE JOHNSTON STRIP MINE (COAL SAMPLE NO. 74-37)

SAMPLE NO. 74-38: ANDERSON-CANYON (WYODAK) UPPER LIFT

INDEX MAPS: See Figures 75 and 84

SAMPLE NO.: 74-38

COAL NAMES(S): Anderson-Canyon (Wyodak)
Upper Lift

GEOLOGIC FORMATION: Fort Union

AGE: Paleocene

COAL FIELD: Powder River

COAL-BEARING AREA: Powder River Coal Basin

MEASURED SECTION: See Figure 85

TOTAL SECTION MEASURED (FEET): 121.4

COVER AT SAMPLING POINT (FEET): 39.0

ELEVATION TOP OF SAMPLED COAL: 4440

STRIKE: Approximately N-S

DIP: Westerly, nearly flat

MAJOR JOINT ORIENTATIONS IN COAL:

290-309°, 330°, 56°, 34°, 0°

STATE: Wyoming

COUNTY: Campbell

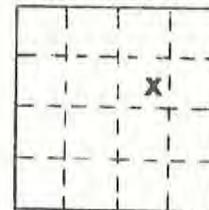
SECTION: 34

TOWNSHIP: T48N

RANGE: R71W

QUADRANGLE: The Gap SW 7 1/2'

LOCATION
IN SECTION



COAL DESCRIPTION: See Figure 86

THICKNESS OF COAL (FEET): 74.4

THICKNESS SAMPLED (FEET): 35

TYPE OF SAMPLE: Face-channel

CONDITION OF SAMPLE: Fresh

TYPE OF EXPOSURE: Strip mine

MINE NAME: Belle Ayr

DATE OF SAMPLING: 7/31/74

SAMPLE COLLECTOR: Wyoming Geological Survey

COMPLETION DATE OF ANALYSES

U. S. Bureau of Mines: 8/19/74

Wyoming Geological Survey: 3/18/75

U. S. Geological Survey: 6/13/75

LABORATORY NUMBERS

K-46217

WGS-38

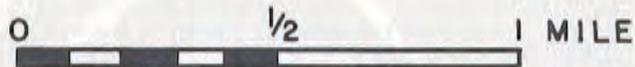
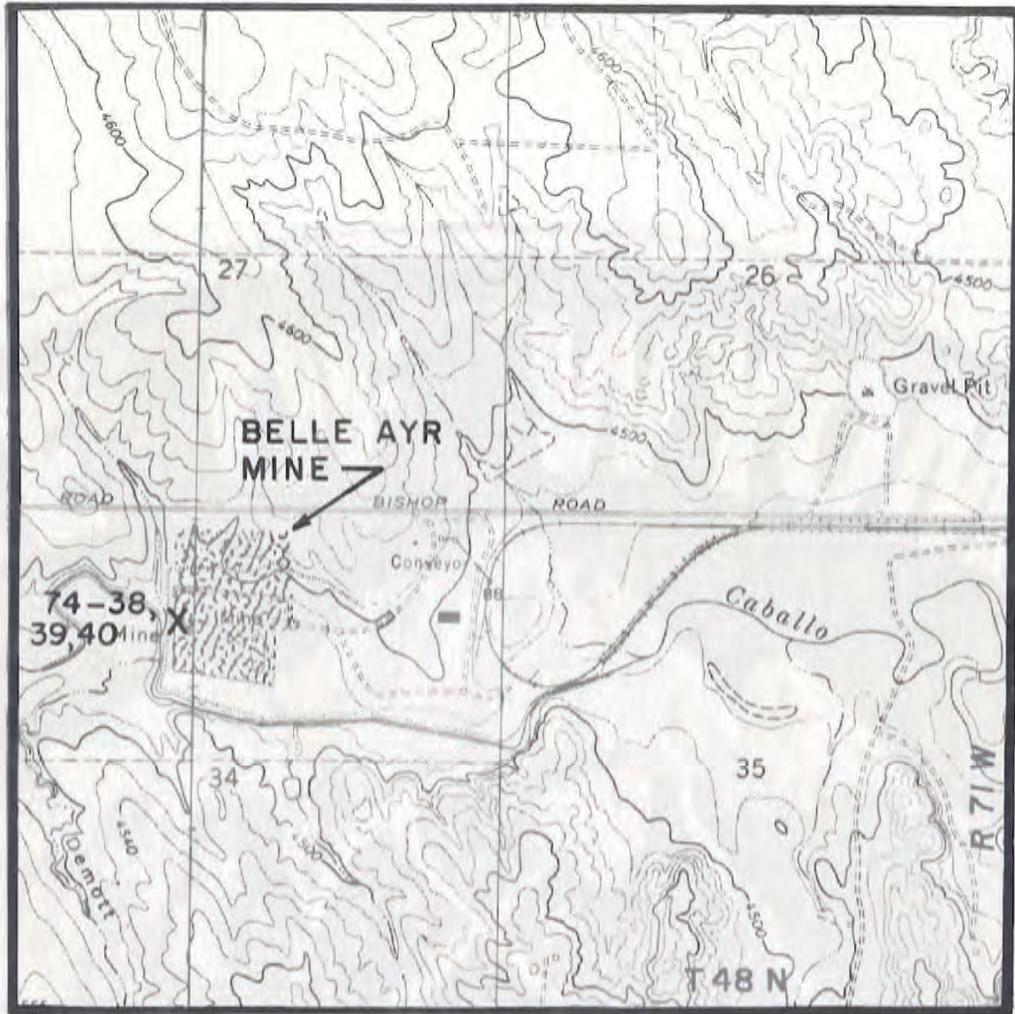
D171827

APPARENT RANK OF COAL: Subbituminous B

MISCELLANEOUS COMMENTS: The as received heat value of this sample is 1400 Btu/pound higher than the average provided by Amax Coal Company. This is probably due to the low moisture content of our sample, 21.4%, compared to an average moisture around 30.4%. On a dry basis there is only 400 Btu/pound difference between this sample and the company average.



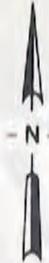
FIGURE 83: AMAX COAL COMPANY'S BELLE AYR MINE
(VIEW LOOKING SOUTHWEST AT THE STRIP MINE. THE COAL IS
MINED IN TWO LIFTS OR BENCHES, EACH ABOUT 35 FEET THICK).



HORIZONTAL SCALE

EXPLANATION

- X 74-38 SAMPLE SITE AND SAMPLE NUMBER
- STRIP MINE



Base map modified from U.S. Geological Survey's
 The Gap SW 7 1/2' (advance proof) and Kicken Creek
 7 1/2' (advance proof) topographic maps.

FIGURE 84: DETAILED LOCATION MAP OF COAL SAMPLES 74-38
 THROUGH 74-40 COLLECTED IN 1974 FROM AMAX
 COAL COMPANY'S BELLE AYR STRIP MINE,
 CAMPBELL COUNTY, WYOMING

SAMPLE NO. 74-39: ANDERSON-CANYON (WYODAK) LOWER LIFT

INDEX MAPS: See Figures 75 and 84

SAMPLE NO.: 74-39

COAL NAMES(S): Anderson-Canyon (Wyodak)
Lower Lift

GEOLOGIC FORMATION: Fort Union

AGE: Paleocene

COAL FIELD: Powder River

COAL-BEARING AREA: Powder River Coal Basin QUADRANGLE: The Gap SW 7 1/2'

MEASURED SECTION: See Figure 85

TOTAL SECTION MEASURED (FEET): 121.4

COVER AT SAMPLING POINT (FEET): 74.0

ELEVATION TOP OF SAMPLED COAL: 4405

STRIKE: Approximately N-S

DIP: Nearly flat to westerly

MAJOR JOINT ORIENTATIONS IN COAL:
See Sample No. 74-38

STATE: Wyoming

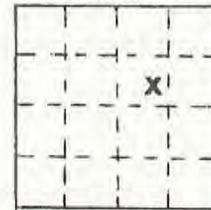
COUNTY: Campbell

SECTION: 34

TOWNSHIP: T48N

RANGE: R71W

LOCATION
IN SECTION



COAL DESCRIPTION: See Figure 86

THICKNESS OF COAL (FEET): 74.4

THICKNESS SAMPLED (FEET): 39.4

TYPE OF SAMPLE: Face-channel

CONDITION OF SAMPLE: Fresh

TYPE OF EXPOSURE: Strip mine

MINE NAME: Belle Ayr

DATE OF SAMPLING: 7/31/74

SAMPLE COLLECTOR: Wyoming Geological Survey

COMPLETION DATE OF ANALYSES

U. S. Bureau of Mines: 8/19/74

Wyoming Geological Survey: 3/18/75

U. S. Geological Survey: 6/13/75

LABORATORY NUMBERS

K-46216

WGS-39

D171826

APPARENT RANK OF COAL: Subbituminous B

MISCELLANEOUS COMMENTS: The as received heat value of this sample is about 1300 Btu/pound higher than an average analysis provided by Amax Coal Company. See Sample No. 74-40 for an average analysis. In the case of Sample No. 74-39, the heat value on a dry basis is 500 Btu/pound above average.

SAMPLE NO. 74-40: ANDERSON-CANYON (WYODAK) COAL

INDEX MAPS: See Figures 75 and 84

SAMPLE NO.: 74-40

COAL NAME(S): Anderson-Canyon (Wyodak)

GEOLOGIC FORMATION: Fort Union

AGE: Paleocene

COAL FIELD: Powder River

COAL-BEARING AREA: Powder River Coal Basin QUADRANGLE: The Gap SW 7 1/2'

MEASURED SECTION: See Figure 85

TOTAL SECTION MEASURED (FEET): 121.4

COVER AT SAMPLING POINT (FEET): 39.0

ELEVATION TOP OF SAMPLED COAL: 4440

STRIKE: Approximately N-S

DIP: Nearly flat to westerly

MAJOR JOINT ORIENTATIONS IN COAL:
See Sample No. 74-38

STATE: Wyoming

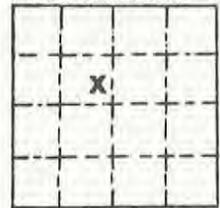
COUNTY: Campbell

SECTION: 34

TOWNSHIP: T48N

RANGE: R71W

LOCATION
IN SECTION



COAL DESCRIPTION: See Figure 86

THICKNESS OF COAL (FEET): 74.4

THICKNESS SAMPLED (FEET): 74.4

TYPE OF SAMPLE: Face-channel

CONDITION OF SAMPLE: Fresh

TYPE OF EXPOSURE: Strip mine

MINE NAME: Belle Ayr

DATE OF SAMPLING: 7/31/74

SAMPLE COLLECTOR: Wyoming Geological Survey

COMPLETION DATE OF ANALYSES

U. S. Bureau of Mines: 8/19/74

Wyoming Geological Survey: 3/18/75

U. S. Geological Survey: 6/13/75

LABORATORY NUMBERS

K-46218

WGS-40

D171828

APPARENT RANK OF COAL: Subbituminous B.

MISCELLANEOUS COMMENTS: Amax Coal Company's identification of the coals in this mine are the "Roland and Smith seams, Belle Ayr coal".

This sample combines both lifts or benches into a single composite sample. Again the heat value is higher than expected when compared to Amax Coal Company's average analysis. The average analysis of this coal in the Belle Ayr mining property is as follows:

AVERAGE FIELD ANALYSIS OF THE ANDERSON-CANYON (WYODAK)
PROVIDED BY AMAX COAL COMPANY

PROXIMATE ANALYSIS

	<u>As Received</u>
Moisture	30.4%
Ash	6.4%
Volatile Matter	31.2%
Fixed Carbon	32.0%

FUSION TEMPERATURES

Initial Deformation	2142°F
Fluid	2272°F

SULFUR FORMS

	<u>As Received</u>
Pyritic	0.110%
Organic	0.330%
Sulfate	0.040%

HEAT VALUE

As Received	8,020 Btu/lb.
Dry Basis	11,523 Btu/lb.

ULTIMATE ANALYSIS

As Received

Carbon	47.85%
Hydrogen	7.20%
Nitrogen	0.62%
Chlorine	0.03%
Sulfur	0.48%
Ash	6.40%
Oxygen	37.43%

ASH COMPOSITION (OXIDES)

P ₂ O ₅	0.75%
SiO ₂	31.59%
Fe ₂ O ₃	4.55%
Al ₂ O ₃	15.29%
TiO ₂	1.12%
CaO	22.85%
MgO	4.74%
SO ₃	16.55%
K ₂ O	0.44%
Na ₂ O	1.27%

TRACE ELEMENTS

(These values were derived from core samples on Amax's property north of Gillette)

PPM On Whole-Coal Basis

As	2.40
B	72.00
Ba	120.00
Be	0.98
Cd	0.56
Ce	8.90
Co	2.20
Cr	9.40
Cu	11.00
F	520.00
Ga	1.00
Ge	0.46
Hg	0.08
La	2.80
Li	3.10
Mn	62.00
Mo	5.00
Nb	3.50
Nd	5.50
Ni	4.90
Pb	2.00
Sb	0.09
Sc	4.10
Se	0.30
Th	2.90
U	1.90
V	70.00
Y	6.20
Yb	0.25L
Zn	31.00
Zr	62.00

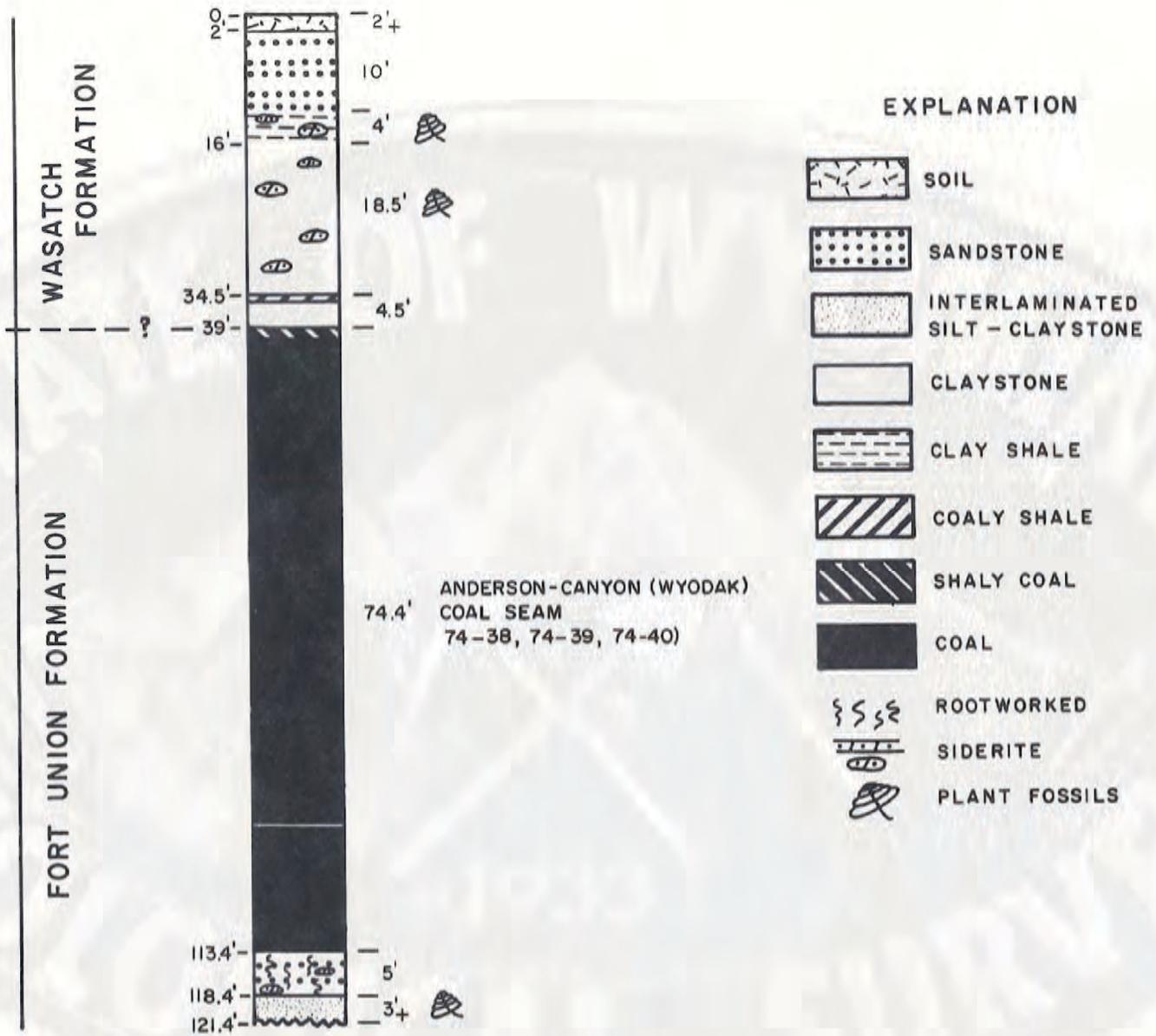


FIGURE 85: MEASURED SECTION AT THE ANDERSON-CANYON (WYODAK) COAL SAMPLE SITE IN THE BELLE AYR STRIP MINE (COAL SAMPLE NOS. 74-38 TO 74-40)

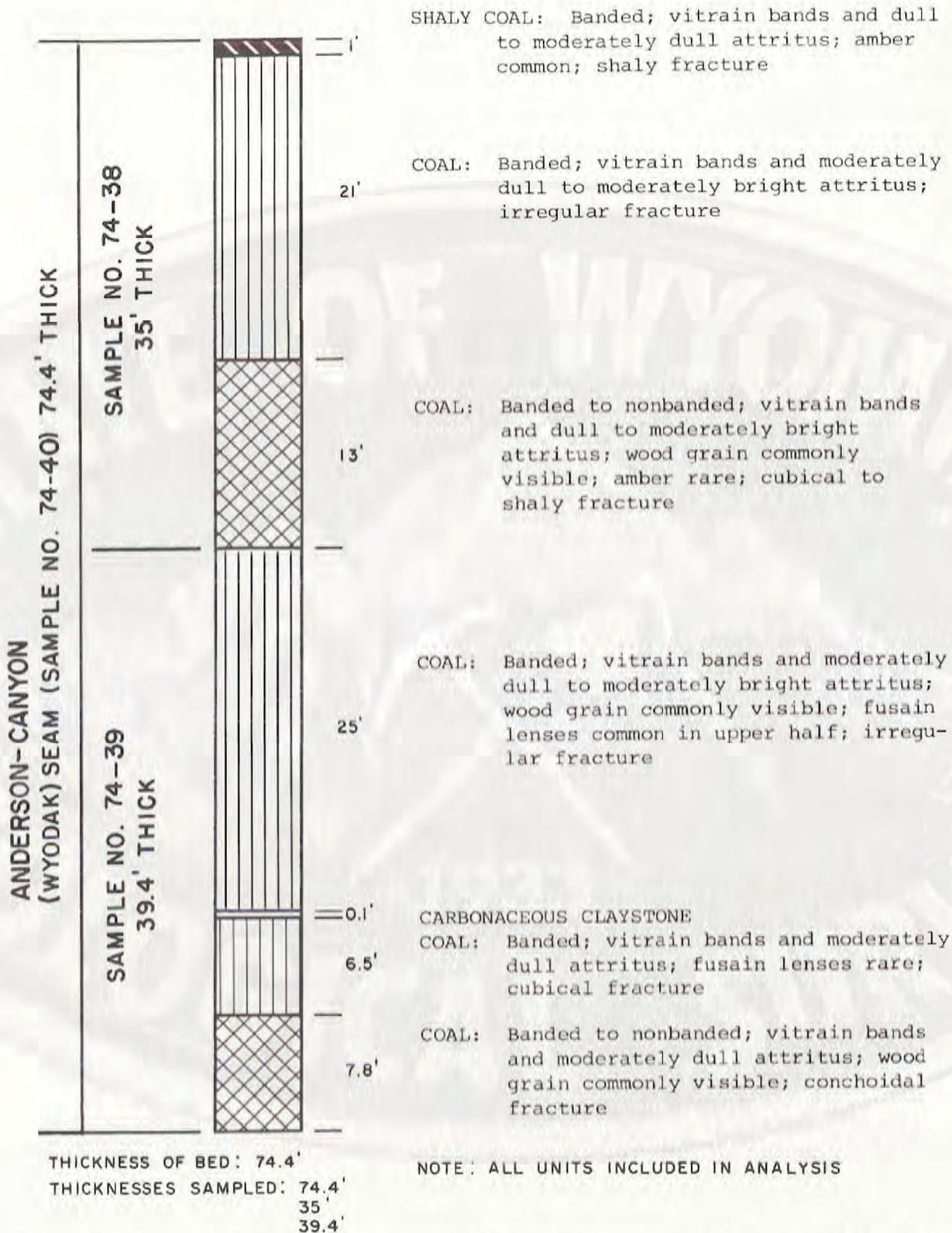


FIGURE 86: MEGASCOPIC DESCRIPTION OF THE ANDERSON-CANYON (WYODAK) COAL SEAM IN THE BELLE AYR STRIP MINE (COAL SAMPLE NOS. 74-38, 39, AND 40)

SAMPLE NO. 74-41: ANDERSON (WYODAK) COAL

INDEX MAPS: See Figures 75 and 88

SAMPLE NO.: 74-41

COAL NAME(S): Anderson (Wyodak)

GEOLOGIC FORMATION: Fort Union

AGE: Paleocene

COAL FIELD: Gillette

COAL-BEARING AREA: Powder River Coal Basin

MEASURED SECTION: See Figure 89

TOTAL SECTION MEASURED (FEET): 106.8

COVER AT SAMPLING POINT (FEET): 15.0

ELEVATION TOP OF SAMPLED COAL: 4380+

STRIKE: Approximately N-S

DIP: Nearly flat to westerly

MAJOR JOINT ORIENTATIONS IN COAL:

85-92°, 98-110°, 350°, 2°

STATE: Wyoming

COUNTY: Campbell

SECTION: 28

TOWNSHIP: T50N

RANGE: R71W

QUADRANGLE: Rozet 2 SW 7 1/2'

LOCATION
IN SECTION

			X

COAL DESCRIPTION: See Figure 90

THICKNESS OF COAL (FEET): 91.8+

THICKNESS SAMPLED (FEET): 41.7

TYPE OF SAMPLE: Face-channel

CONDITION OF SAMPLE: Weathered

TYPE OF EXPOSURE: Strip mine

MINE NAME: Wyodak North Pit

DATE OF SAMPLING: 8/9/74

SAMPLE COLLECTOR: Wyoming Geological Survey

COMPLETION DATE OF ANALYSES

U. S. Bureau of Mines: 8/26/74

Wyoming Geological Survey: 3/18/75

U. S. Geological Survey: 6/13/75

LABORATORY NUMBERS

K-46430

WGS-41

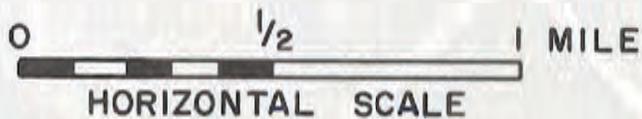
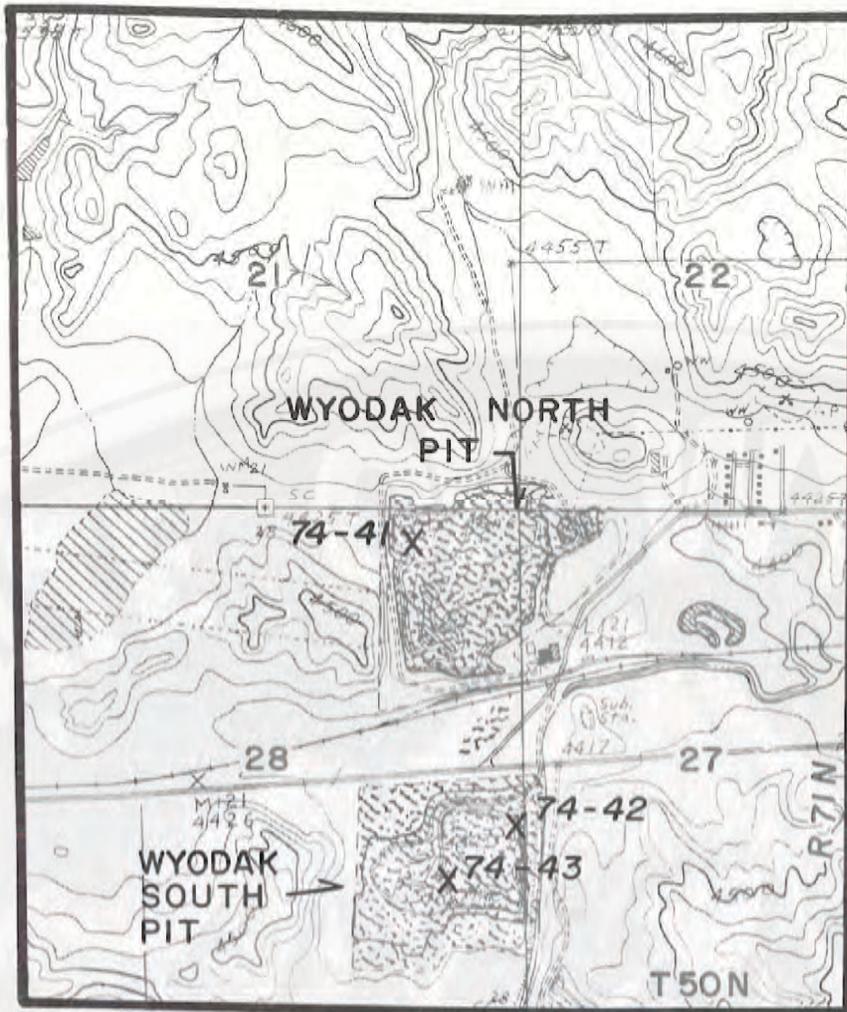
D171831

APPARENT RANK OF COAL: Subbituminous B

MISCELLANEOUS COMMENTS: The low moisture content of this sample probably accounts for a higher than average, as received heat value.



FIGURE 87: WYODAK RESOURCES' NORTH PIT
(VIEW OF THE 91 FOOT THICK ANDERSON-CANYON
(WYODAK) COAL IN THE NORTH WALL OF THE PIT)



EXPLANATION

- X⁷⁴⁻⁴¹ SAMPLE SITE AND SAMPLE NUMBER
-  STRIP MINE



Base map modified from U.S. Geological Survey's Rozet 2 SW 7 1/2' (advance proof) topographic map.

FIGURE 88: DETAILED LOCATION MAP OF COAL SAMPLES 74-41 THROUGH 74-43 COLLECTED IN 1974 FROM WYODAK RESOURCES' WYODAK PITS, CAMPBELL COUNTY, WYOMING

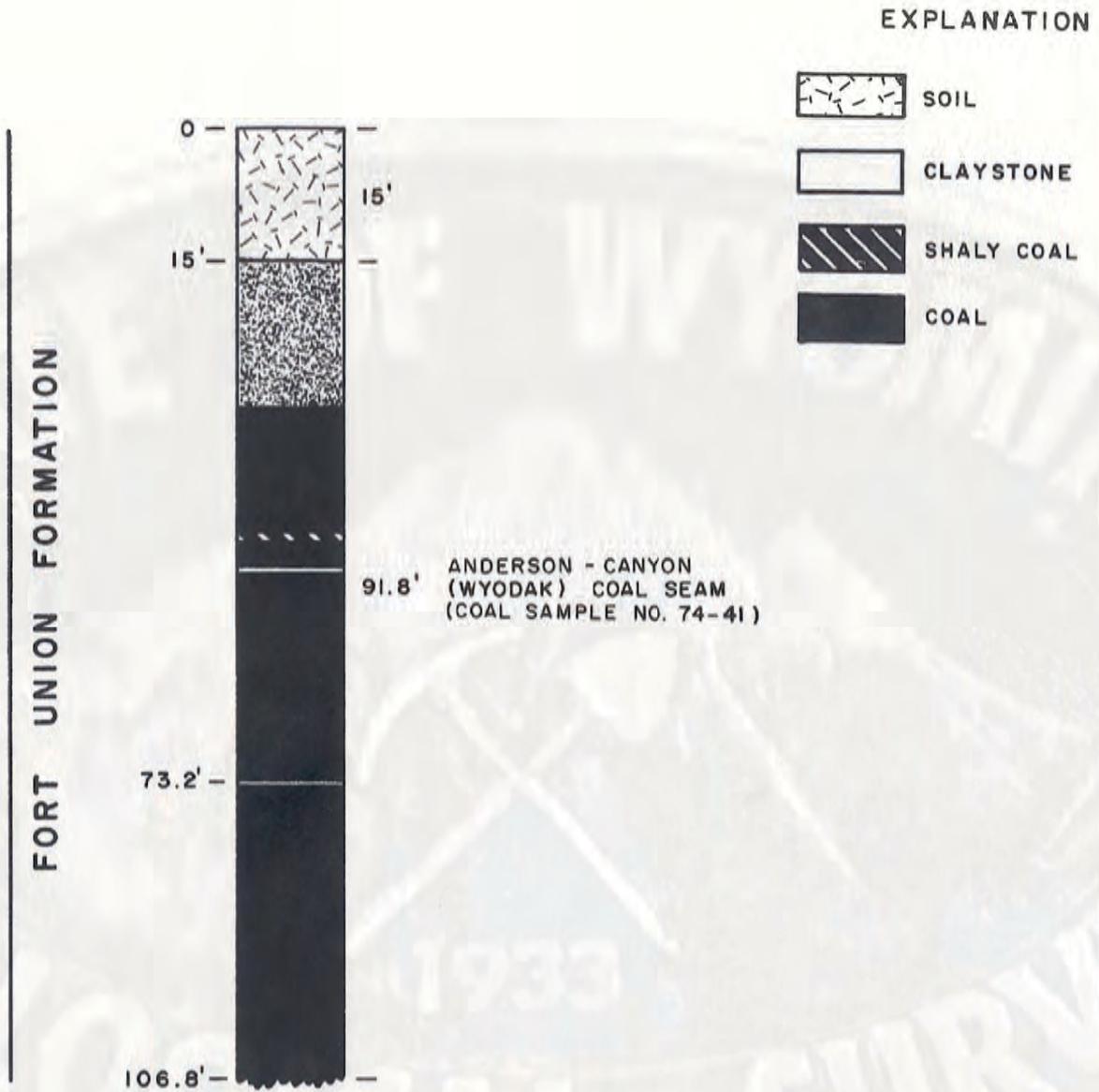


FIGURE 89: MEASURED SECTION AT THE ANDERSON COAL SAMPLE SITE IN THE WYODAK NORTH PIT (COAL SAMPLE NO. 74-41)

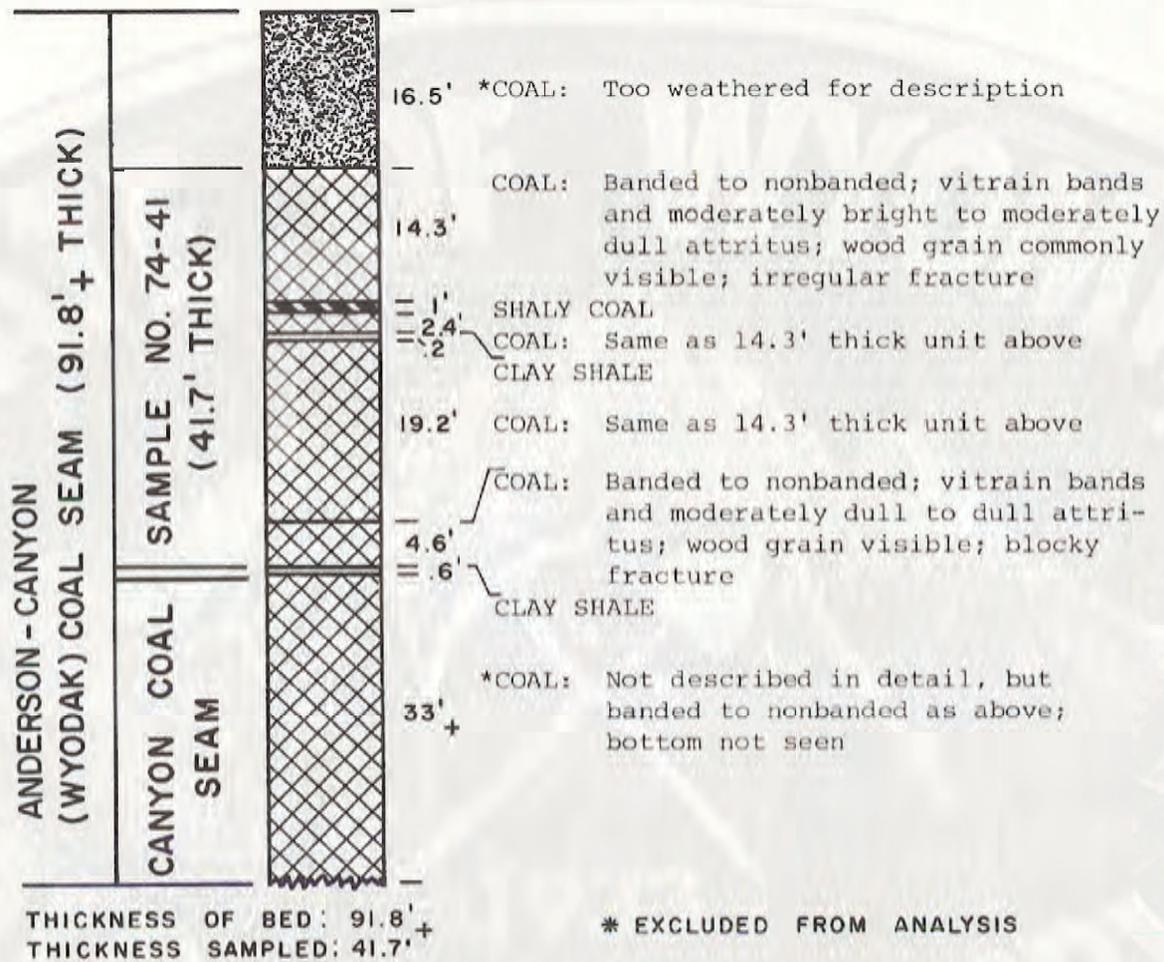


FIGURE 90: MEGASCOPIC DESCRIPTION OF THE ANDERSON-CANYON (WYODAK) COAL SEAM IN THE WYODAK NORTH PIT (COAL SAMPLE NO. 74-41)

SAMPLE NO. 74-42: ANDERSON (WYODAK) COAL

INDEX MAPS: *See Figures 75 and 88*

SAMPLE NO.: 74-42

COAL NAME(S): *Anderson (Wyodak)*

GEOLOGIC FORMATION: *Fort Union*

AGE: *Paleocene*

COAL FIELD: *Gillette*

COAL-BEARING AREA: *Powder River Coal Basin* QUADRANGLE: *Rozet 2 SW 7 1/2'*

MEASURED SECTION: *See Figure 91*

TOTAL SECTION MEASURED (FEET): 134.85

COVER AT SAMPLING POINT (FEET): 23.3

ELEVATION TOP OF SAMPLED COAL: 4380+

STRIKE: *Approximately N-S*

DIP: *Nearly flat to westerly*

MAJOR JOINT ORIENTATIONS IN COAL:

*89-91°, 120-123°, 26-38°, 57-70°
5°*

STATE: *Wyoming*

COUNTY: *Campbell*

SECTION: 28

TOWNSHIP: *T50N*

RANGE: *R71W*

LOCATION
IN SECTION

			X

COAL DESCRIPTION: *See Figure 92*

THICKNESS OF COAL (FEET): 109.05

THICKNESS SAMPLED (FEET): 59.15

TYPE OF SAMPLE: *Face-channel*

CONDITION OF SAMPLE: *Weathered*

TYPE OF EXPOSURE: *Strip mine*

MINE NAME: *Wyodak South Pit*

DATE OF SAMPLING: 8/7/74

SAMPLE COLLECTOR: *Wyoming Geological Survey*

COMPLETION DATE OF ANALYSES

U. S. Bureau of Mines: 8/30/74

Wyoming Geological Survey: 3/18/75

U. S. Geological Survey: 6/13/75

LABORATORY NUMBERS

K-46566

WGS-42

D171830

APPARENT RANK OF COAL: *Subbituminous C*

MISCELLANEOUS COMMENTS: *The as received heat value of this sample is typical of the Anderson coal.*

SAMPLE NO. 74-43: CANYON (WYODAK) COAL

INDEX MAPS: See Figure 75 and 88

SAMPLE NO.: 74-43

COAL NAMES(S): Canyon (Wyodak)

GEOLOGIC FORMATION: Fort Union

AGE: Paleocene

COAL FIELD: Gillette

COAL-BEARING AREA: Powder River Coal Basin

MEASURED SECTION: See Figure 91

TOTAL SECTION MEASURED (FEET): 134.85

COVER AT SAMPLING POINT (FEET): 92

ELEVATION TOP OF SAMPLED COAL: 4310+

STRIKE: Approximately N-S

DIP: Nearly flat to westerly

MAJOR JOINT ORIENTATIONS IN COAL:

See Sample No. 74-42

STATE: Wyoming

COUNTY: Campbell

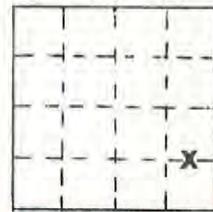
SECTION: 28

TOWNSHIP: T50N

RANGE: R71W

QUADRANGLE: Rozet 2 SW 7 1/2'

LOCATION
IN SECTION



COAL DESCRIPTION: See Figure 92

THICKNESS OF COAL (FEET): 109.05

THICKNESS SAMPLED (FEET): 42.0

TYPE OF SAMPLE: Face-channel

CONDITION OF SAMPLE: Weathered

TYPE OF EXPOSURE: Strip mine

MINE NAME: Wyodak South Pit

DATE OF SAMPLING: 8/8/74

SAMPLE COLLECTOR: Wyoming Geological Survey

COMPLETION DATE OF ANALYSES

U. S. Bureau of Mines: 8/30/74

Wyoming Geological Survey: 3/18/75

U. S. Geological Survey: 6/13/75

LABORATORY NUMBERS

K-46565

WGS-43

D171829

APPARENT RANK OF COAL: Subbituminous C

MISCELLANEOUS COMMENTS: The as received heat value of this sample is typical of the Canyon (Wyodak) coal.

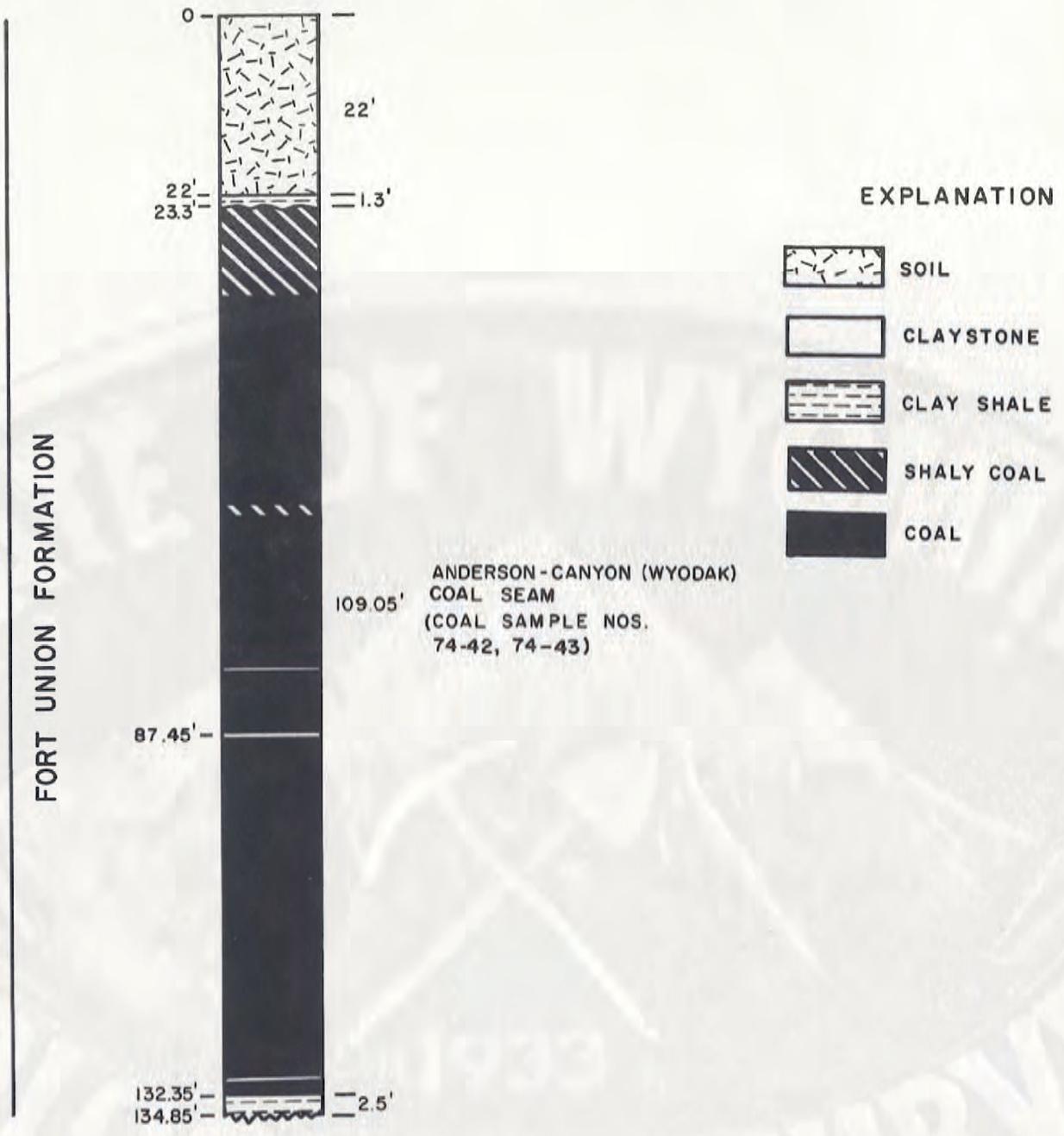


FIGURE 91: MEASURED SECTION AT THE ANDERSON-CANYON (WYODAK) COAL SAMPLE SITE IN THE WYODAK SOUTH PIT (COAL SAMPLE NOS. 74-42 AND 74-43)

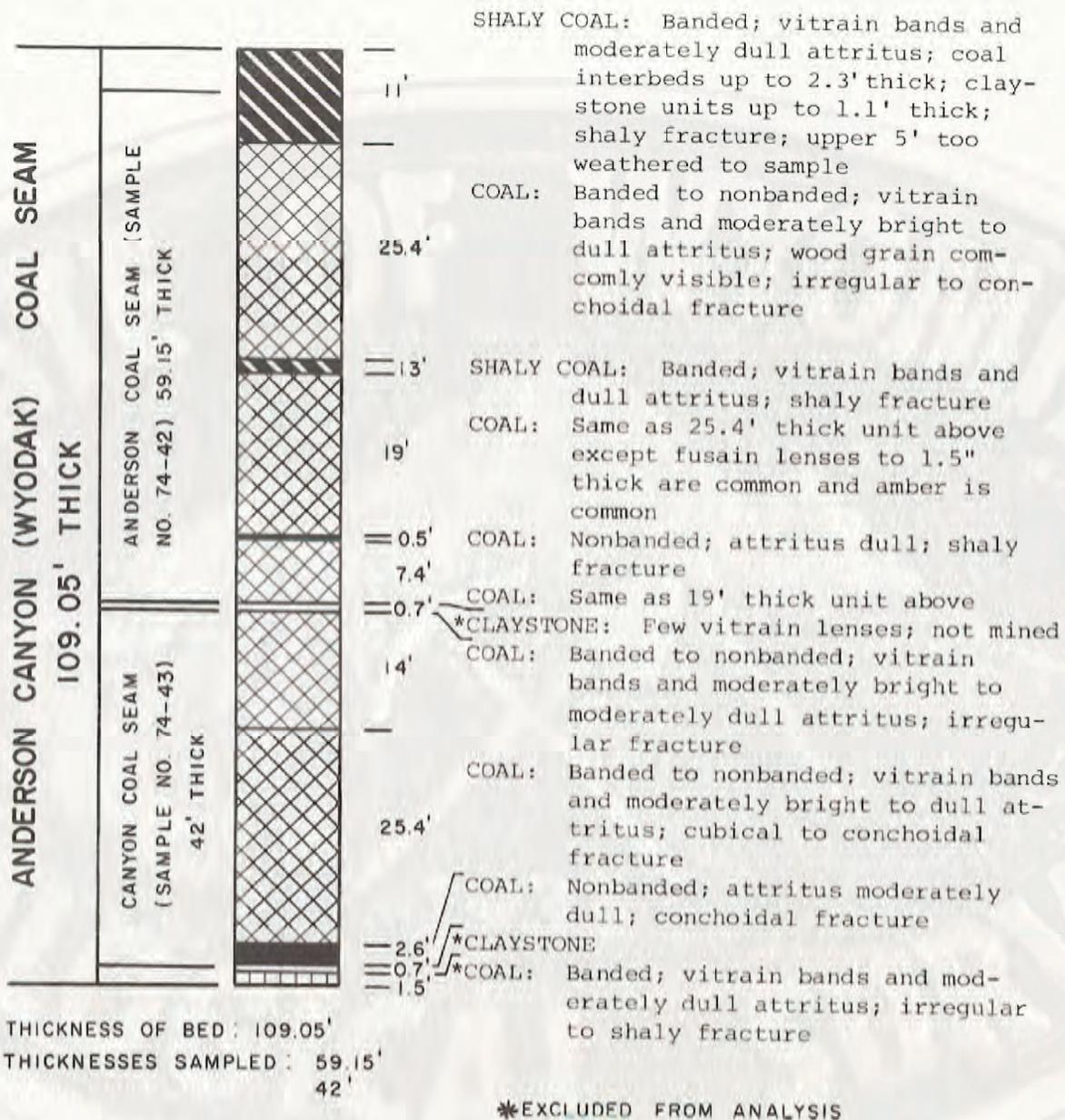


FIGURE 92: MEGASCOPIC DESCRIPTION OF THE ANDERSON-CANYON (WYODAK) COAL SEAM IN THE WYODAK SOUTH PIT (COAL SAMPLE NOS. 74-42 AND 74-43)

SAMPLE NO. 74-44: DIETZ NO. 2 COAL

INDEX MAPS: See Figures 75 and 93

SAMPLE NO.: 74-44

COAL NAME(S): Dietz No. 2

GEOLOGIC FORMATION: Fort Union

AGE: Paleocene

COAL FIELD: Sheridan

COAL-BEARING AREA: Powder River Coal Basin QUADRANGLE: Acme 7 1/2'

MEASURED SECTION: See Figure 95

TOTAL SECTION MEASURED (FEET): 239.3

COVER AT SAMPLING POINT (FEET): 30+

ELEVATION TOP OF SAMPLED COAL: 3630

STRIKE: Not measurable

DIP: Horizontal

MAJOR JOINT ORIENTATIONS IN COAL:

See Sample No. 74-48

STATE: Wyoming

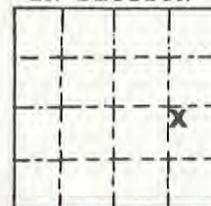
COUNTY: Sheridan

SECTION: 22

TOWNSHIP: T57N

RANGE: R84W

LOCATION
IN SECTION



COAL DESCRIPTION: See Figure 96

THICKNESS OF COAL (FEET): 11.1

THICKNESS SAMPLED (FEET): 11.1

TYPE OF SAMPLE: Face-channel

CONDITION OF SAMPLE: Weathered

TYPE OF EXPOSURE: Strip mine

MINE NAME: Big Horn No. 1

DATE OF SAMPLING: 7/24/74

SAMPLE COLLECTOR: Wyoming Geological Survey

COMPLETION DATE OF ANALYSES

U. S. Bureau of Mines: 8/12/74

Wyoming Geological Survey: 3/18/75

U. S. Geological Survey: 6/13/75

LABORATORY NUMBERS

K-45925

WGS-44

D171843

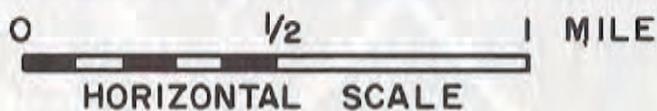
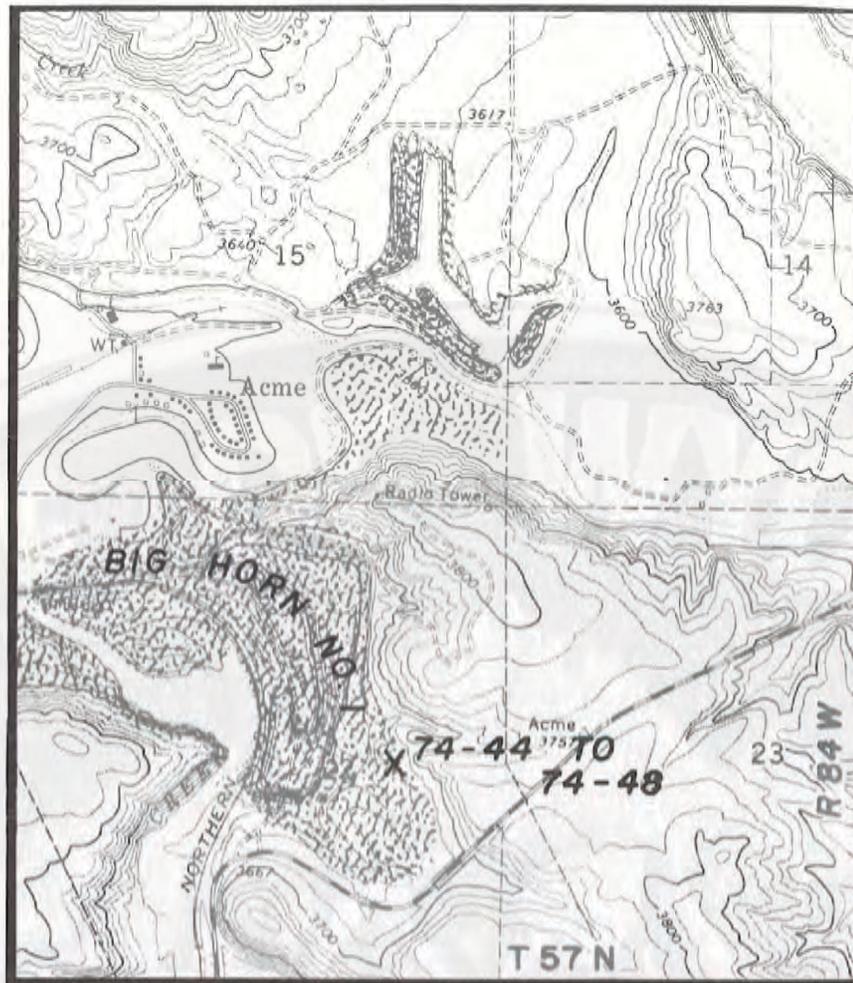
APPARENT RANK OF COAL: Subbituminous B

MISCELLANEOUS COMMENTS: The proximate analysis of this sample is very similar to an average of analyses provided by the Big Horn Coal Company.

AVERAGE OF THREE ANALYSES OF THE DIETZ NO. 2 COAL
PROVIDED BY BIG HORN COAL COMPANY (DRILL CUTTINGS OR CORES)

As Received

Moisture	23.29%
Ash	6.05%
Heat Value	9291 Btu/lb.
Sulfur	0.84%

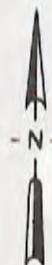


EXPLANATION

X 74-44
 SAMPLE SITE
 AND SAMPLE
 NUMBER



STRIP MINE



Base map modified from U.S. Geological Survey's
 Acme 7 1/2' (1968) topographic map.

FIGURE 93: DETAILED LOCATION MAP OF COAL SAMPLES
 74-44 THROUGH 74-48 COLLECTED IN 1974
 FROM BIG HORN COAL COMPANY'S BIG HORN
 NO. 1 STRIP MINE, SHERIDAN COUNTY,
 WYOMING

SAMPLE NO. 74-45: UNNAMED DIETZ COAL

INDEX MAPS: See Figures 75 and 93

SAMPLE NO.: 74-45

COAL NAME(S): Unnamed Dietz

GEOLOGIC FORMATION: Fort Union

AGE: Paleocene

COAL FIELD: Sheridan

COAL-BEARING AREA: Powder River Coal Basin

MEASURED SECTION: See Figure 95

TOTAL SECTION MEASURED (FEET): 239.3

COVER AT SAMPLING POINT (FEET): 45+

ELEVATION TOP OF SAMPLED COAL: 3615

STRIKE: Not measurable

DIP: Horizontal

MAJOR JOINT ORIENTATIONS IN COAL:

See Sample No. 74-48

STATE: Wyoming

COUNTY: Sheridan

SECTION: 22

TOWNSHIP: T57N

RANGE: R84W

QUADRANGLE: Acme 7 1/2'

LOCATION
IN SECTION



COAL DESCRIPTION: See Figure 97

THICKNESS OF COAL (FEET): 5.1

THICKNESS SAMPLED (FEET): 5.1

TYPE OF SAMPLE: Face-channel

CONDITION OF SAMPLE: Weathered

TYPE OF EXPOSURE: Strip mine

MINE NAME: Big Horn No. 1

DATE OF SAMPLING: 7/24/74

SAMPLE COLLECTOR: Wyoming Geological Survey

COMPLETION DATE OF ANALYSES

U. S. Bureau of Mines: 8/12/74

Wyoming Geological Survey: 3/18/75

U. S. Geological Survey: 6/13/75

LABORATORY NUMBERS

K-45924

WGS-45

D171842

APPARENT RANK OF COAL: Subbituminous B

MISCELLANEOUS COMMENTS: This coal was not mined. The high as received ash (14.8%) and sulfur (2.2%) contents rendered it undesirable.

SAMPLE NO. 74-46: FOUR-FOOT COAL

INDEX MAPS: See Figures 75 and 93

SAMPLE NO.: 74-46

COAL NAMES(S): Four-foot

GEOLOGIC FORMATION: Fort Union

AGE: Paleocene

COAL FIELD: Sheridan

COAL-BEARING AREA: Powder River Coal Basin

MEASURED SECTION: See Figure 95

TOTAL SECTION MEASURED (FEET): 239.3

COVER AT SAMPLING POINT (FEET): 85±

ELEVATION TOP OF SAMPLED COAL: 3575

STRIKE: Not measurable

DIP: Horizontal

MAJOR JOINT ORIENTATIONS IN COAL:

See Sample No. 74-48

STATE: Wyoming

COUNTY: Sheridan

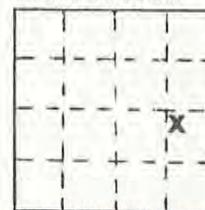
SECTION: 22

TOWNSHIP: T57N

RANGE: R84W

QUADRANGLE: Acme 7 1/2'

LOCATION
IN SECTION



COAL DESCRIPTION: See Figure 98

THICKNESS OF COAL (FEET): 25.2

THICKNESS SAMPLED (FEET): 4.1

TYPE OF SAMPLE: Face-channel

CONDITION OF SAMPLE: Fresh

TYPE OF EXPOSURE: Strip mine

MINE NAME: Big Horn No. 1

DATE OF SAMPLING: 7/24/74

SAMPLE COLLECTOR: Wyoming Geological Survey

COMPLETION DATE OF ANALYSES

U. S. Bureau of Mines: 8/19/74

Wyoming Geological Survey: 3/18/75

U. S. Geological Survey: 6/13/75

LABORATORY NUMBERS

K-46219

WGS-46

D171844

APPARENT RANK OF COAL: Subbituminous B

MISCELLANEOUS COMMENTS: This coal is actually the top 4.1 feet of the Dietz No. 3 coal seam. The Four-foot coal was also included in with the Dietz No. 3 sample (74-47).

SAMPLE NO. 74-47: DIETZ NO. 3 COAL

INDEX MAPS: See Figures 75 and 93

SAMPLE NO.: 74-47

COAL NAME(S): Dietz No. 3

GEOLOGIC FORMATION: Fort Union

AGE: Paleocene

COAL FIELD: Sheridan

COAL-BEARING AREA: Powder River Coal Basin QUADRANGLE: Acme 7 1/2'

MEASURED SECTION: See Figure 95

TOTAL SECTION MEASURED (FEET): 239.3

COVER AT SAMPLING POINT (FEET): 85+

ELEVATION TOP OF SAMPLED COAL: 3575

STRIKE: Not measurable

DIP: Horizontal

MAJOR JOINT ORIENTATIONS IN COAL:

See Sample No. 74-48

STATE: Wyoming

COUNTY: Sheridan

SECTION: 22

TOWNSHIP: T57N

RANGE: R84W

LOCATION
IN SECTION



COAL DESCRIPTION: See Figure 98

THICKNESS OF COAL (FEET): 25.2

THICKNESS SAMPLED (FEET): 24.9

TYPE OF SAMPLE: Face-channel

CONDITION OF SAMPLE: Fresh

TYPE OF EXPOSURE: Strip mine

MINE NAME: Big Horn No. 1

DATE OF SAMPLING: 7/24/74

SAMPLE COLLECTOR: Wyoming Geological Survey

COMPLETION DATE OF ANALYSES

U. S. Bureau of Mines: 8/12/74

Wyoming Geological Survey: 3/18/75

U. S. Geological Survey: 6/13/75

LABORATORY NUMBERS

K-45923

WGS-47

D171841

APPARENT RANK OF COAL: Subbitminous B

MISCELLANEOUS COMMENTS: In the past, analyses of this seam were probably reported as Monarch coal samples, or the seam was combined with the Monarch coal before analysis.

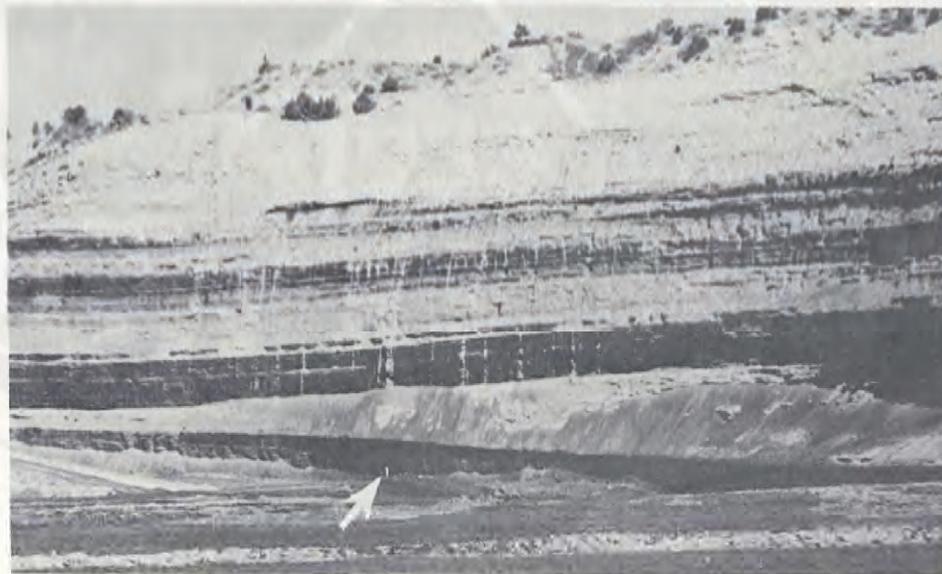


FIGURE 94: BIG HORN COAL COMPANY'S BIG HORN NO. 1 MINE (NORTH OF THE SAMPLING SITE, THE MONARCH AND DIETZ NO. 3 COALS ARE SEPARATED BY UP TO 30 FEET OF ROCK. FOR SCALE, THE ARROW POINTS TO A MAN STANDING AT THE BASE OF THE MONARCH COAL. THE UNNAMED DIETZ COAL AND THE DIETZ NO. 2 COAL ARE ALSO VISIBLE IN THE HIGHWALL.)

SAMPLE NO. 74-48: MONARCH COAL

INDEX MAPS: See Figures 75 and 93

SAMPLE NO.: 74-48

COAL NAMES(S): Monarch

GEOLOGIC FORMATION: Fort Union

AGE: Paleocene

COAL FIELD: Sheridan

COAL-BEARING AREA: Powder River Coal Basin QUADRANGLE: Acme 7 1/2'

MEASURED SECTION: See Figure 95

TOTAL SECTION MEASURED (FEET): 239.3

COVER AT SAMPLING POINT (FEET): 110±

ELEVATION TOP OF SAMPLED COAL: 3550

STRIKE: Not measurable

DIP: Horizontal

MAJOR JOINT ORIENTATIONS IN COAL:

349-357°, 320-330°, 309-315°,
23°, 44°, 61-67°

STATE: Wyoming

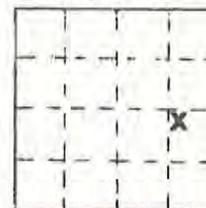
COUNTY: Sheridan

SECTION: 22

TOWNSHIP: T57N

RANGE: R84W

LOCATION
IN SECTION



COAL DESCRIPTION: See Figure 99

THICKNESS OF COAL (FEET): 26.1

THICKNESS SAMPLED (FEET): 26.1

TYPE OF SAMPLE: Face-channel

CONDITION OF SAMPLE: Fresh

TYPE OF EXPOSURE: Strip mine

MINE NAME: Big Horn No. 1

DATE OF SAMPLING: 7/24/74

SAMPLE COLLECTOR: Wyoming Geological Survey

COMPLETION DATE OF ANALYSES

U. S. Bureau of Mines: 8/12/74

Wyoming Geological Survey: 3/18/75

U. S. Geological Survey: 6/13/75

LABORATORY NUMBERS

K-45922

WGS-48

D171840

APPARENT RANK OF COAL: Subbitminous B

MISCELLANEOUS COMMENTS: The proximate and ultimate analysis of this sample compares favorably with a typical production analysis provided by Big Horn Coal Company. The production analysis, however, combines both the Dietz No. 3 and Monarch coals.

TYPICAL PRODUCTION ANALYSIS OF THE MONARCH/DIETZ NO. 3 COALS
PROVIDED BY BIG HORN COAL COMPANY

PROXIMATE ANALYSIS (AS RECEIVED)

Moisture	23.85%
Ash	5.30%
Volatile Matter	32.36%
Fixed Carbon	38.49%

HEAT VALUE

As Received 9300 Btu/lb.

ULTIMATE ANALYSIS (AS RECEIVED)

Carbon	53.70%
Hydrogen	6.74%
Nitrogen	0.76%
Chlorine	0.00%
Sulfur	0.61%
Oxygen	32.89%
Ash	5.30%

ASH COMPOSITION (OXIDES)

P_2O_5	0.82%
SiO_2	27.28%
Fe_2O_3	10.02%
Al_2O_3	15.12%
TiO_2	1.28%
CaO	17.32%
MgO	5.79%
SO_3	19.16%
K_2O	1.00%
Na_2O	1.80%
Undetermined	0.41%

FUSION TEMPERATURE OF ASH

Initial Deformation	2050°F
Softening (H=W)	2140°F
Fluid	2310°F

HARDGROVE GRINDABILITY INDEX

40.3

FORT UNION FORMATION

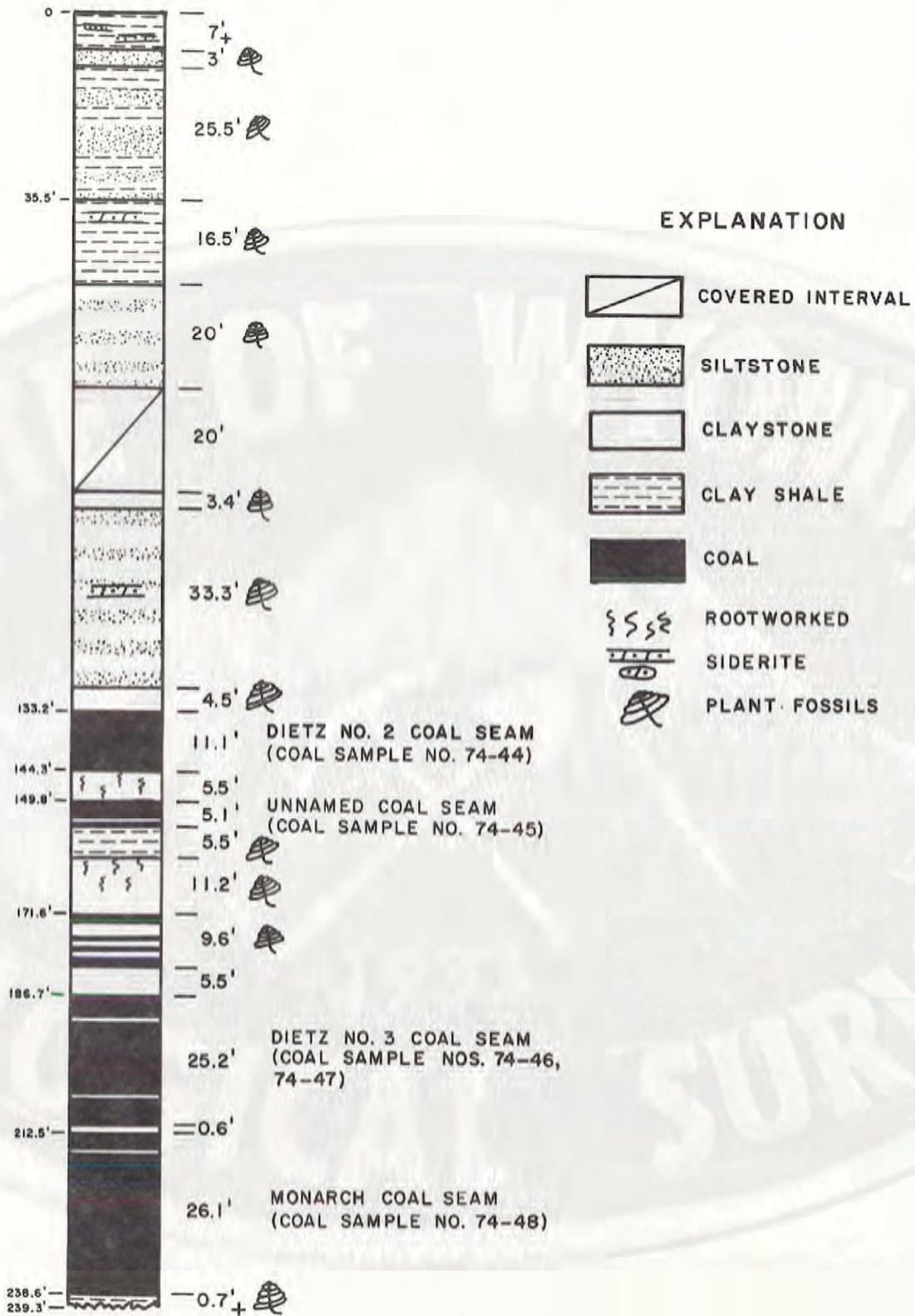
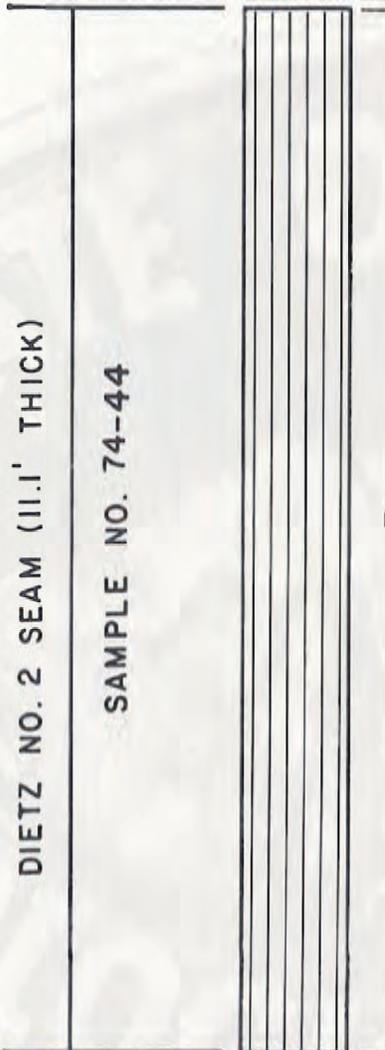


FIGURE 95: MEASURED SECTION AT THE DIETZ NO. 2, UNNAMED DIETZ, FOUR-FOOT BED, DIETZ NO. 3 AND MONARCH COAL SAMPLE SITE IN THE BIG HORN NO. 1 STRIP MINE (COAL SAMPLE NOS. 74-44 TO 74-48)



COAL: Banded; vitrain bands and moderately bright attritus; thin shaly partings common; fusain lenses common; amber common; white powdery stain common; shaly to irregular fracture

11.1'

THICKNESS OF BED : 11.1'
 THICKNESS SAMPLED : 11.1'

NOTE: ENTIRE SEAM ANALYZED

FIGURE 96: MEGASCOPIIC DESCRIPTION OF THE DIETZ NO. 2 COAL SEAM IN THE BIG HORN NO. 1 STRIP MINE (COAL SAMPLE NO. 74-44)

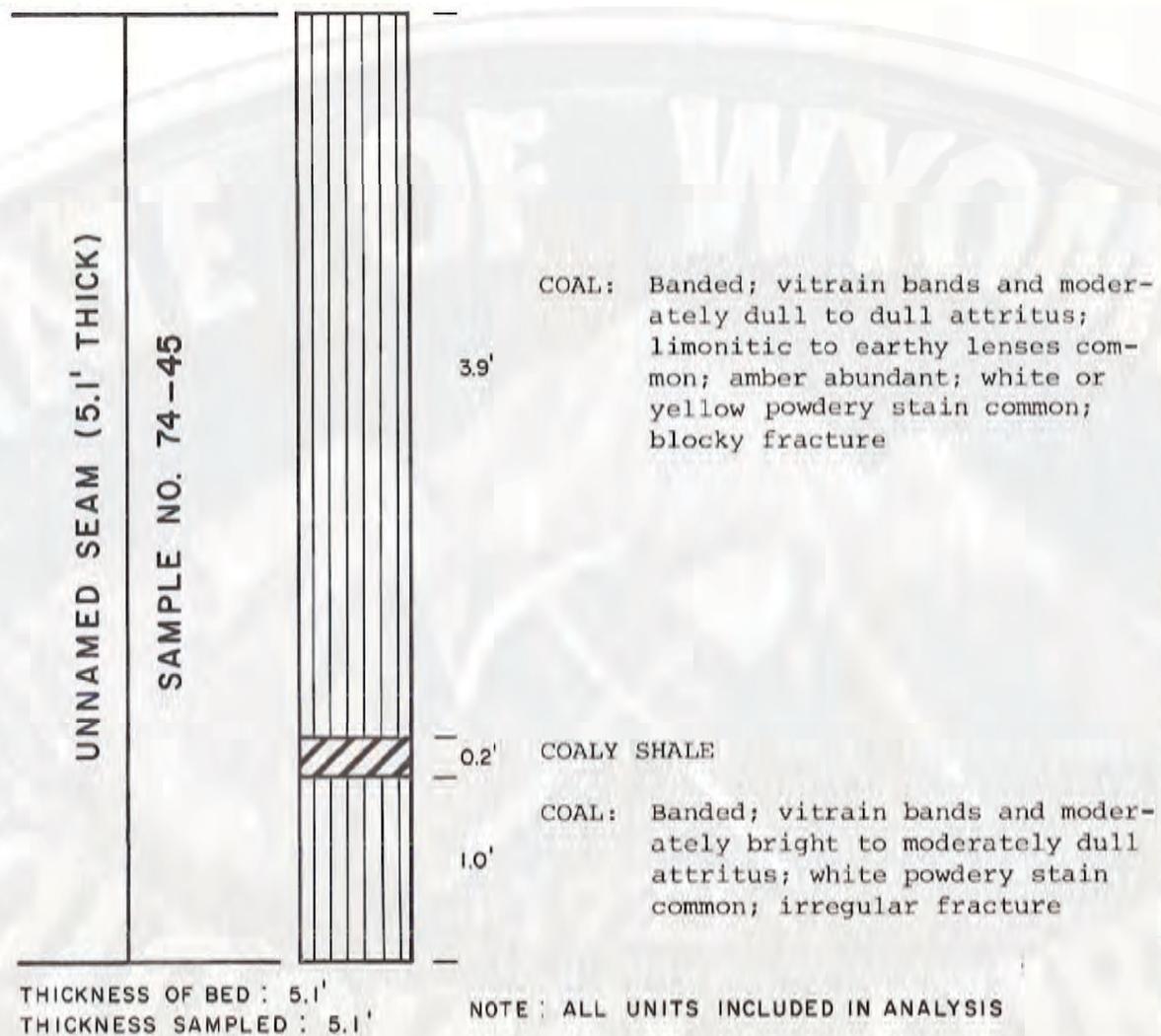
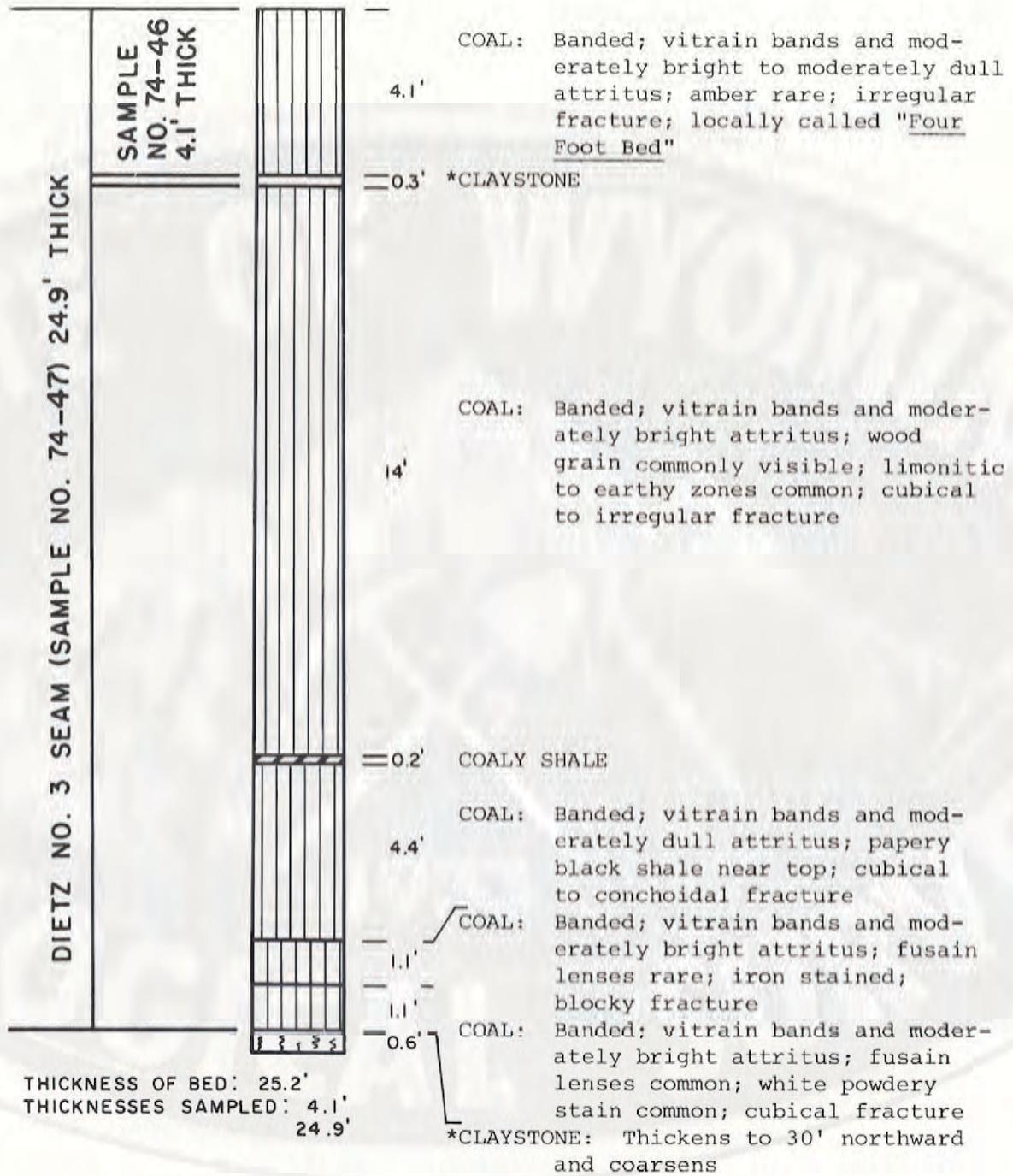


FIGURE 97: MEGASCOPIIC DESCRIPTION OF AN UNNAMED DIETZ COAL SEAM IN THE BIG HORN NO. 1 STRIP MINE (COAL SAMPLE NO. 74-45)



* EXCLUDED FROM ANALYSIS

FIGURE 98: MEGASCOPIC DESCRIPTION OF THE DIETZ NO. 3 COAL SEAM AND THE "FOUR FOOT BED" IN THE BIG HORN NO. 1 STRIP MINE (COAL SAMPLE NOS. 74-47 AND 74-46, RESPECTIVELY)

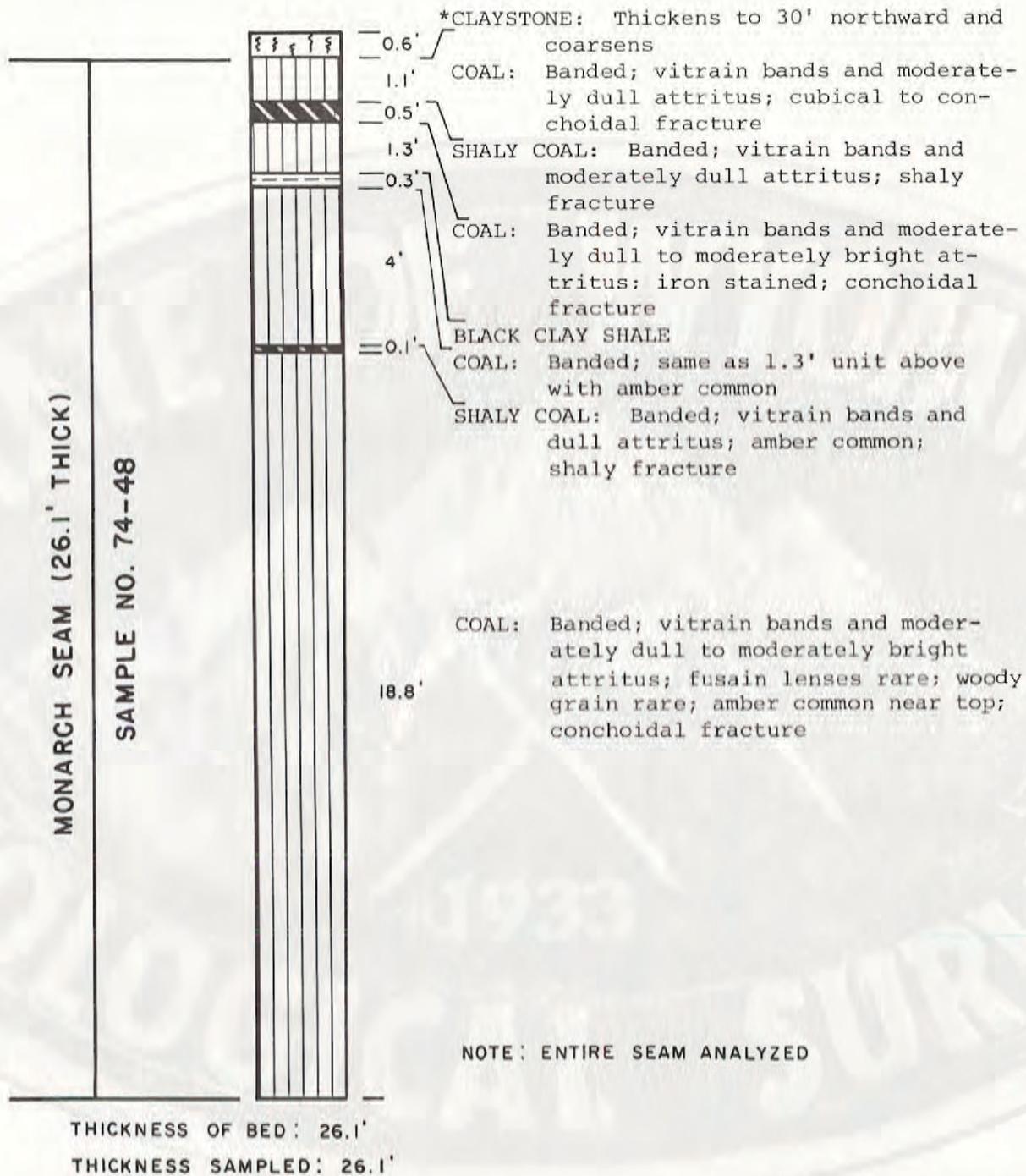


FIGURE 99: MEGASCOPIC DESCRIPTION OF THE MONARCH COAL SEAM IN THE BIG HORN NO. 1 STRIP MINE (COAL SAMPLE NO. 74-48)

SAMPLE NO. 74-49: MONARCH RIDER COAL

INDEX MAPS: *See Figures 75 and 100*

SAMPLE NO.: 74-49

COAL NAME(S): *Monarch Rider*

GEOLOGIC FORMATION: *Fort Union*

AGE: *Paleocene*

COAL FIELD: *Sheridan*

COAL-BEARING AREA: *Powder River Coal Basin* QUADRANGLE: *Monarch 7 1/2'*

MEASURED SECTION: *See Figure 102*

TOTAL SECTION MEASURED (FEET): 92.65

COVER AT SAMPLING POINT (FEET): 60

ELEVATION TOP OF SAMPLED COAL: 3780

STRIKE: ? *NE-SW*

DIP: ? *easterly, very nearly flat*

MAJOR JOINT ORIENTATIONS IN COAL:
See Sample No. 74-54

STATE: *Wyoming*

COUNTY: *Sheridan*

SECTION: 22

TOWNSHIP: *T57N*

RANGE: *R85W*

LOCATION
IN SECTION



COAL DESCRIPTION: *See Figure 103*

THICKNESS OF COAL (FEET): 3.9

THICKNESS SAMPLED (FEET): 3.9

TYPE OF SAMPLE: *Face-channel*

CONDITION OF SAMPLE: *Weathered*

TYPE OF EXPOSURE: *Strip mine*

MINE NAME: *Welch*

DATE OF SAMPLING: *7/26/74*

SAMPLE COLLECTOR: *Wyoming Geological Survey*

COMPLETION DATE OF ANALYSES

U. S. Bureau of Mines: *8/12/74*

Wyoming Geological Survey: *3/18/75*

U. S. Geological Survey: *6/13/75*

LABORATORY NUMBERS

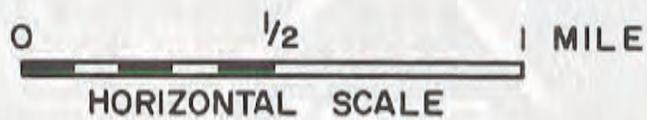
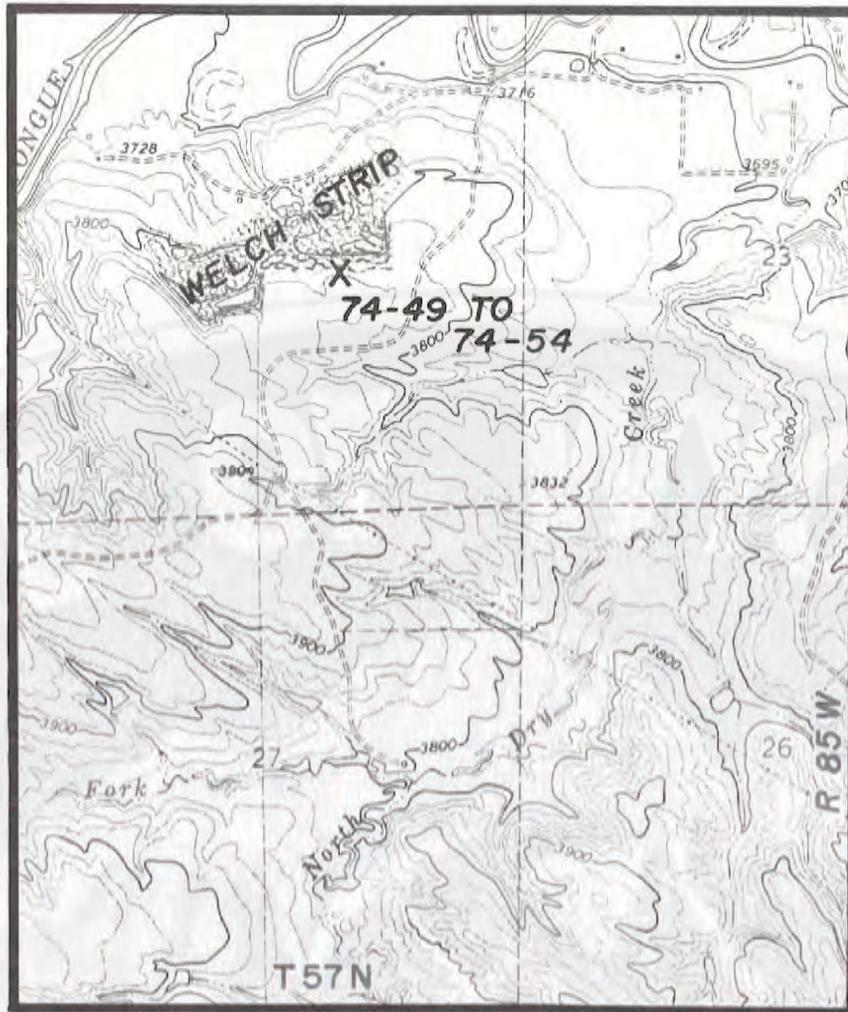
K-45921

WGS-49

D171850

APPARENT RANK OF COAL: *Subbituminous B*

MISCELLANEOUS COMMENTS: *This coal may split off the top of the Monarch coal. It is not clear whether any Dietz coals are represented in this mine.*



EXPLANATION

- X 74-49 SAMPLE SITE AND SAMPLE NUMBER
-  STRIP MINE



Base map modified from U.S. Geological Survey's Monarch 7 1/2' (1964) topographic map.

FIGURE 100: DETAILED LOCATION MAP OF COAL SAMPLES 74-49 THROUGH 74-54 COLLECTED IN 1974 FROM WELCH COAL COMPANY'S WELCH STRIP MINE, SHERIDAN COUNTY, WYOMING

SAMPLE NO. 74-50: MONARCH COAL (UPPER BENCH)

INDEX MAPS: See Figures 75 and 100

SAMPLE NO.: 74-50

COAL NAME(S): Monarch (Upper Bench)

GEOLOGIC FORMATION: Fort Union

AGE: Paleocene

COAL FIELD: Sheridan

COAL-BEARING AREA: Powder River Coal Basin

MEASURED SECTION: See Figure 102

TOTAL SECTION MEASURED (FEET): 92.65

COVER AT SAMPLING POINT (FEET): 79

ELEVATION TOP OF SAMPLED COAL: 3760

STRIKE: ? NE-SW

DIP: ? easterly, very nearly flat

MAJOR JOINT ORIENTATIONS IN COAL:

See Sample 74-54

STATE: Wyoming

COUNTY: Sheridan

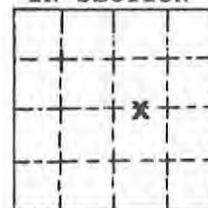
SECTION: 22

TOWNSHIP: T57N

RANGE: R85W

QUADRANGLE: Monarch 7 1/2'

LOCATION
IN SECTION



COAL DESCRIPTION: See Figure 104

THICKNESS OF COAL (FEET): 12.05

THICKNESS SAMPLED (FEET): 2.9

TYPE OF SAMPLE: Face-channel

CONDITION OF SAMPLE: Fresh

TYPE OF EXPOSURE: Strip mine

MINE NAME: Welch

DATE OF SAMPLING: 7/26/74

SAMPLE COLLECTOR: Wyoming Geological Survey

COMPLETION DATE OF ANALYSES

U. S. Bureau of Mines: 8/19/74

Wyoming Geological Survey: 3/18/75

U. S. Geological Survey: 6/13/75

LABORATORY NUMBERS

K-46223

WGS-50

D171848

APPARENT RANK OF COAL: Subbituminous B

MISCELLANEOUS COMMENTS: Welch Coal Company identifies this bench as part of the Monarch coal.

SAMPLE NO. 74-51: MONARCH COAL (UPPER MIDDLE BENCH)

INDEX MAPS: See Figures 75 and 100

SAMPLE NO.: 74-51

COAL NAMES(S): Monarch (Upper Middle Bench)

GEOLOGIC FORMATION: Fort Union

AGE: Paleocene

COAL FIELD: Sheridan

COAL-BEARING AREA: Powder River Coal Basin

MEASURED SECTION: See Figure 102

TOTAL SECTION MEASURED (FEET): 92.65

COVER AT SAMPLING POINT (FEET): 83

ELEVATION TOP OF SAMPLED COAL: 3756

STRIKE: ? NE-SW

DIP: ? easterly, very nearly flat

MAJOR JOINT ORIENTATIONS IN COAL:

See Sample 74-54

STATE: Wyoming

COUNTY: Sheridan

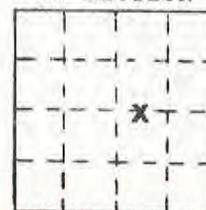
SECTION: 22

TOWNSHIP: T57N

RANGE: R85W

QUADRANGLE: Monarch 7 1/2'

LOCATION IN SECTION



COAL DESCRIPTION: See Figure 104

THICKNESS OF COAL (FEET): 12.05

THICKNESS SAMPLED (FEET): 1.7

TYPE OF SAMPLE: Face-channel

CONDITION OF SAMPLE: Fresh

TYPE OF EXPOSURE: Strip mine

MINE NAME: Welch

DATE OF SAMPLING: 7/26/74

SAMPLE COLLECTOR: Wyoming Geological Survey

COMPLETION DATE OF ANALYSES

U. S. Bureau of Mines: 8/19/74

Wyoming Geological Survey: 3/18/75

U. S. Geological Survey: 6/13/75

LABORATORY NUMBERS

K-46222

WGS-51

D171847

APPARENT RANK OF COAL: Subbituminous B

MISCELLANEOUS COMMENTS: Welch Coal Company identifies this bench as part of the Monarch coal.

SAMPLE NO. 74-52: MONARCH COAL (LOWER MIDDLE BENCH)

INDEX MAPS: See Figures 75 and 100

SAMPLE NO.: 74-52

COAL NAME(S): Monarch (Lower Middle Bench)

GEOLOGIC FORMATION: Fort Union

AGE: Paleocene

COAL FIELD: Sheridan

COAL-BEARING AREA: Powder River Coal Basin QUADRANGLE: Monarch 7 1/2'

MEASURED SECTION: See Figure 102

TOTAL SECTION MEASURED (FEET): 92.65

COVER AT SAMPLING POINT (FEET): 85

ELEVATION TOP OF SAMPLED COAL: 3754

STRIKE: ? NE-SW

DIP: ? easterly, very nearly flat

MAJOR JOINT ORIENTATIONS IN COAL:

See Sample 74-54

STATE: Wyoming

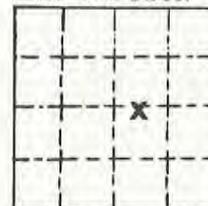
COUNTY: Sheridan

SECTION: 22

TOWNSHIP: T57N

RANGE: R85W

LOCATION
IN SECTION



COAL DESCRIPTION: See Figure 104

THICKNESS OF COAL (FEET): 12.05

THICKNESS SAMPLED (FEET): 2.65

TYPE OF SAMPLE: Face-channel

CONDITION OF SAMPLE: Fresh

TYPE OF EXPOSURE: Strip mine

MINE NAME: Welch

DATE OF SAMPLING: 7/26/74

SAMPLE COLLECTOR: Wyoming Geological Survey

COMPLETION DATE OF ANALYSES

U. S. Bureau of Mines: 8/19/74

Wyoming Geological Survey: 3/18/75

U. S. Geological Survey: 6/13/75

LABORATORY NUMBERS

K-46221

WGS-52

D171846

APPARENT RANK OF COAL: Subbituminous B

MISCELLANEOUS COMMENTS: Welch Coal Company identifies this bench as part of the Monarch coal.

SAMPLE NO. 74-53: MONARCH COAL (LOWER BENCH)

INDEX MAPS: *See Figures 75 and 100*

SAMPLE NO.: 74-53

COAL NAMES(S): *Monarch (Lower Bench)*

GEOLOGIC FORMATION: *Fort Union*

AGE: *Paleocene*

COAL FIELD: *Sheridan*

COAL-BEARING AREA: *Powder River Coal Basin*

MEASURED SECTION: *See Figure 102*

TOTAL SECTION MEASURED (FEET): 92.65

COVER AT SAMPLING POINT (FEET): 89

ELEVATION TOP OF SAMPLED COAL: 3750

STRIKE: ? NE-SW

DIP: ? easterly, very nearly flat

MAJOR JOINT ORIENTATIONS IN COAL:

See Sample No. 74-54

STATE: *Wyoming*

COUNTY: *Sheridan*

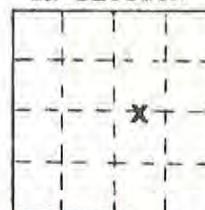
SECTION: 22

TOWNSHIP: *T57N*

RANGE: *R85W*

QUADRANGLE: *Monarch 7 1/2'*

LOCATION
IN SECTION



COAL DESCRIPTION: *See Figure 104*

THICKNESS OF COAL (FEET): 12.05

THICKNESS SAMPLED (FEET): 2.2

TYPE OF SAMPLE: *Face-channel*

CONDITION OF SAMPLE: *Fresh*

TYPE OF EXPOSURE: *Strip mine*

MINE NAME: *Welch*

DATE OF SAMPLING: 7/26/74

SAMPLE COLLECTOR: *Wyoming Geological Survey*

COMPLETION DATE OF ANALYSES

U. S. Bureau of Mines: 8/19/74

Wyoming Geological Survey: 3/18/75

U. S. Geological Survey: 6/13/75

LABORATORY NUMBERS

K-46220

WGS-53

D171845

APPARENT RANK OF COAL: *Subbituminous B*

MISCELLANEOUS COMMENTS: *Welch Coal Company identifies this bench as part of the Monarch coal.*

SAMPLE NO. 74-54: MONARCH COAL

INDEX MAPS: See Figures 75 and 100

SAMPLE NO.: 74-54

COAL NAME(S): Monarch

GEOLOGIC FORMATION: Fort Union

AGE: Paleocene

COAL FIELD: Sheridan

COAL-BEARING AREA: Powder River Coal Basin QUADRANGLE: Monarch 7 1/2'

MEASURED SECTION: See Figure 102

TOTAL SECTION MEASURED (FEET): 92.65

COVER AT SAMPLING POINT (FEET): 79

ELEVATION TOP OF SAMPLED COAL: 3760

STRIKE: ? NE-SW

DIP: ? easterly, very nearly flat

MAJOR JOINT ORIENTATIONS IN COAL:

43-50°, 310-325°

STATE: Wyoming

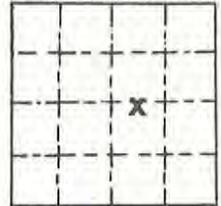
COUNTY: Sheridan

SECTION: 22

TOWNSHIP: T57N

RANGE: R85W

LOCATION
IN SECTION



COAL DESCRIPTION: See Figure 104

THICKNESS OF COAL (FEET): 12.05

THICKNESS SAMPLED (FEET): 9.45

TYPE OF SAMPLE: Face-channel

CONDITION OF SAMPLE: Fresh

TYPE OF EXPOSURE: Strip mine

MINE NAME: Welch

DATE OF SAMPLING: 7/26/74

SAMPLE COLLECTOR: Wyoming Geological Survey

COMPLETION DATE OF ANALYSES

U. S. Bureau of Mines: 8/12/74

Wyoming Geological Survey: 3/18/75

U. S. Geological Survey: 6/13/75

LABORATORY NUMBERS

K-45920

WGS-54

D171849

APPARENT RANK OF COAL: Subbituminous B

MISCELLANEOUS COMMENTS: Welch Coal Company identifies this coal as the Monarch. Another 3 foot thick bench of this coal reportedly underlies the lowermost sampled bench, but was not exposed.

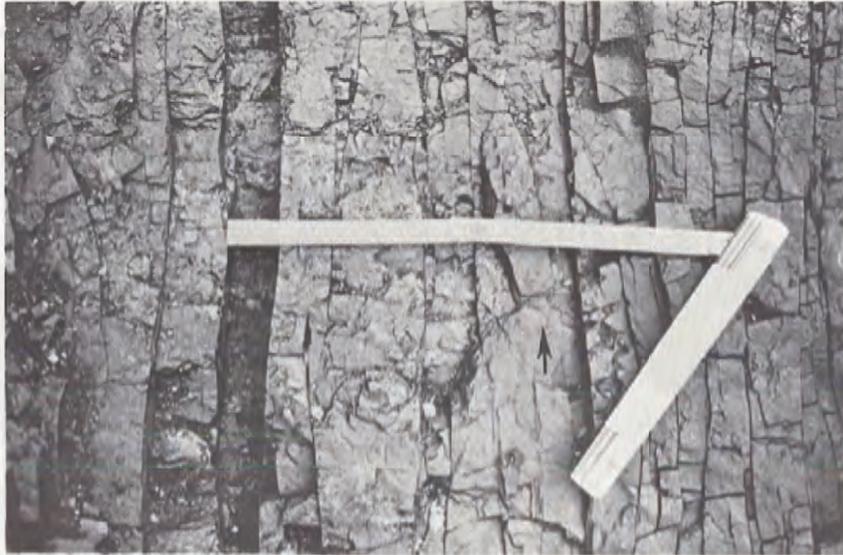


FIGURE 101: JOINTING IN THE FLOOR OF THE WELCH STRIP MINE (ONE CLOSELY SPACED SYSTEMATIC JOINT SET (TRENDING $43-50^\circ$) WAS VERY EVIDENT AT THIS SITE. THE ARROW IS ORIENTED PARALLEL TO THAT JOINT SET. A SECOND JOINT SET ($310-325^\circ$) IS ORIENTED VERY NEARLY PERPENDICULAR TO THE SYSTEMATIC SET AND IS TRUNCATED BY THAT SET. THESE TRUNCATED JOINTS ARE TERMED NONSYSTEMATIC JOINTS.)

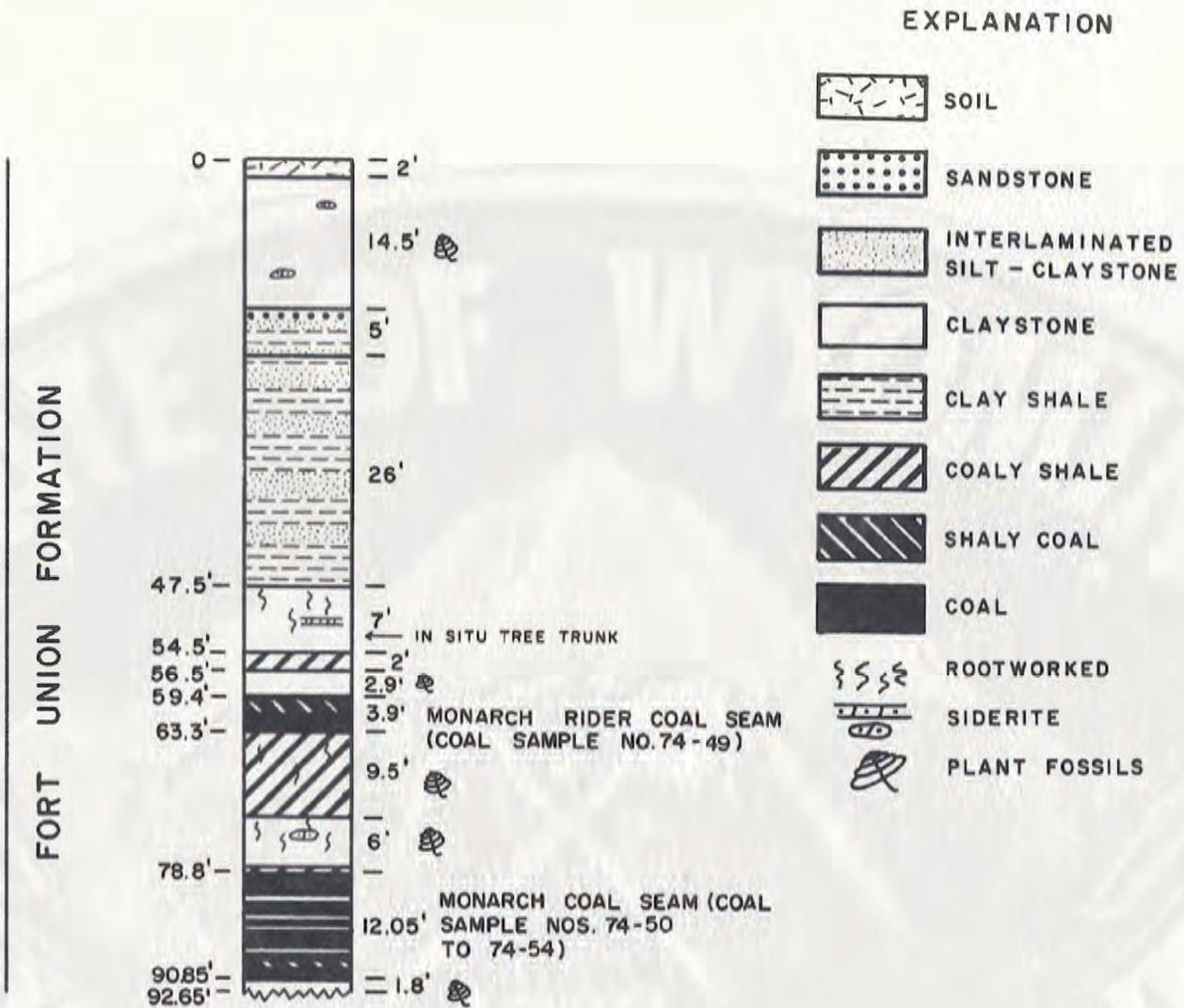


FIGURE 102: MEASURED SECTION AT THE MONARCH RIDER AND MONARCH COAL SAMPLE SITE IN THE WELCH STRIP MINE (COAL SAMPLE NOS. 74-49 TO 74-54)

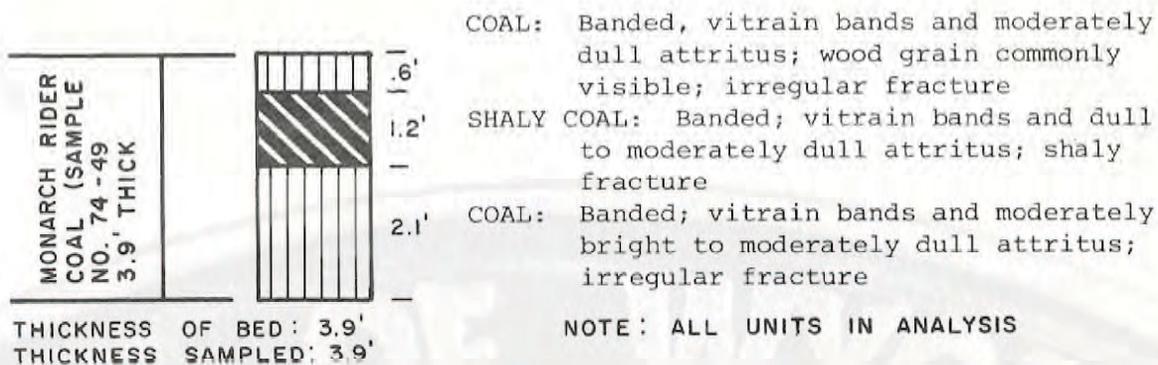


FIGURE 103: MEGASCOPIIC DESCRIPTION OF THE MONARCH RIDER COAL SEAM IN THE WELCH STRIP MINE (COAL SAMPLE NO. 74-49)

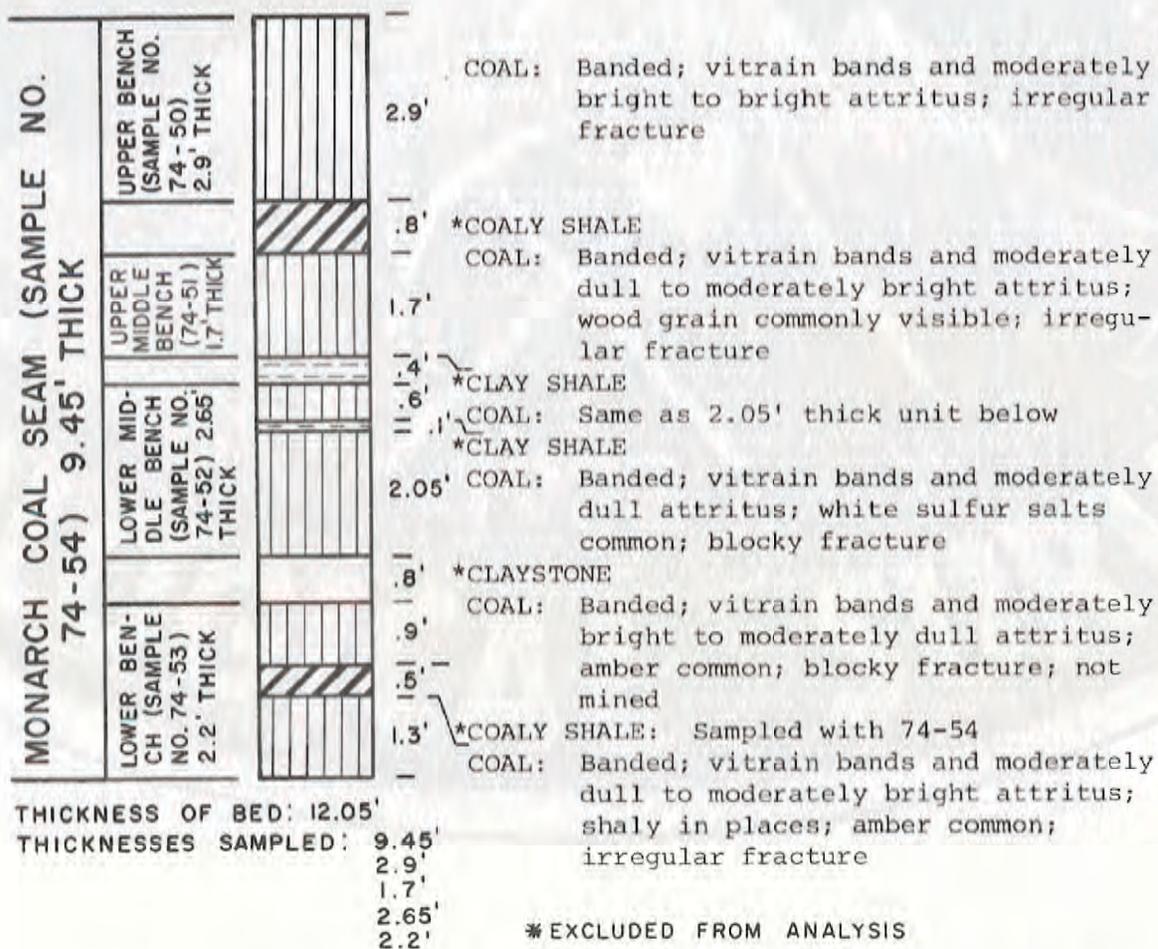


FIGURE 104: MEGASCOPIIC DESCRIPTION OF THE MONARCH COAL SEAM IN THE WELCH STRIP MINE (COAL SAMPLE NOS. 74-50 TO 74-54)

APPENDIX B: PROCEDURES FOR COLLECTING FACE-CHANNEL SAMPLES

In most cases, traditional face-channeling techniques described by Schopf, 1960, were modified for Wyoming coal sampling. As mentioned earlier, partings were not excluded from a coal sample unless they were also removed in the mining process (see text for a more detailed discussion). More importantly, however, the actual techniques of cutting and catching the samples were also modified to accommodate unique, undescribed problems posed by Wyoming's thick coal seams. Traditional techniques were developed for use in the eastern coal fields where coals seldom exceed 10 feet in thickness and average less than 5 feet thick. In contrast, most sampled Wyoming coals averaged 20-30 feet in thickness while several were 70-100 feet thick.

Appendix B is an illustrated discussion of the actual sampling procedures developed during the course of the 1974 sampling program. For discussion purposes, the following informal names are applied to various face-channeling methods:

<u>FACE-CHANNELING METHODS</u>	<u>DESIRABLE COAL SEAM THICKNESSES</u>
Traditional	Less Than 10 Feet
Single-Ladder ¹	10-30 Feet
Double-Ladder	10-30 Feet
Talus Slope or Step	Greater Than 30 Feet

¹Not recommended if two ladders are available

The first step in all four sampling methods is to expose the entire coal seam. Talus debris piled up against the base of the strip mine highwall or outcrop must be removed. If this step is done first, the actual channel sampling can proceed with a minimum of further delay.



FIGURE 105:
EXPOSING THE
BASE OF THE
COAL FACE

Short, D-handled spades work best on the loose talus. A mattock is also useful, especially when the talus is coarse or wet. Loose debris must be shoveled off the top of the coal, as well, to prevent later contamination during channeling.



FIGURE 106:
EXPOSING THE TOP
OF THE COAL IS
ALSO IMPORTANT
(THE ARROWS POINT
AT LOOSE DEBRIS
THAT MUST BE
REMOVED BEFORE
SAMPLING BEGINS)

At times it is advantageous to shore deeper holes dug to the base of the coal. This prevents collapse of loose talus back into the hole during sampling. Shoring is also needed at some locations to protect sampling personnel. Three-quarter inch marine plywood sheets braced with two-by-fours proved more than adequate shoring materials.



FIGURE 107:
SHORING AN
EXCAVATION

After the entire coal seam is exposed, loose or mud-spattered coal in the vicinity of the channel sample must be chipped away with a light-weight, pointed pick. This picked zone should be 2-3 feet wide and deep enough to expose clean, solid coal. The depth varies with each sample, of course, but it is seldom less than 3 inches.



FIGURE 108: CHIPPING
LOOSE OR DIRTY COAL
FROM THE COAL FACE

After loose coal is chipped from the coal face, the face is best cleaned of dust or fine grained coal with a full-sized broom.



FIGURE 109: SWEEPING THE COAL FACE WITH A BROOM

A whisk broom is helpful on thinner coals as well as during the actual sampling. Since the channel is cut from the top down, the face must be kept clean of loose coal and dust throughout the sampling process.



FIGURE 110:
FINAL CLEANING
OF THE COAL FACE

Thin coals (less than 10 feet thick) are easily sampled by the traditional face-channeling method. After the coal is exposed and cleaned, a large canvas or rubberized tarp is spread out at the base of the seam. A tarp 9 feet by 10 feet or larger is recommended. A channel is then cut with a pointed pick, starting at the top. In this method, the coal is allowed to fall directly onto the tarp.



*FIGURE 111:
CUTTING A CHANNEL
SAMPLE BY THE
TRADITIONAL METHOD*

Because of its shorter handle, a pointed rock hammer works better than a pick at the base of any channel. Normally, the width and depth of the channel is gaged to yield at least 6 pounds of coal per foot of thickness. In this sampling program, however, the channel size generally yielded more than 6 pounds per foot. No sample weighed less than 60 pounds. Most were 80 to 120 pound samples, and two exceeded 500 pounds before quartering.



*FIGURE 112:
FINISHING THE
BASAL PORTION
OF A CHANNEL*

For thicker seams, the traditional method results in very poor sample recovery, especially during sampling at the top of the coal. The single-ladder method of face-channel sampling is a better technique to use on moderately thick coals (10-30 feet thick). In this method samples are caught in a canvas catcher or metal tray and then dumped into a sample can hung on a ladder. For best results, only one person can be on the ladder. Benches must be cut in the coal face to give the second man a working area.



FIGURE 113: CUTTING A CHANNEL BY THE SINGLE-LADDER METHOD



FIGURE 114: TRANSFERRING THE SAMPLE FROM A CATCHER TO A SAMPLE CAN

A thirty-foot aluminum extension ladder is recommended since it is easily carried on top of a pickup truck or station wagon. Although the thirty-foot ladder allowed sampling of 30 foot thick seams, coals under 25 feet thick were more easily sampled. The single-ladder method is not recommended if two ladders are available because (1) it takes considerable time to cut benches for a second person to stand on, (2) improperly cut benches could collapse and injure the samplers, and (3) it is difficult and dangerous to carry a full sample can down a ladder.

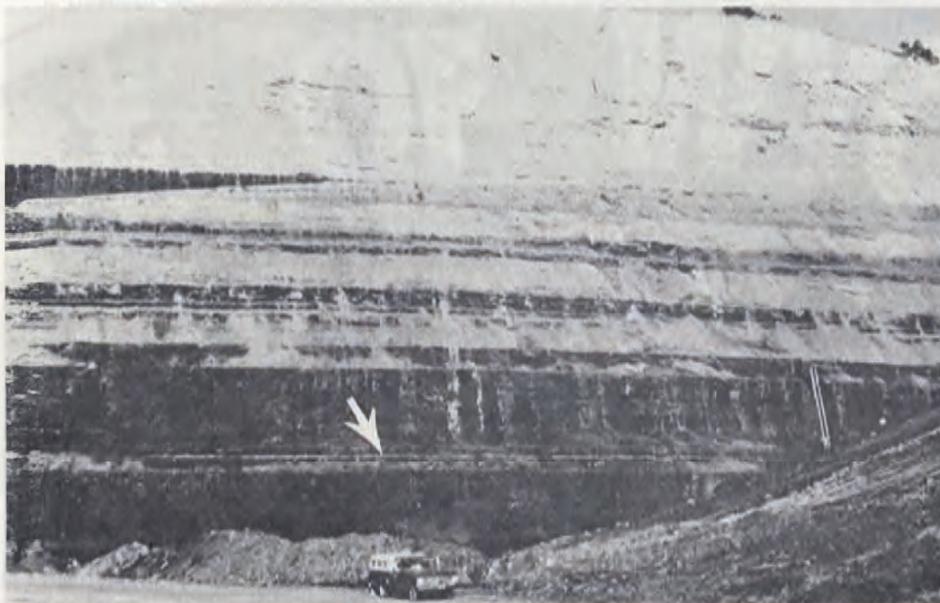


FIGURE 115:
SAMPLING THE
DIETZ NO. 3 AND
MONARCH COALS IN
THE BIG HORN NO.
1 MINE (BOTH
THESE COALS ARE
OVER 25 FEET
THICK. THE ARROW
POINTS AT A THIN,
LIGHT COLORED
ROCK PARTING THAT
SEPARATES THE TWO
COALS).

The double ladder method is preferable to the single-ladder method. It is a safer and faster sampling technique since both the cutting and sample catching are done from ladders.



FIGURE 116:
CUTTING A CHAN-
NEL SAMPLE BY
THE DOUBLE-
LADDER METHOD

This method makes the transfer of coal from the catcher to the sample can easier. It also allows the samplers to aid one another in carrying a full sample can down the ladders.



FIGURE 117:
TRANSFERRING
PART OF THE
SAMPLE TO THE
SAMPLE CAN (THE
SAMPLE CAN IS
SITTING ON A
RUNG OF THE LAD-
DER IMMEDIATELY
IN FRONT OF THE
MAN ON THE
RIGHT).

In all the sampling methods but the traditional method, the channel sample is caught in a hand-held catcher. A piece of rubberized canvas tacked to two wooden handles makes an acceptable sample catcher. As the coal is cut from the channel with the pick, it falls into the catcher, which is held against the coal face just below the finished portion of the channel. Note that personnel wear goggles, safety glasses, or plastic face shields while sampling.



FIGURE 118:
CATCHING A
CHANNEL SAMPLE
WITH A CANVAS
CATCHER

Once a catcher is filled, it is emptied into a sample can lined with a plastic bag. Since it is very difficult to carry a full canvas catcher down a ladder, the sample can has to be placed on the ladder much of the time.



FIGURE 119:
DUMPING THE CANVAS CATCHER

About mid-summer, steel sampling trays were acquired. They not only simplified sampling but also improved sample recovery. These steel trays are 30 inches long, 14 inches wide and 4 inches deep. A movable, strap steel handle near their open end makes the trays easy to hold tightly against the coal face.

FIGURE 120:
CATCHING A CHANNEL SAMPLE WITH
A STEEL TRAY
(SINCE THESE
TRAYS ARE EASILY
CARRIED DOWN A
LADDER, THE PRO-
CEDURE OF PLAC-
ING SAMPLE CANS
ON THE LADDERS
WAS DISCONTIN-
UED.)



The talus slope or step method of sampling was developed for use on coals greater than 30 feet thick because the extension ladders were too short. But it can be used on thinner coals as well. This sampling method takes advantage of talus slopes that extend to the full height of the coal seam.



FIGURE 121:
CHOOSING A SITE
FOR THE TALUS
SLOPE METHOD
(FOR SCALE, THE
ARROW IS POINTING
AT A MAN STANDING
NEAR THE TOP OF
A TALUS SLOPE IN
THE DAVE JOHNSTON
MINE. THE SCHOOL
SEAM IS 37 FEET
THICK AT THIS
POINT IN THE
MINE.)

In the talus slope method, a series of 5-6 foot high channels are taken in an offset, step fashion down the coal face and along the slope of the talus. Each new channel begins at a position in the coal seam parallel to the base of the previous sample but offset 5-10 feet downslope from it. Figure 122 illustrates this procedure.



FIGURE 122:
CUTTING A CHAN-
NEL SAMPLE BY THE
TALUS SLOPE OR
STEP METHOD (THE
DASHED WHITE LINES
INDICATE WHERE
EACH PORTION OF
THE CHANNEL SAMPLE
WILL BE CUT.)

After a channel sample is completed by any of the four described methods, the sample is pounded into fragments less than 3 centimeters in diameter. This crushing is done with rock hammers. A stainless steel plate serves as a pounding surface. To minimize contamination, considerable care is needed to avoid striking the steel plate with the hammers.



*FIGURE 123:
CRUSHING A SAMPLE*

More recently, a hand-driven grinder (similar in design to an old style meat grinder) was acquired. This grinder can be attached to the truck bumper, and will grind coal samples to a smaller and more uniform size in half the time of the hammer method. Crushing with a hammer, as described above, is not recommended if a grinder is available.



*FIGURE 124:
CLOSEUP OF
SAMPLE CRUSHING*

Once a sample is crushed, it is mixed thoroughly by rolling it back and forth on a large canvas tarp.



FIGURE 125:
MIXING A SAMPLE
AFTER CRUSHING

After a sample is thoroughly mixed, it is ready for quartering. By simultaneously lifting all four corners of the tarp, a single conical pile of coal is formed near its center.



FIGURE 126:
A CONED SAMPLE
READY FOR QUARTER-
ING (THE COAL IN
THE BACKGROUND WAS
LEFT OVER FROM AN
EARLIER SAMPLE.)

Using a flat-ended shovel, the cone is split into four equal quarters.



*FIGURE 127:
QUARTERING THE
SAMPLE*

The first quarter is picked up and transferred to an airtight sample can lined with a heavy plastic bag.



*FIGURE 128:
PICKING UP THE
FIRST QUARTER
OF THE SAMPLE*

Next, the quarter located diagonally across from the first quarter is also put into the same sample can. This sample split is the one retained by the Wyoming Geological Survey. A sample was later split from it for the Wyoming Geological Survey's laboratory.



FIGURE 129:
PICKING UP THE
SECOND QUARTER OF
THE SAMPLE (AFTER
THIS QUARTER IS
PUT IN THE CAN,
THE PLASTIC BAG
IS TWISTED SHUT
AND TIED BEFORE
THE LID IS LATCHED
DOWN. MOST OF
THESE SAMPLES
WEIGH 30-40
POUNDS.)

The two remaining quarters are then mixed together, formed into a cone, and quartered as before. Two diagonal quarters are then put into a sample can and sent to the U. S. Bureau of Mines. The remaining two quarters are put into another can and sent to the U. S. Geological Survey. Each of these two samples average 15-20 pounds.



FIGURE 130:
MIXING THE RE-
MAINING TWO
QUARTERS

In larger than normal samples, an earlier cone and quartering is used to reduce the sample down to about 80 pounds. The excess portions of these larger samples were usually but not always discarded. Some were saved and given to other investigators that requested large sample splits.

This cone and quartering method of sample splitting was used in 1974. The Wyoming Geological Survey now uses a commercially-made, portable sample splitter instead of the quartering procedure. The cone and quartering procedure is not recommended if a sample splitter is available.

