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Characterization and Evaluation of Washability of Alaskan Coals

Final Technical Report for Phase I
Contractor—University of Alaska

May 1979

Contract No. U.S.D.O.E. ET-78-G-01-8969
(formerly U.S.B.M. G0166212)

U. S. Department of Energy

Assistant Secretary for Energy Technology

Division of Fossil Fuel Extraction
Mining Research and Development

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CHARACTERIZATION AND EVALUATION OF WASHABILITY OF ALASKAN COALS

Selected Seams from Nenana, Jarvis Creek and Matanuska Coal Fields

FINAL TECHNICAL REPORT FOR PHASE I

September 30, 1976, to June 30, 1977

This report represents work on a program that was originated by the Interior Department's Bureau of Mines and was transferred to the Department of Energy on October 1, 1977.

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U.S. DEPARTMENT OF ENERGY
Assistant Secretary for Fossil Energy
Office of Coal Mining
Pittsburgh Mining Technology Center

ABSTRACT

This report covers the results of a study conducted to obtain washability data for Alaskan coals to supplement the efforts of the U.S. Department of Energy (formerly U.S. Bureau of Mines) in its ongoing studies on washability of U.S. coals. Alaska has 130 billion tons of identified coal resources and could be in a position to supply environmentally acceptable low-ash and low-sulfur coals to other states.

Preparation characteristics were obtained for nine coal samples collected from the Nenana, Jarvis Creek, and Matanuska coal fields. The raw coals were crushed to 1-1/2 inches, 3/8 inch, and 14 mesh (Tyler) sizes and float-sink separations were made at 1.30, 1.40, and 1.60 specific gravities.

The results showed that six subbituminous C coals from the Nenana coal field, when crushed to minus 14 mesh and floated at specific gravity 1.40, yielded products ranging in heating values from 10,098 to 11,664 Btu/lb with 0.15 percent to 0.23 percent sulfur on a moisture free basis, making them among the most environmentally acceptable coals in the United States.

A subbituminous C coal from the Jarvis Creek coal field yielded 84.9 weight-percent of float 1.40 specific gravity product with 11,272 Btu/lb on a moisture free basis and 0.98 percent sulfur after crushing to 14 mesh top size.

A high volatile A and a high volatile B bituminous coal from the Matanuska coal field yielded 65.7 and 75.3 weight-percent of float 1.40 specific gravity product with heating values of 14,383 and 13,371 Btu/lb when crushed to 14 mesh top size. The sulfur in these two coals was very low (less than 0.50 percent) and was virtually all organic sulfur; therefore, no sulfur reduction occurred during washing.

ACKNOWLEDGMENTS

The studies for this report were conducted under the joint sponsorship of the U.S. Department of Energy (formerly U.S. Bureau of Mines) and Usibelli Coal Mine, Inc., Healy, Alaska. The cooperation of Messrs. Joseph Usibelli and Paul Ohmlin is greatly appreciated. The help of Mr. Steven Denton of Usibelli Coal Mine in sampling seams in the Nenana coal field and Messrs. Paul Metz and Mark Robinson in sampling the Jarvis Creek coal field is gratefully acknowledged. Thanks are due to Dr. Earl H. Beistline, Dean, School of Mineral Industry, University of Alaska, Fairbanks, for his interest and encouragement in coal investigations.

The authors are especially grateful to Messrs. Joseph A. Cavallaro and Albert W. Deurbrouck, Pittsburgh Mining Technology Center, U.S. Department of Energy, for their helpful suggestions during the course of the investigation, and careful review of the final report.

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INTRODUCTION

Alaska has very extensive coal deposits. Barnes[1] estimates identified coal resources at 130 billion tons. Recent estimates based on oil well drill logs in Cook Inlet[2] nd the North Slope[3] could place the coal resources of Alaska at several trillion tons, exceeding the resources of the rest of the nation. Alaska is in an enviable position of being able to supply the energy needs of this state as well as the nation.

For more than half a century, coal has played a significant role in supplying the energy needs of the rail belt, and today furnishes the energy base for much of the state's interior region. Usibelli Coal Mine, the only operating coal mine in Alaska, produces about 0.75 million tons to meet the annual demand. There has been an increased interest in Alaskan coals during the past few years, thus necessitating a need for more information concerning the amenability of these coals to beneficiation. Figure 1 shows the major coal resource areas in Alaska.

Alaska can supply coal to lessen the nation's reliance on imported oil and reduce the balance of payments deficit by exporting Alaskan coals to other Pacific belt nations and to the west coast of the United States. This coal would come from the Nenana and Matanuska coal fields, accessible to the Alaska Railroad, or from the Beluga coal field, accessible to a deep water port.

There are three major undesirable substances in coal: moisture, ash, and sulfur. Although moisture is the most undesirable of the constituents in Alaska's subbituminous coals, it is not being addressed in the present investigation. The extent to which ash and sulfur can be reduced depends to a large extent on the form and mode of occurrence and is readily evaluated by standard washability tests. These involve crushing and float-sink separation of coals in organic liquids at varying densities, followed by chemical analysis and evaluation of the densimetric fractions.

COAL FIELDS SAMPLED

Nine 600-lb raw coal channel samples were collected, six from the Nenana, one from the Jarvis Creek, and two from the Matanuska coal field. In operating mines, samples were obtained from freshly exposed seams; elsewhere, fresh surfaces were exposed on outcrops of weathered coal. The samples were transported to the laboratory in heavy duty plastic bags in gunny sacks.

Nenana Coal Field

The Nenana coal field is located about 110 miles south of Fairbanks on the Parks Highway at Healy (Figure 2). The field extends 80 miles in the east-west direction and is one to thirty miles wide[4,5,6]. The coal bearing formation consisting of sandstone, siltstone, claystone, and shale has numerous thick coal beds and is divided into five formations by Clyde Wahrhaftig et al[7].

Figure 3 is a generalized geological section showing coal beds exposed at Suntrana and Healy Creeks. No. 2 Seam (UA-105) was sampled in this sequence.

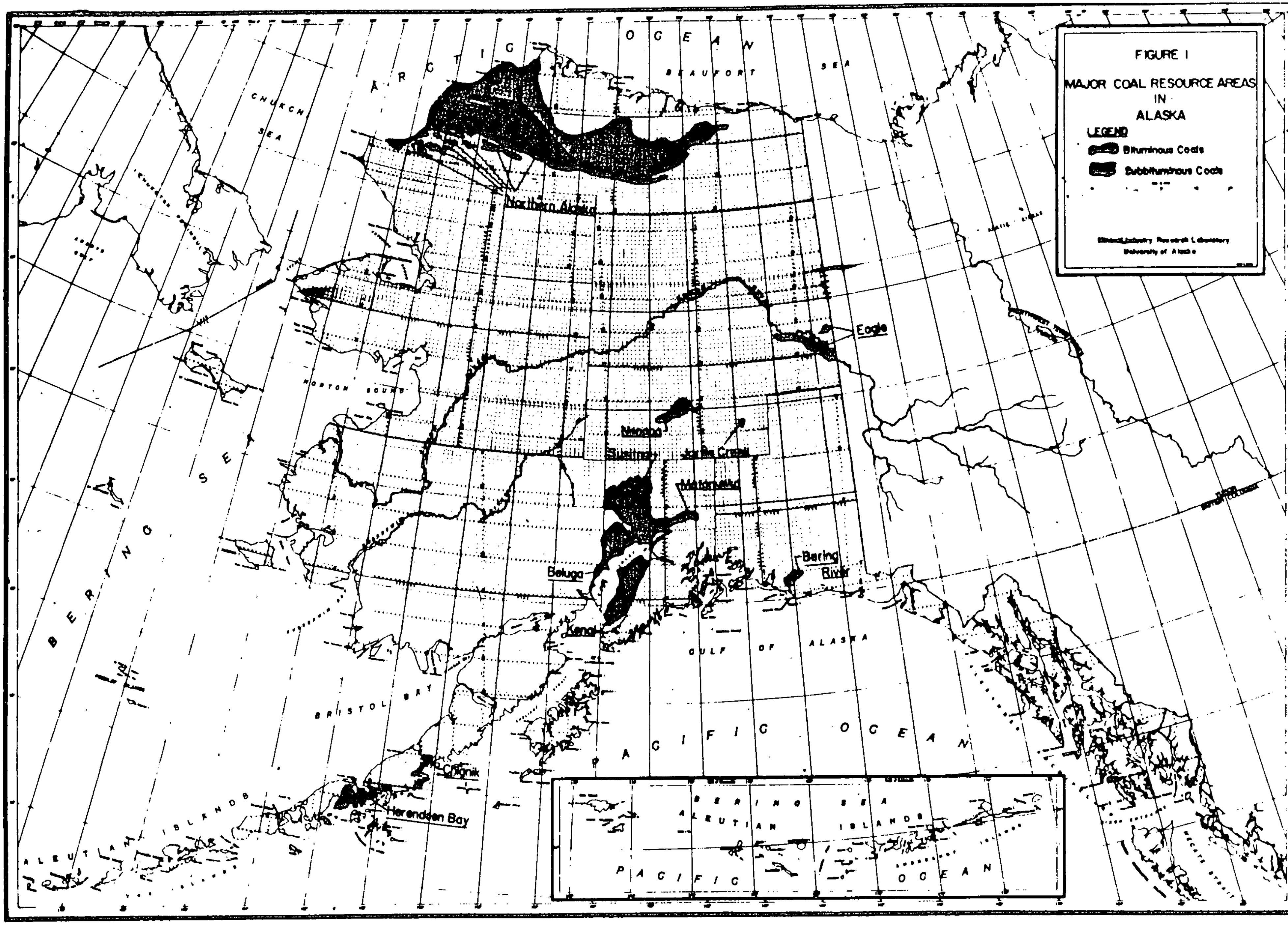
FIGURE I
MAJOR COAL RESOURCE AREAS
IN
ALASKA
LEGEND
Bituminous Coals
Subbituminous Coals
ARCTIC OCEAN
BEAUFORT SEA
CHUKCHI SEA
NORTON SOUND
BERING SEA
BRISTOL BAY
GULF OF ALASKA
PACIFIC OCEAN
ALEUTIAN ISLANDS
BERING SEA
Northern Alaska
Eagle
Nenana
Susitna
Jarvis Creek
Matanuska
Bering River
Beluga
Kenai
Chignik
Herendeen Bay

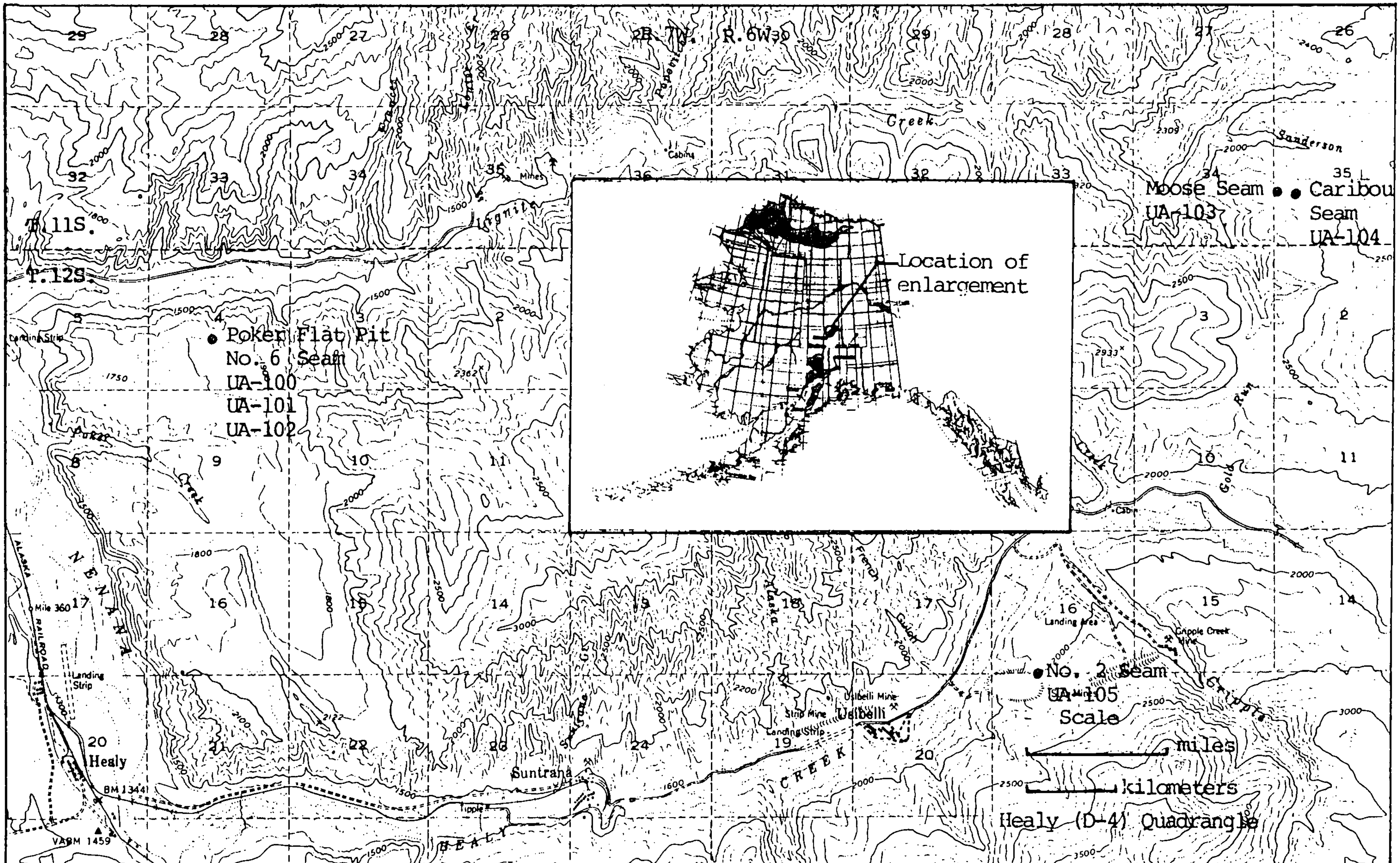

Figure 2: Location of Sample Sites in the Nenana Coal Field

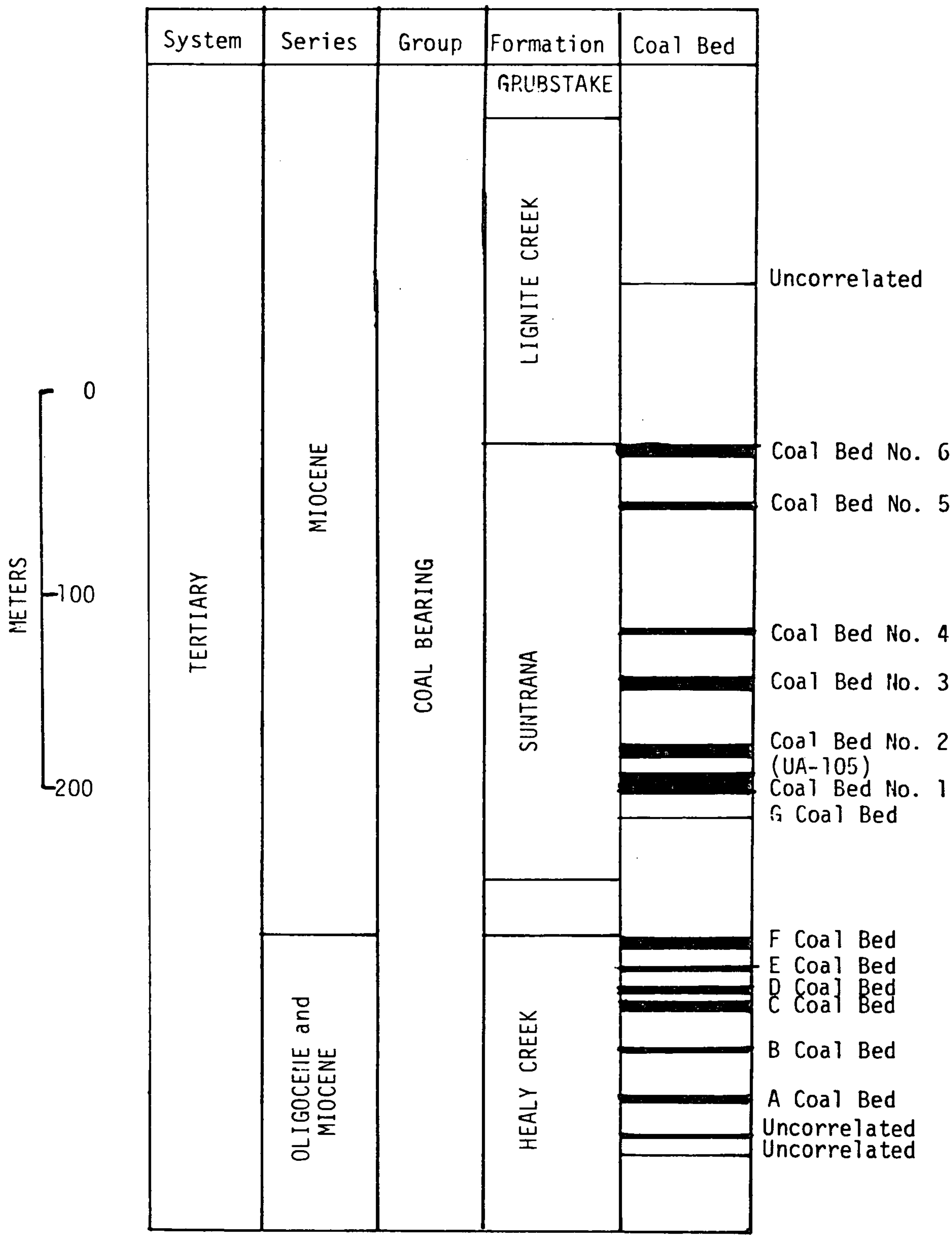

Figure 3: Geological Column Showing Mineable Coal Beds on Suntrana and Healy Creeks, Nenana Coal Field

A geological section of coal seams exposed on Lower Lignite Creek is shown in Figure 4 (Wahrhaftig[6]), and the coal seams are correlated with those shown in Figure 3.

Figure 5 is a geological section of seams exposed on Upper Lignite Creek. Moose seam of this section has been correlated to F seam in Figure 3 above. Caribou and Bear seams, however, have not been correlated to seams in other parts of the coal field.

Barnes[1] estimates the original resources of the Nenana coal field at 7 billion tons, of which 3 billion tons are on Lignite Creek. Accurate estimates of recoverable reserves for individual seams are not available.

Jarvis Creek Coal Field

The Jarvis Creek coal field is located about 125 miles southeast of Fairbanks on the north side of the Alaska Range (Figure 6). The coal field is 16 square miles in area and the site of sporadic mining activity. It is about 6 miles via a pioneer gravel road from the Richardson Highway, Mile 242. The coal field has been mapped by Wahrhaftig and Hickcox[8]. It is Tertiary in age and has been correlated to the Healy Creek formation of the Nenana coal field, 100 miles to the west.

The coal bearing formation consists of a sequence of interbedded lenses of poorly consolidated sandstone, siltstone, claystone, and conglomerate. Although there are numerous coal beds, those with thicknesses exceeding 2-1/2 feet are rare.

Figure 7 is a geological section showing coal beds in the Jarvis Creek coal field and is a combination of several sections measured by Wahrhaftig and Hickcox[8]. Beds B and C are the only beds containing minable coal. Recent drilling by Warfield[9] seems to indicate depositional continuity over a fairly long distance. The seam that was sampled (UA-106), designated Mine Seam, has been intersected by three drill holes at 62 feet, 34.6 feet, and 20 feet below the surface[9]. This seam has not been correlated with the seams measured by Wahrhaftig. From the drill data, it is conservatively estimated that the Mine Seam has a strip mining potential of 375,000 tons[9]. Additional geological and drill data are needed to assess the potential of the coal field and to correlate Mine Seam with seams exposed in other parts of the coal field.

Matanuska Coal Field

Matanuska coal field is about 45 miles northeast of Anchorage on the Glenn Highway. In the Upper Matanuska Valley (Figure 8), the coal increases in rank from high volatile A bituminous at the Castle Mountain Mine, to anthracite at the Anthracite Ridge. The coal in the Wishbone Hill District of the Lower Matanuska Valley (Figure 9) is high volatile B bituminous. The coal seams are limited to the Chickaloon formation of Tertiary age. This formation consists of nonmarine rocks that include all gradations from coarse sandstone and conglomerate to claystone. It is concealed by a mantle of Quaternary deposits or by a capping of younger Tertiary conglomerate[10,11].

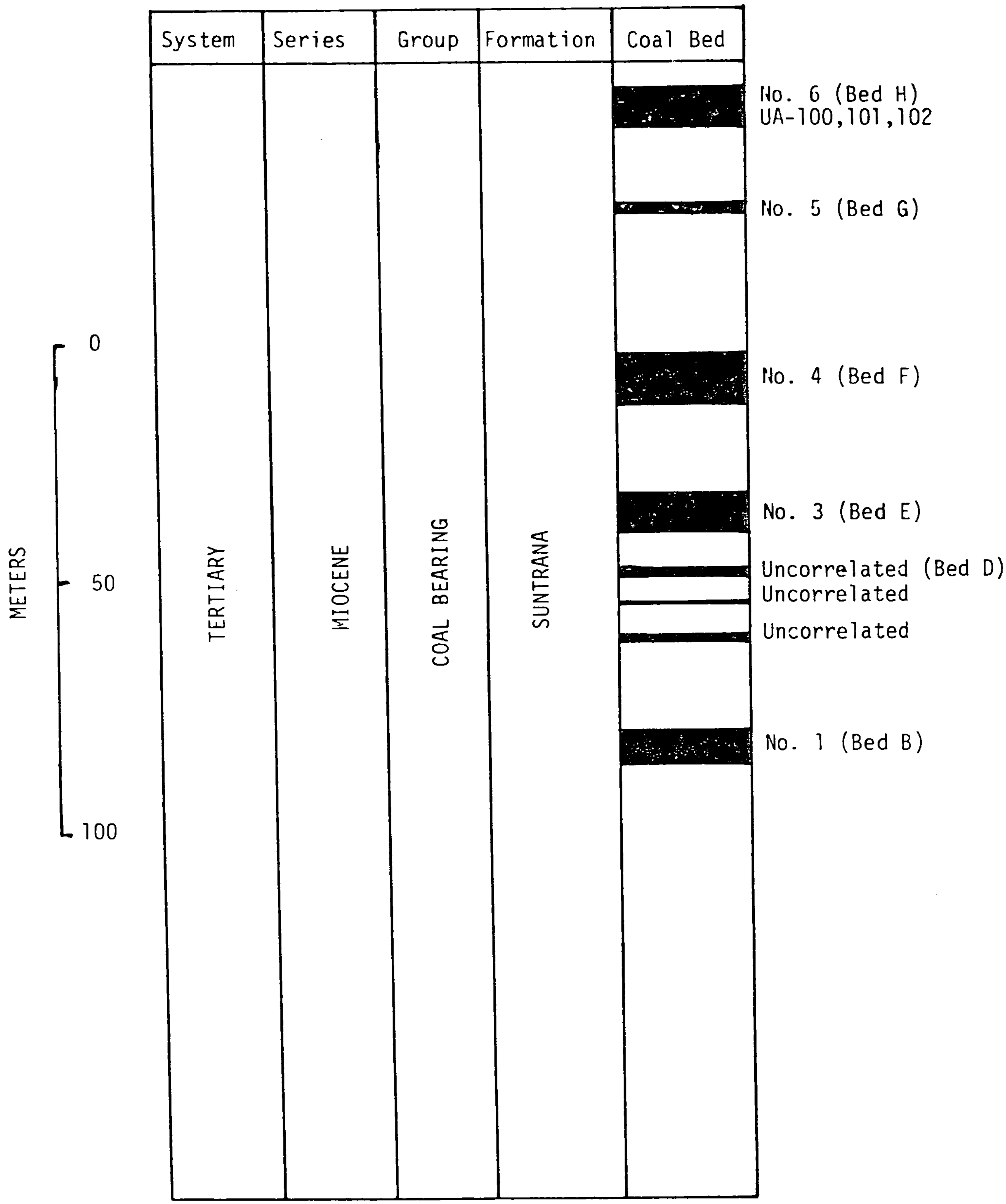

Figure 4: Geological Column Showing Mineable Coal Beds on Lower Lignite Creek, Nenana Coal Field

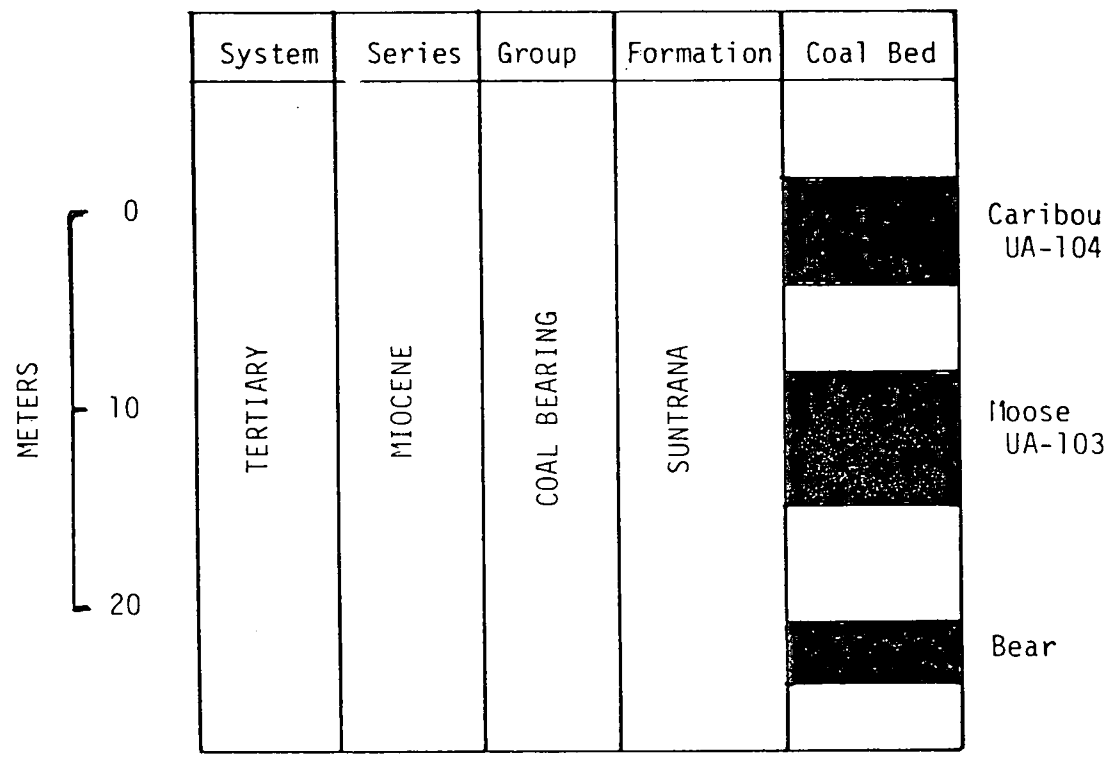

Figure 5: Geological Column Showing Coal Beds on the Upper Lignite Creek, Nenana Coal Field

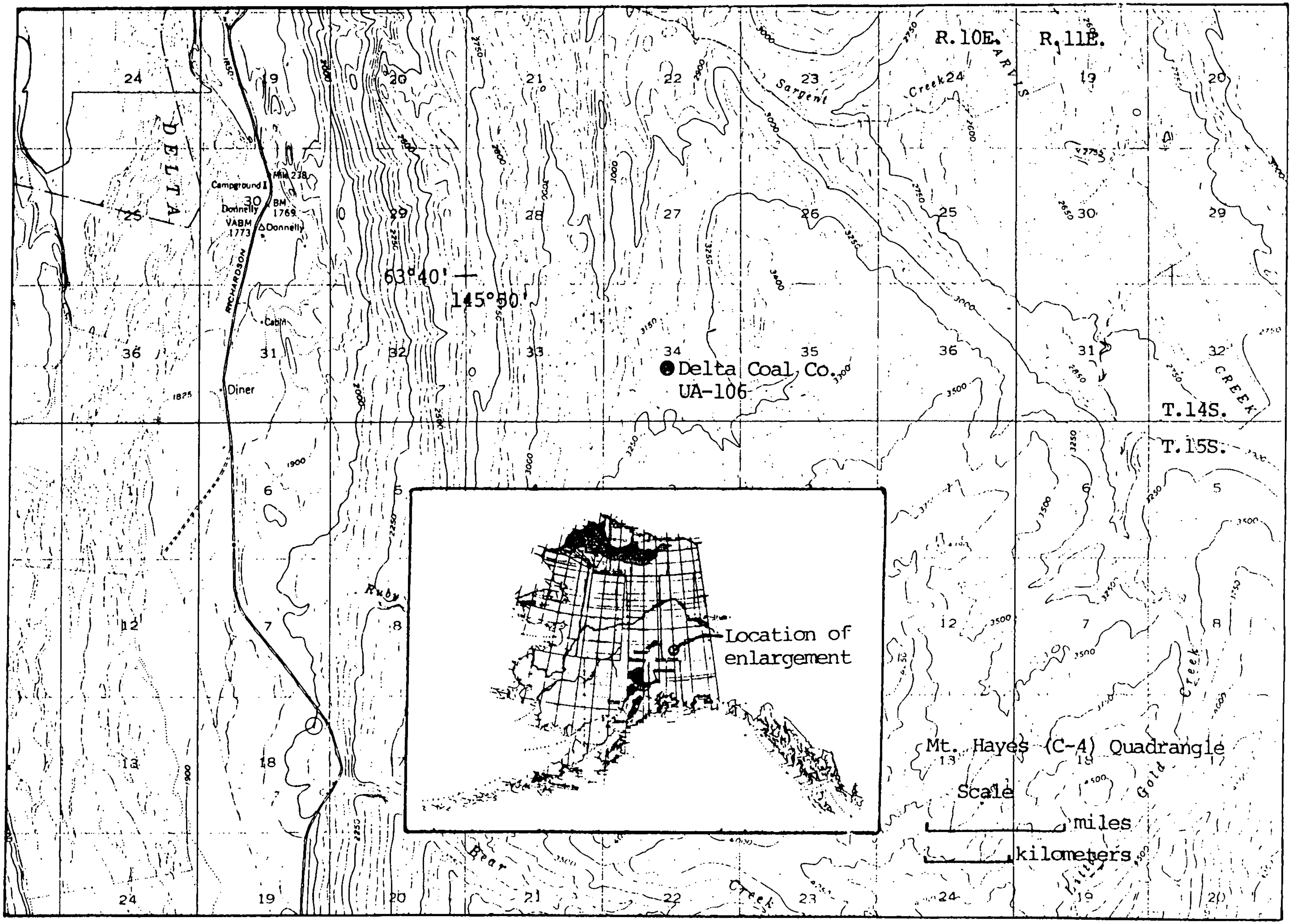

Figure 6: Location of sampling site in the Jarvis Creek Coal Field

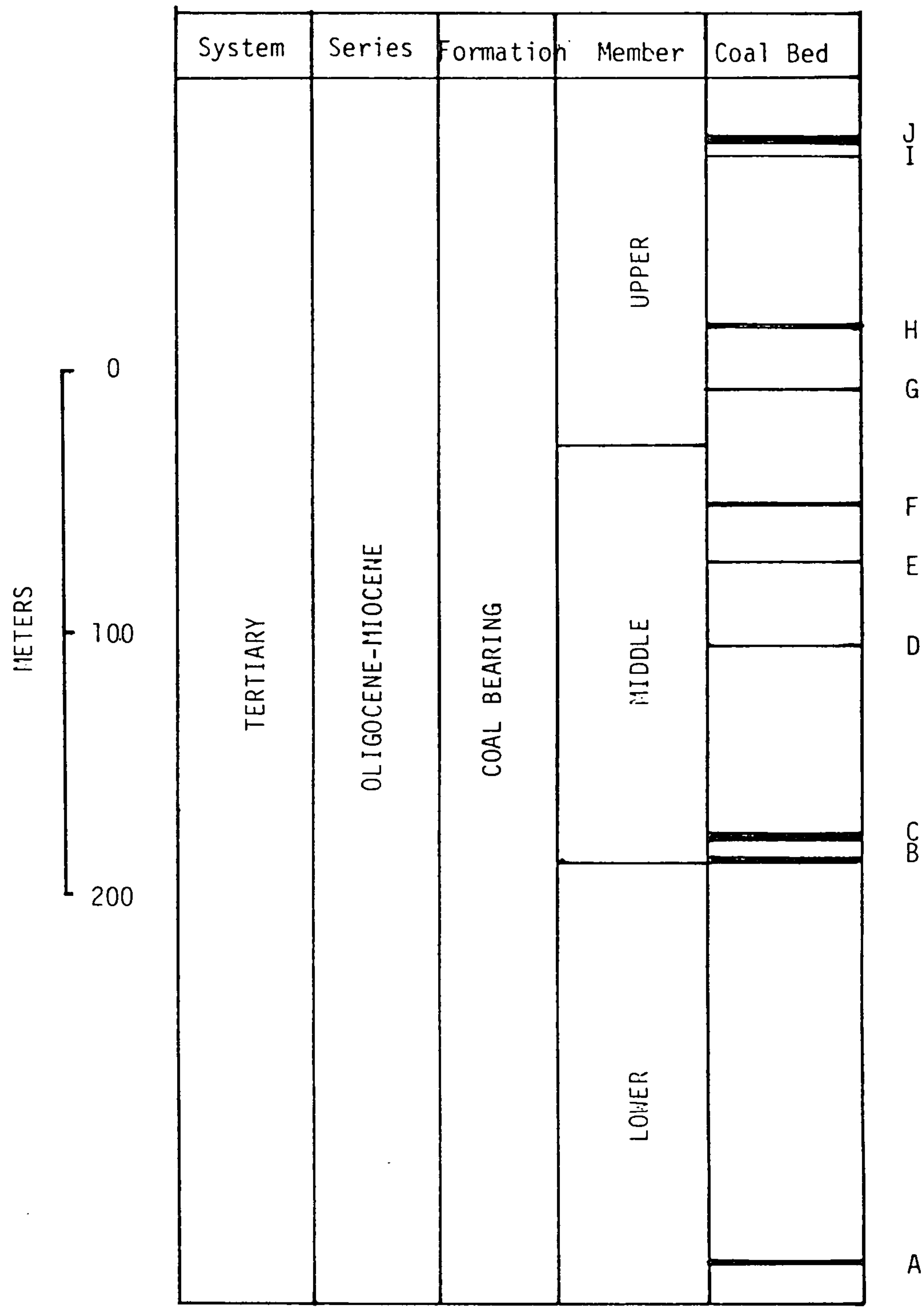

Figure 7: Geological Column Showing Coal Beds in the Jarvis Creek Coal Field

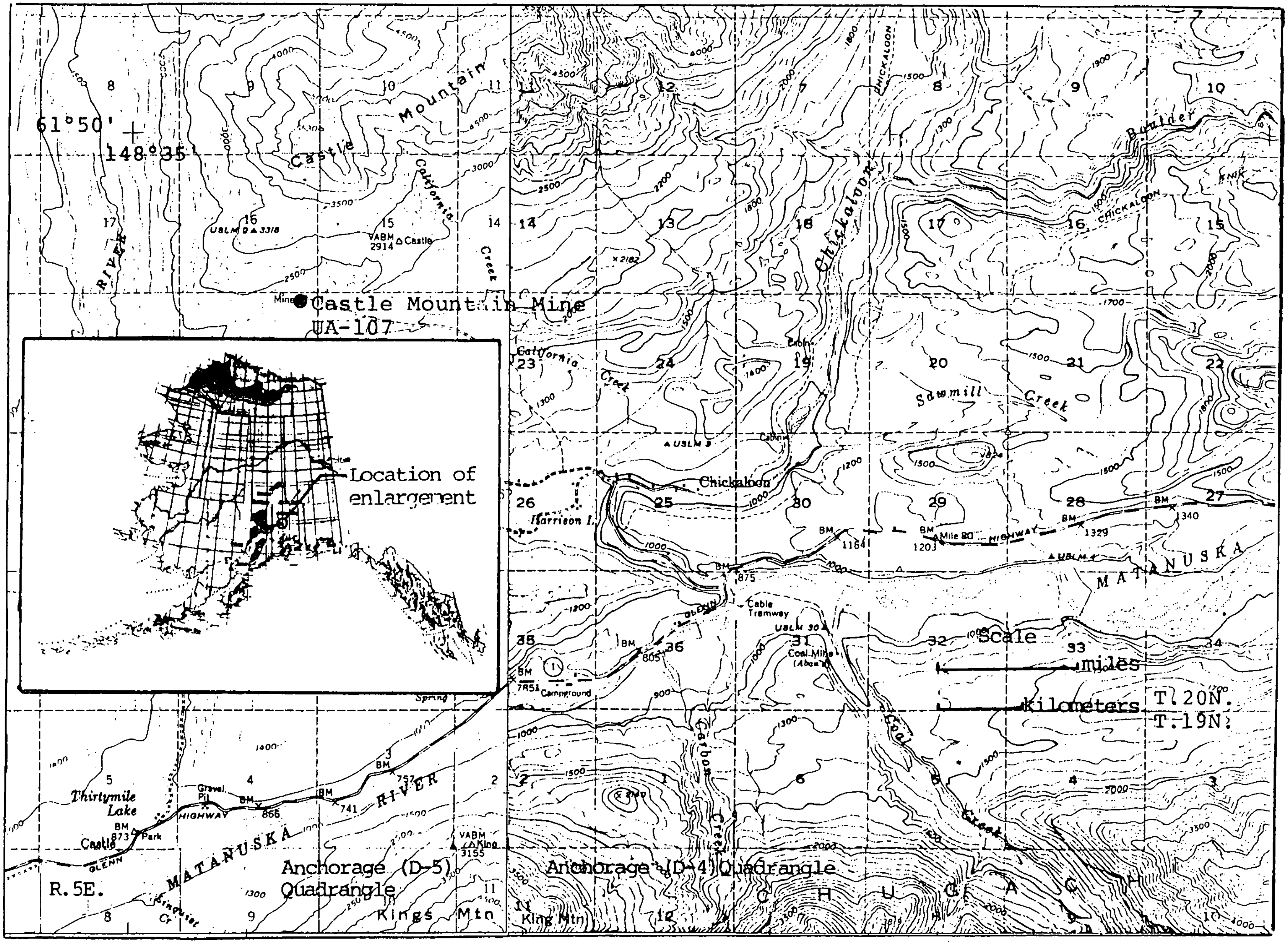

Figure 8: Location of sampling site in the Upper Matanuska Valley, Matanuska Coal Field

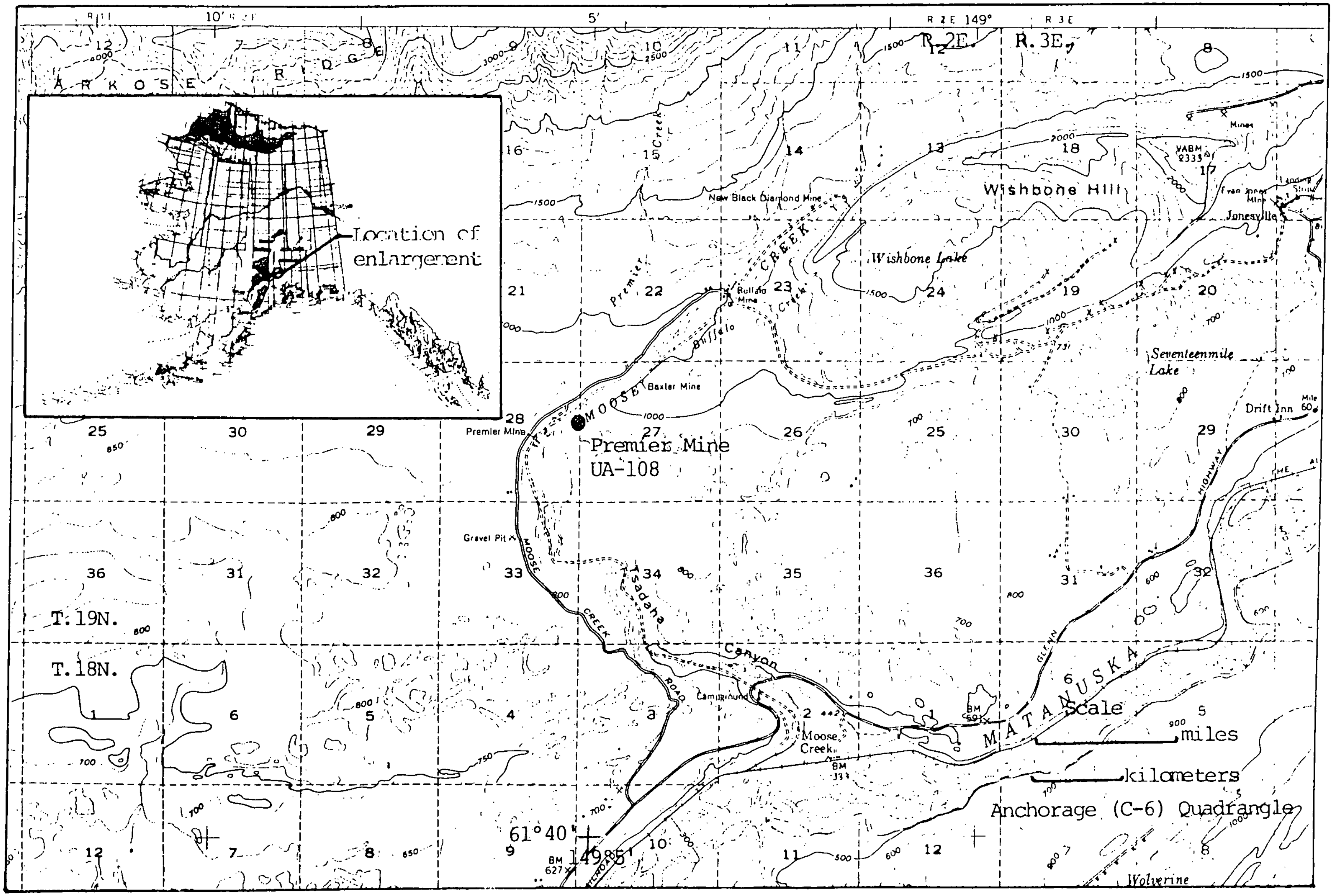

Figure 9 : Location of sampling site in the Lower Matanuska Valley, Matanuska Coal Field

Figure 10 is a geological section showing the principal coal beds in the Wishbone Hill District. A coal seam sampled at the Premier Mine (UA-108) is from a region highly faulted and at the crest of an anticline. This seam could not be correlated or located in the general geological section (Figure 10). Barnes estimates that the Wishbone Hill has resources of 51.7 million tons in the indicated category and 53.7 million tons in the inferred category. Detailed information on the remaining resources of various coal beds is lacking.

There are two coal beds exposed at the Castle Mountain Mine (not operated since the early 1960's) (Figure 8). The lower bed, 7.0 feet thick, was sampled (UA-107); the upper bed, 5.0 feet thick, was not. Continuity of the coal beds has not been established and the remaining resources of the seams are not known. Complex structure, lack of continuity of coal beds, and widespread igneous intrusions add to the difficulties in estimating the reserves[12].

LABORATORY PROCEDURES

This investigation closely followed the laboratory procedures described by Cavallaro et al[13]. Figure 11 is a flowsheet of procedures used in the laboratory for processing the samples. Raw coal samples were crushed to 1-1/2 inches, 3/8 inch, and 14 mesh sizes. Minus 100-mesh material was removed from the 1-1/2 inches and 3/8 inch crushed samples, leaving the coarse fraction for float-sink testing in 60 liter containers. The 14 mesh by 0 samples were separated in glass separatory flasks joined by ground taper joints. Float-sink separations were made at 1.30, 1.40, and 1.60 specific gravities using perchloroethylene-naptha mixtures as heavy liquid. The air dried products were first crushed in a hammer mill to 14 mesh and pulverized to 60 mesh for analysis. Proximate and ultimate analyses of raw coals are presented in Table I. The concentration of major elements and the fusibility of ash are presented in Table II.

All float-sink products were analyzed for ash, moisture, heating value, total sulfur, and pyritic sulfur. All data were calculated on a moisture free basis. American Society for Testing and Materials (ASTM) standard procedures were used for all analyses except for a slight modification made in the procedure for the determination of pyritic sulfur. In the modified procedure, 1 g. of coal sample was digested with 50 ml. of 2:3 HCl for 30 minutes in a 250 ml. flask connected to a water cooled condenser. The contents were cooled, filtered, and washed. The filter paper with the residue was inserted back into the flask and digested again with 50 ml. of 1:7 HNO_3 for 30 minutes. The contents were again filtered and washed and the Fe content in the solution was determined using a Perkin-Elmer 303 atomic absorption spectrophotometer. It was assumed that the determined iron was entirely from pyrite (FeS_2).

The Hardgrove grindability indexes of the samples were determined with air dried samples as per ASTM designation D409-71 using standards HGI 41, HGI 54, HGI 80, and HGI 92, supplied by ASTM. For subbituminous coals, grindability of the samples was also determined in "as received" condition with minimum loss of bed-moisture as this would be of more practical significance.

Table III shows the Free Swelling Indexes and gives a comparison of HGI of dry coals, and "as received" coals, along with the moisture content of the 16 by 30 mesh fraction used for hardness determination. All samples did not show the same trend.

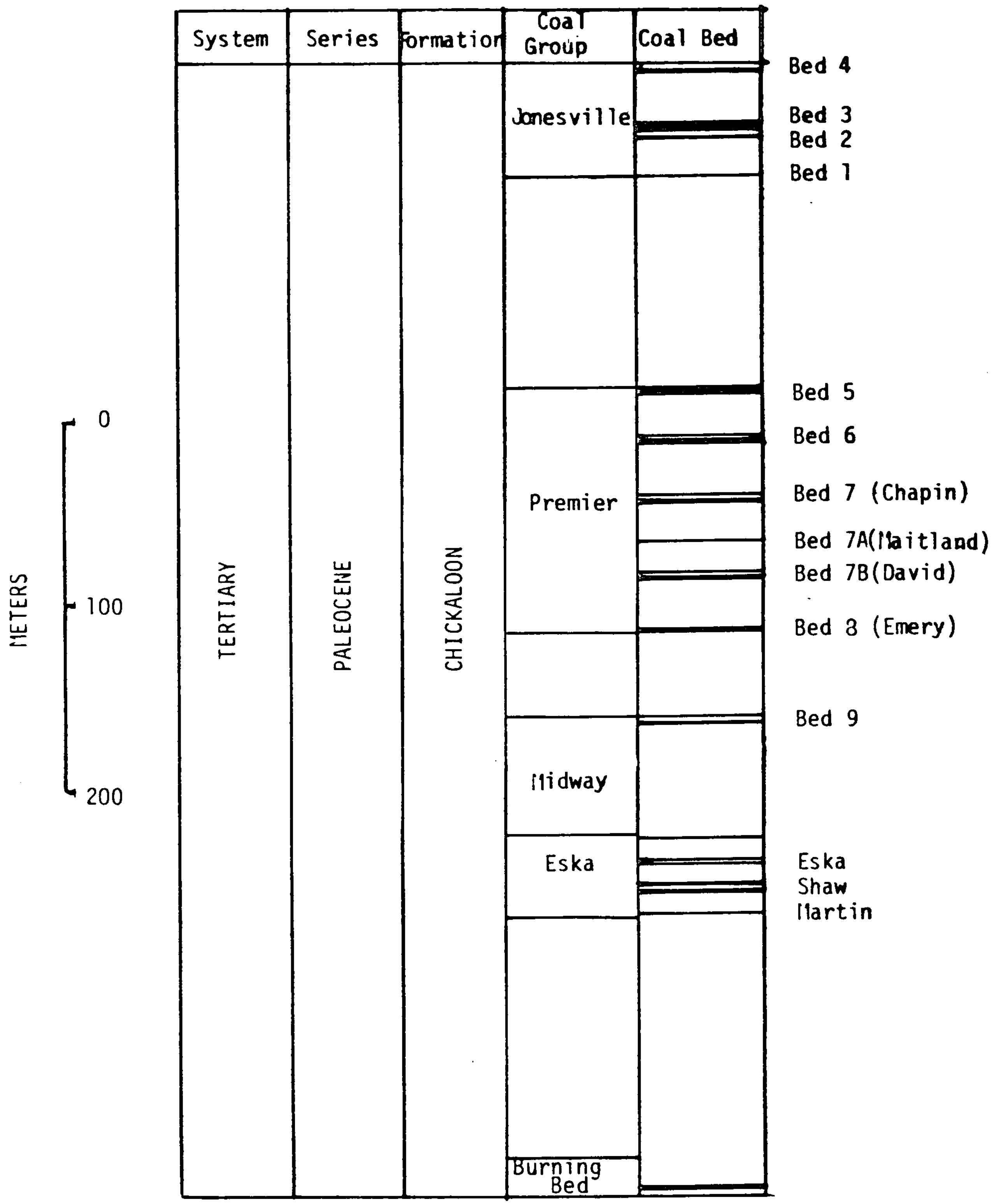

Figure 10: Geological Column Showing Mineable Coal Beds in the Wishbone Hill District, Matanuska Coal Field

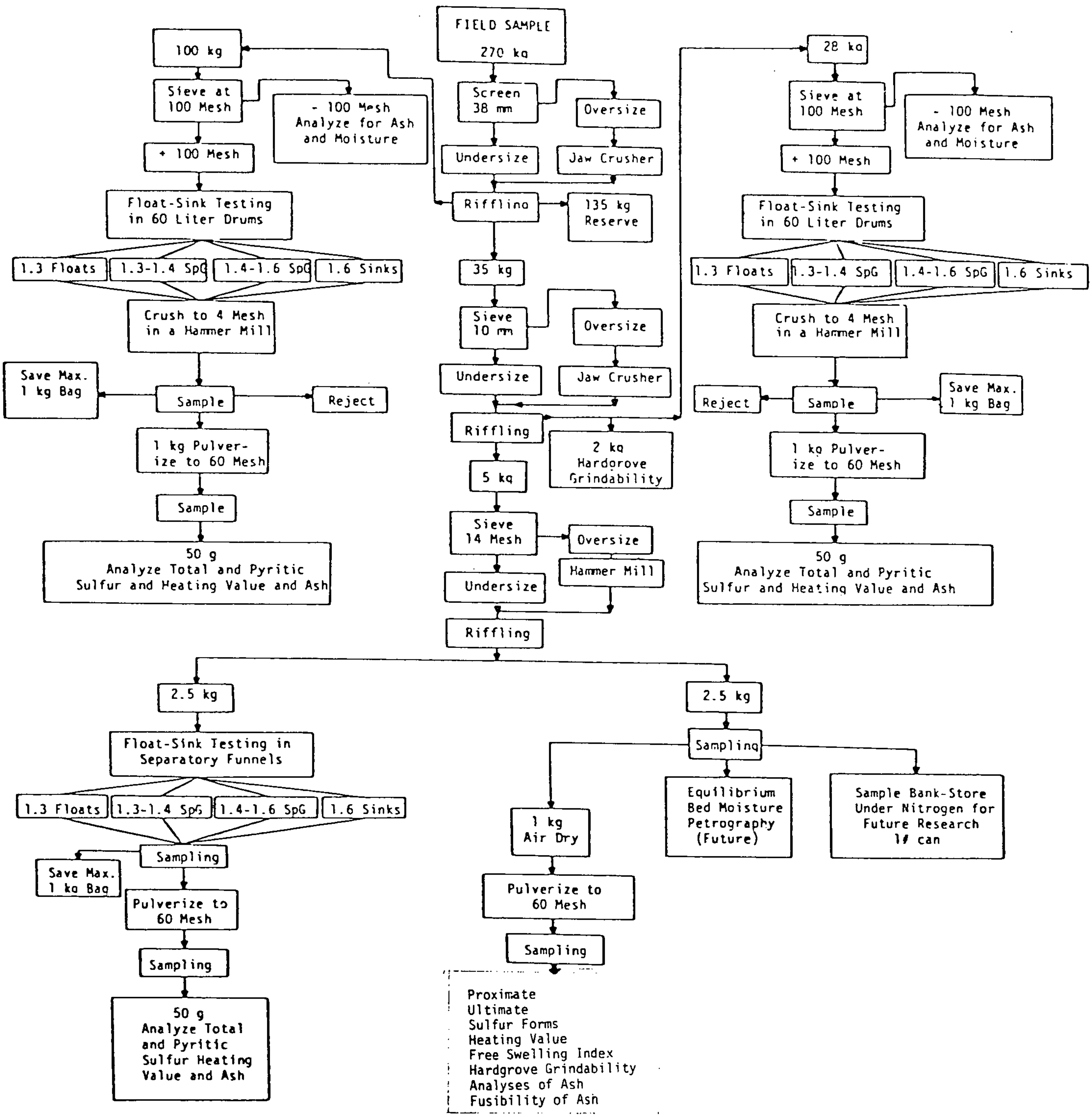

Figure 11: Flowsheet for Washability Characterization

TABLE I

Proximate and Ultimate Analyses of Raw Coals

Coal Field and Seam	ASTM Rank	Thickness Meters (feet)	Sample Numbers	Basis*	Moisture %	Volatile Matter,%	Fixed Carbon,%	Ash %	Heating Value BTU/lb.	C,%	H,%	N,%	O,%	Sulfur Pyritic	Sulfur Total
Nenana				1	7.94	39.53	31.98	20.55	8463	48.92	4.85	0.67	24.81	0.01	0.20
	Subbit.C	0.98	UA-100	2	23.61	32.80	26.54	17.05	7022	40.59	5.93	0.56	35.70	0.01	0.17
No.6 Seam		(3.2)		3		42.94	34.74	22.32	9193	53.14	4.30	0.73	19.29	0.01	0.22
Top				4		55.28	44.72		11834	68.40	5.54	0.94	24.84	0.01	0.28
Nenana				1	13.47	41.33	36.33	8.87	9416	53.33	5.53	0.69	31.44	0.01	0.14
	Subbit.C	5.58	UA-101	2	25.23	35.71	31.40	7.66	8136	46.08	6.30	0.60	39.24	0.01	0.12
No.6 Seam		(18.3)		3		47.76	41.99	10.25	10882	61.64	4.65	0.80	22.50	0.01	0.16
Middle				4		53.22	46.78		12124	68.68	5.18	0.89	25.07	0.01	0.18
Nenana				1	13.44	39.74	34.74	12.08	8754	51.10	5.21	0.69	30.77	0.01	0.15
	Subbit.C	1.00	UA-102	2	25.68	34.12	29.83	10.37	7516	43.87	6.05	0.59	38.99	0.01	0.13
No.6 Seam		(3.3)		3		45.91	40.14	13.95	10113	59.03	4.28	0.80	21.77	0.01	0.17
Lower				4		53.36	46.64		11752	58.60	4.97	0.93	25.30	0.01	0.20
Nenana				1	16.81	38.11	36.89	8.13	9478	54.72	6.06	0.86	30.07	0.01	0.16
Moose Seam	Subbit.C	6.58	UA-103	2	21.42	36.02	34.88	7.68	8953	51.69	6.34	0.81	33.33	0.01	0.15
		(21.6)		3		45.85	44.38	9.77	11393	65.78	5.02	1.03	18.25	0.01	0.15
				4		50.81	49.19		12627	72.90	5.56	1.15	20.18	0.01	0.21
Nenana				1	12.74	40.10	36.72	10.44	9575	55.26	5.50	0.77	27.88	0.02	0.15
Caribou Seam	Subbit.C	5.06	UA-104	2	21.93	35.88	32.85	9.34	8567	49.44	6.10	0.69	34.30	0.02	0.13
		(16.6)		3		45.96	42.08	11.96	10973	63.33	4.67	0.88	18.99	0.02	0.17
				4		52.20	47.80		12464	71.93	5.30	1.00	21.57	0.03	0.20
Nenana				1	16.05	37.97	36.96	9.02	9130	53.20	5.72	0.72	31.15	0.02	0.19
No.2 Seam	Subbit.C	8.47	UA-105	2	26.76	33.12	32.25	7.87	7966	46.41	6.42	0.63	38.50	0.02	0.17
		(27.8)		3		45.23	44.03	10.74	10876	63.38	4.68	0.86	20.11	0.02	0.23
				4		50.67	49.33		12185	71.01	5.24	0.96	22.54	0.03	0.25
Jarvis Creek				1	13.10	39.61	37.37	9.92	9567	54.53	5.33	0.87	28.20	0.34	1.15
	Subbit.C	3.05	UA-106	2	20.58	36.20	34.16	9.06	8746	49.83	5.84	0.80	33.42	0.31	1.05
		(10)		3		45.58	43.01	11.41	11012	62.75	4.45	1.00	19.07	0.39	1.32
No. 1 Seam				4		51.45	48.55		12430	70.83	5.02	1.13	21.53	0.44	1.49
Matanuska				1	1.08	28.44	52.58	17.90	12345	69.83	4.61	1.66	5.54	0.09	0.46
	hv Ab	2.13	UA-107	2	1.78	28.23	52.20	17.78	12258	69.33	4.66	1.64	6.13	0.09	0.46
		(7)		3		28.75	53.15	18.10	12480	70.59	4.54	1.68	4.62	0.09	0.47
Lower Seam				4		35.10	64.90		15238	86.19	5.54	2.05	5.65	0.11	0.57
Matanuska				1	2.66	36.95	45.46	14.93	11480	65.80	4.90	1.18	12.83	0.04	0.36
	hv Bb		UA-108	2	5.87	35.73	43.96	14.44	11101	63.63	5.11	1.14	15.33	0.04	0.35
Big Seam				3		37.95	46.70	15.34	11794	67.60	4.73	1.21	10.75	0.04	0.37
				4		44.84	55.16		13864	79.85	5.59	1.43	12.70	0.05	0.43

* 1. Air-Dried Basis
2. Equilibrated Bed Moisture Basis
3. Moisture-Free Basis
4. Moisture-Ash-Free Basis

TABLE II

Concentration of Major Elements and Fusibility of Ash of the Raw Coal Samples

Sample number	Concentration of Major Elements in Coal Ash (750° C), percent									
	SiO_2	Al_2O_3	Fe_2O_3	MgO	CaO	Na_2O	K_2O	TiO_2	SO_3	MnO
UA-100	55.3	19.3	7.1	2.2	9.4	0.08	1.8	1.0	3.1	0.44
UA-101	37.7	22.6	9.4	3.8	22.8	0.08	1.1	0.9	5.0	0.37
UA-102	39.5	21.4	6.6	2.5	24.1	0.05	1.1	1.0	3.5	0.19
UA-103	34.7	25.0	5.2	7.7	16.7	0.38	1.6	1.2	7.2	0.06
UA-104	43.1	21.4	9.0	5.2	14.7	0.97	1.8	1.1	5.6	0.07
UA-105	47.3	20.7	8.9	2.8	12.9	0.05	1.2	0.9	6.3	0.44
UA-106	42.7	16.6	11.2	2.2	20.8	0.05	0.7	1.1	21.7	0.12
UA-107	53.3	25.7	4.4	1.9	3.6	0.43	2.1	1.3	1.7	0.12
UA-108	53.5	28.8	6.5	2.3	4.4	0.16	1.9	1.6	2.4	0.10

Fusibility of Ash, °F

Sample number	Initial deformation	Softening	Fluid
UA-100	2,350	2,400	2,560
UA-101	2,100	2,130	2,160
UA-102	2,150	2,180	2,210
UA-103	2,200	2,250	2,300
UA-104	2,150	2,180	2,210
UA-105	2,150	2,180	2,210
UA-106	1,980	2,030	2,080
UA-107	2,670	2,720	2,830
UA-108	2,520	2,570	2,670

TABLE III

Hardgrove Grindability and Free Swelling Indexes of Raw Coals

Sample number	Air dried samples ASTM method D409-71			As received samples	
	Moisture	FSI	HGI	Moisture	HGI
UA-100	7.1	0	32	22.7	29
UA-101	6.3	0	31	22.9	33
UA-102	6.5	0	32	26.6	39
UA-103	6.4	0	28	19.7	29
UA-104	4.8	0	31	19.5	26
UA-105	5.1	0	28	21.8	20
UA-106	5.7	0	28	16.9	24
UA-107	1.1	8	65	-	-
UA-108	2.7	3	37	-	-

"As received" samples UA-100, UA-104, UA-105, and UA-106 had lower HGI than the same samples when air dried. Air dried samples UA-101, UA-102, and UA-103 had lower HGI than "as received" samples. No explanation can be offered for this.

INTERPRETATION OF WASHABILITY DATA

Tables IV through XIII show washability data for the nine samples processed. The tables show weight-percent distribution, ash, heating value, pyritic sulfur, and total sulfur on a moisture free basis for the various gravimetric fractions as well as values for cumulated floats. The quality of the float at any of the three densities can be directly read from the tables. The tables also show cumulative sink weight-percent and ash content that may be expected at any of the three densities.

Nenana Coal Field

Poker Flat Pit. Poker Flat Pit, now being developed for mining using a new dragline, will supply all coal requirements for Fairbanks and Interior Alaska for the near future. This pit is on Lower Lignite Creek (Figure 2). The sampled seam is No. 6 Seam and is 24.8 feet thick. The top and bottom portions of the seam are high in ash, with a possible need for washing; the middle portion is low in ash and can be shipped directly. For this reason, the seam was sampled in three portions and the coal was processed in the laboratory as three independent samples. As with all coals from the Nenana coal field, these samples showed low total sulfur (<0.2 percent) and barely detectable pyritic sulfur (0.01 percent); thus, physical beneficiation did not reduce the sulfur content in the coal, since all sulfur is organically bound to the coal substance.

Sample UA-100 was obtained from the top 3.3 feet of the seam and contained an average of 20.9 percent ash. Washing this coal at 1.40 specific gravity and 14 mesh top size, yielded 51.7 percent as clean coal with 11.4 percent ash, 0.18 percent sulfur and 10,413 Btu/lb on a moisture free basis (Table IV).

Sample UA-101 was obtained from the middle 18.3 feet of the seam and had an ash content of 9.4 percent. Cleaning the 14 mesh by 0 coal at 1.40 specific gravity gave a product with 8.1 percent ash and 0.15 percent sulfur with a heating value of 10,767 Btu/lb on a moisture free basis (Table V).

Sample UA-102 was obtained from the bottom 3.3 feet of the seam and averaged 13.5 percent ash. Washing minus 14-mesh coal at 1.40 specific gravity reduced the ash content to 12.5 percent with 93.4 percent yield (Table VI).

Table VII shows the composite washability for the whole No. 6 seam. The raw coal contained an average of 11.4 percent ash on a moisture free basis. Washing 14 mesh by 0 coal at 1.40 specific gravity reduced the ash content to 9.4 percent with 11,647 Btu/lb on a moisture free basis. However, from a practical standpoint, it would be preferable to ship the middle portion of the seam (UA-101) direct and wash the top and bottom portions (UA-100 and UA-102).

Moose Seam and Caribou Seam. Moose Seam (UA-103) and Caribou Seam (UA-104) are on Upper Lignite Creek (Figure 2). These seams are currently being mined and will continue to be mined for some time. These coals are low in ash and like all other Nenana coals, are low in total sulfur (0.21 percent for sample UA-103 and 0.23 percent for sample UA-104).

TABLE IV

Washability Analyses of Top 0.98 Meters (3.2') of No. 6 Seam, (UA-100), Poker Flat Pit, Usibelli Coal Mine, Nenana Coal Field, Healy, Alaska

Raw Coal Bed Moisture = 23.16%

SPECIFIC GRAVITY		ACTUAL PRODUCTS					CUMULATIVE FLOAT					CUMULATIVE SINK	
					SULFUR					SULFUR			
SINK	FLOAT	WT,%	ASH %	BTU/LB.	PYR.	TOT.	WT,%	ASH	BTU/LB.	PYR.	TOT.	WT,%	ASH %
SINK-FLOAT SIZE 1.5" x 100 MESH -100 Mesh Fraction: Weight 0.3 %, Ash 28.46%													
	1.30	10.94	6.88	10829	.01	0.19	10.94	6.88	10829	.01	0.19	100.00	20.86
1.30	1.40	57.20	15.12	9970	.01	0.24	68.14	13.80	10108	.01	0.23	89.06	22.58
1.40	1.60	26.99	32.39	6897	.01	0.30	95.13	19.07	9196	.01	0.25	31.86	35.99
1.60		4.87	55.91	3375	.02	0.08	100.00	20.86	8913	.01	0.24	4.87	55.91
SINK-FLOAT SIZE 3/8" x 100 MESH -100 Mesh Fraction: Weight 0.9 %, Ash 32.39%													
	1.30	24.14	7.05	11144	.01	0.26	24.14	7.05	11144	.01	0.26	100.00	20.02
1.30	1.40	48.28	16.76	9985	.01	0.29	72.42	13.52	10371	.01	0.28	75.86	24.15
1.40	1.60	22.14	32.68	7782	.01	0.26	94.56	18.00	9765	.01	0.28	27.58	37.09
1.60		5.44	55.04	4486	.02	0.12	100.00	20.02	9478	.01	0.27	5.44	55.04
SINK-FLOAT SIZE 14 MESH x 0													
	1.30	4.17	3.10	11603	.01	0.34	4.17	3.10	11603	.01	0.34	100.00	21.76
1.30	1.40	47.55	12.08	10309	.01	0.17	51.72	11.36	10413	.01	0.18	95.83	22.57
1.40	1.60	41.46	28.69	8181	.01	0.22	93.18	19.07	9420	.01	0.20	48.28	32.90
1.60		6.82	58.48	4846	.03	0.07	100.00	21.76	9108	.01	0.19	6.82	58.48

All results are on Moisture Free Basis.

TABLE V

Washability Analyses of Middle 5.58 Meters (18.3') of No. 6 Seam (UA-101), Poker Flat Pit, Usibelli Coal Mine, Nenana Coal Field, Healy, Alaska

Raw Coal Bed Moisture = 25.23%

SPECIFIC GRAVITY		ACTUAL PRODUCTS					CUMULATIVE FLOAT					CUMULATIVE SINK	
					SULFUR					SULFUR			
SINK	FLOAT	WT,%	ASH %	BTU/LB.	PYR.	TOT.	WT,%	ASH	BTU/LB.	PYR.	TOT.	WT,%	ASH %
SINK-FLOAT SIZE 1.5" x 100 MESH; -100 Mesh Fraction: Weight 0.1 %, Ash 13.74%													
	1.30	40.50	6.46	11430	.01	0.13	40.50	6.46	11430	.01	0.13	100.00	9.58
1.30	1.40	55.96	10.47	10789	.01	0.16	96.46	8.79	11058	.01	0.15	59.50	11.70
1.40	1.60	3.31	30.10	8015	.01	0.23	99.77	9.49	10957	.01	0.15	3.54	31.15
1.60		0.23	46.25	5405	.02	0.14	100.00	9.58	10944	.01	0.15	0.23	46.25
SINK-FLOAT SIZE 3/8" x 100 MESH; -100 Mesh Fraction: Weight 1.4 %, Ash 12.50													
	1.30	40.61	6.78	11102	.01	0.14	40.61	6.78	11102	.01	0.14	100.00	9.34
1.30	1.40	56.20	10.32	10712	.01	0.21	96.81	8.83	10876	.01	0.18	59.39	11.10
1.40	1.60	2.91	24.41	10361	.01	0.19	99.72	9.29	10861	.01	0.18	3.19	24.88
1.60		0.28	29.82	7617	.03	0.05	100.00	9.34	10852	.01	0.18	0.28	29.82
SINK-FLOAT SIZE 14 MESH x 0													
	1.30	28.61	5.97	11205	.01	0.12	28.61	5.97	11205	.01	0.12	100.00	9.34
1.30	1.40	67.32	9.74	10581	.01	0.16	95.93	8.12	10767	.01	0.15	71.39	10.70
1.40	1.60	3.16	21.72	8728	.01	0.15	99.09	9,03	10702	.01	0.15	4.07	26.50
1.60		0.91	43.10	5633	.03	0.08	100.00	9.34	10656	.01	0.15	0.91	43.10

All results are on Moisture Free Basis.

TABLE VI

Washability Analyses of Lower 1.0 Meters (3.3') of No. 6 Seam (UA-102), Poker Flat Pit, Usibelli Coal Mine, Nenana Coal Field, Healy, Alaska

Raw Coal Bed Moisture = 25.68%

Specific Gravity		Actual Products					Cumulative Float					Cumulative Sink	
					Sulfur					Sulfur			
SINK	FLOAT	WT,%	ASH %	BTU/LB.	PYR.	TOT.	WT,%	ASH	BTU/LB.	PYR.	TOT.	WT,%	ASH %
SINK-FLOAT SIZE 1.5" x 100 MESH; -100 Mesh Fraction: Weight 0.7 %, Ash 15.20%													
	1.30	14.28	8.94	10438	.01	0.16	14.28	8.94	10438	.01	0.16	100.00	13.09
1.30	1.40	81.51	12.61	10039	.01	0.16	95.79	12.06	10098	.01	0.16	85.72	13.79
1.40	1.60	3.03	29.64	7766	.01	0.18	98.82	12.60	10026	.01	0.16	4.21	36.57
1.60		1.18	54.35	4238	.02	0.07	100.00	13.09	9959	.01	0.16	1.18	54.35
SINK-FLOAT SIZE 3/8" x 100 MESH; -100 Mesh Fraction: Weight 1.1 %, Ash 14.64%													
	1.30	19.78	9.15	10645	.01	0.13	19.78	9.15	10645	.01	0.13	100.00	13.51
1.30	1.40	73.48	13.35	10118	.01	0.19	93.26	12.46	10230	.01	0.18	80.22	14.59
1.40	1.60	5.00	20.29	9080	.01	0.20	98.26	12.86	10171	.01	0.18	6.74	28.11
1.60		1.74	50.59	5043	.02	0.07	100.00	13.51	10082	.01	0.18	1.74	50.59
SINK-FLOAT SIZE 14 MESH x 0													
	1.30	4.08	6.75	10583	.01	0.16	4.08	6.75	10583	.01	0.16	100.00	13.82
1.30	1.40	89.34	12.76	10056	.01	0.23	93.42	12.50	10098	.01	0.22	95.92	14.12
1.40	1.60	5.26	25.67	8680	.01	0.17	98.68	13.20	9987	.01	0.22	6.58	32.56
1.60		1.32	60.04	5265	.02	0.07	100.00	13.82	9923	.01	0.22	1.32	60.04

All results are on Moisture Free Basis.

TABLE VII

Washability Analyses (Calculated) of No. 6 Seam (UA-100, 101, and 102), Poker Flat Pit, Usibelli Coal Mine, Nenana Coal Field, Healy, Alaska

Raw Coal Bed Moisture = 25.08%

SPECIFIC GRAVITY		ACTUAL PRODUCTS					CUMULATIVE FLOAT					CUMULATIVE SINK	
SINK	FLOAT	WT,%	ASH %	BTU/LB.	SULFUR PYR.	SULFUR TOT.	WT,%	ASH	BTU/LB.	SULFUR PYR.	SULFUR TOT.	WT,%	ASH %
SINK-FLOAT SIZE 1.5" x 100 MESH; -100 Mesh Fraction: Weight 0.21%, Ash 16.80%													
	1.30	33.20	6.62	11347	.01	0.13	33.20	6.62	11347	.01	0.13	100.00	11.51
1.30	1.40	59.50	11.44	10551	.01	0.17	92.70	9.71	10836	.01	0.16	66.80	13.94
1.40	1.60	6.34	31.33	7385	.01	0.27	99.04	11.10	10615	.01	0.16	7.30	34.30
1.60		0.96	53.94	3876	.02	0.09	100.00	11.51	10550	.01	0.16	0.96	53.94
SINK-FLOAT SIZE 3/8" x 100 MESH; -100 Mesh Fraction: Weight 1.3%, Ash 14.48%													
	1.30	35.72	6.98	11072	.01	0.15	35.72	6.98	11072	.01	0.15	100.00	11.28
1.30	1.40	57.46	11.53	10532	.01	0.22	93.18	9.79	10739	.01	0.19	64.28	13.67
1.40	1.60	5.68	28.11	8908	.01	0.23	98.86	10.84	10634	.01	0.20	6.82	31.70
1.60		1.14	49.57	5165	.02	0.10	100.00	11.28	10571	.01	0.19	1.14	49.57
SINK-FLOAT SIZE 14 MESH x 0													
	1.30	22.20	5.92	11200	.01	0.13	22.20	5.92	11200	.01	0.13	100.00	11.54
1.30	1.40	67.67	10.48	10465	.01	0.17	89.87	9.35	10647	.01	0.16	77.80	13.15
1.40	1.60	8.40	26.51	8374	.01	0.20	98.27	10.82	10452	.01	0.16	10.13	30.98
1.60		1.73	52.66	5194	.03	0.07	100.00	11.54	10361	.01	0.16	1.73	52.66

All results are on Moisture Free Basis.

TABLE VIII

Washability Analyses of Moose Seam, (UA-103), Upper Lignite Creek, Usibelli Coal Mine, Nenana Coal Field, Healy, Alaska

Raw Coal Bed Moisture = 21.42%

SPECIFIC GRAVITY		ACTUAL PRODUCTS					CUMULATIVE FLOAT					CUMULATIVE SINK	
					SULFUR					SULFUR			
SINK	FLOAT	WT,%	ASH %	BTU/LB.	PYR.	TOT.	WT,%	ASH	BTU/LB.	PYR.	TOT.	WT,%	ASH %
SINK-FLOAT SIZE 1.5" x 100 MESH -100 Mesh Fraction: Weight 1.6 %, Ash 10.47%													
	1.30	65.70	6.75	11847	.01	0.21	65.70	6.75	11847	.01	0.21	100.00	9.12
1.30	1.40	32.23	12.36	10952	.01	0.21	97.93	8.60	11552	.01	0.21	34.30	13.65
1.40	1.60	1.39	28.23	9181	.02	0.17	99.32	8.66	11519	.01	0.21	2.07	33.74
1.60		0.68	45.00	5669	.13	0.15	100.00	9.12	11479	.01	0.21	0.68	45.00
SINK-FLOAT SIZE 3/8" x 100 MESH -100 Mesh Fraction: Weight 6.2 %, Ash 9.26%													
	1.30	81.17	7.77	11798	.01	0.21	81.17	7.77	11798	.01	0.21	100.00	9.05
1.30	1.40	16.37	11.61	11042	.02	0.21	97.54	8.41	11671	.01	0.21	18.83	14.57
1.40	1.60	1.58	27.50	9080	.03	0.15	99.12	8.72	11630	.01	0.21	2.46	34.28
1.60		0.88	46.46	5580	.13	0.17	100.00	9.05	11577	.01	0.21	0.88	46.46
SINK-FLOAT SIZE 14 MESH x 0													
	1.30	59.01	6.57	11804	.01	0.20	59.01	6.57	11804	.01	0.20	100.00	8.55
1.30	1.40	37.86	10.09	11445	.01	0.20	96.87	7.95	11664	.01	0.20	40.99	11.41
1.40	1.60	2.35	23.22	9476	.01	0.16	99.22	8.31	11612	.01	0.20	3.13	27.42
1.60		0.78	40.06	6733	.09	0.15	100.00	8.55	11574	.01	0.20	0.78	40.06

All results are on Moisture Free Basis.

TABLE IX

Washability Analyses of Caribou Seam, (UA-104), Upper Lignite Creek, Usibelli Coal Mine, Nenana Coal Field, Healy, Alaska

Raw Coal Bed Moisture = 21.93%

SPECIFIC GRAVITY		ACTUAL PRODUCTS					CUMULATIVE FLOAT					CUMULATIVE SINK	
					SULFUR					SULFUR			
SINK	FLOAT	WT,%	ASH %	BTU/LB.	PYR.	TOT.	WT,%	ASH	BTU/LB.	PYR.	TOT.	WT,%	ASH %
SINK-FLOAT SIZE 1.5" x 100 MESH, -100 Mesh Fraction: Weight 1.4 %, Ash 20.91%													
	1.30	40.81	6.92	11592	.01	0.23	40.81	6.92	11592	.01	0.23	100.00	11.94
1.30	1.40	52.88	11.58	10937	.01	0.25	93.69	9.55	11222	.01	0.24	59.19	15.40
1.40	1.60	2.87	24.67	9188	.03	0.18	96.56	10.00	11162	.01	0.24	6.31	47.43
1.60		3.44	66.42	3460	.12	0.14	100.00	11.94	10900	.01	0.24	3.44	66.42
SINK-FLOAT SIZE 3/8" x 100 MESH, -100 Mesh Fraction: Weight 2.5 %, Ash 14.60%													
	1.30	40.76	7.09	11704	.01	0.21	40.76	7.04	11704	.01	0.21	100.00	10.81
1.30	1.40	51.98	10.78	11072	.01	0.21	92.74	9.16	11350	.01	0.21	59.24	13.37
1.40	1.60	4.57	19.85	9916	.02	0.21	97.31	9.66	11282	.01	0.21	7.26	31.94
1.60		2.69	52.49	5008	.12	0.14	100.00	10.81	11114	.01	0.21	2.69	52.49
SINK-FLOAT SIZE 14 MESH x 0													
	1.30	47.99	7.26	11916	.01	0.24	47.99	7.26	11916	.01	0.24	100.00	10.80
1.30	1.40	47.65	12.15	10792	.01	0.22	95.64	9.70	11356	.01	0.23	52.01	14.06
1.40	1.60	3.02	24.67	9221	.01	0.22	98.66	10.15	11201	.01	0.23	4.36	34.95
1.60		1.34	58.13	4166	.12	0.16	100.00	10.80	11195	.01	0.23	1.34	58.13

All results are on Moisture Free Basis.

TABLE X

Washability Analyses of No. 2 Seam, (UA-105), Healy Creek, Usibelli Coal Mine, Nenana Coal Field, Healy, Alaska

Raw Coal Bed Moisture = 26.76%

SPECIFIC GRAVITY		ACTUAL PRODUCTS					CUMULATIVE FLOAT					CUMULATIVE SINK	
					SULFUR					SULFUR			
SINK	FLOAT	WT,%	ASH %	BTU/LB.	PYR.	TOT.	WT,%	ASH	BTU/LB.	PYR.	TOT.	WT,%	ASH %
SINK-FLOAT SIZE 1.5" x 100 MESH, -100 Mesh Fraction: Weight 0.3 %, Ash 25.78%													
	1.30	68.70	6.50	11566	.01	0.18	68.70	6.50	11566	.01	0.18	100.00	9.89
1.30	1.40	24.72	12.52	10356	.01	0.21	93.42	8.09	11246	.01	0.19	31.30	17.35
1.40	1.60	5.11	30.82	8254	.02	0.26	98.53	9.27	11091	.01	0.19	6.58	35.50
1.60		1.47	51.76	5262	.07	0.26	100.00	9.89	11005	.01	0.19	1.47	51.76
SINK-FLOAT SIZE 3/8" x 100 MESH, -100 Mesh Fraction: Weight 2.0 %, Ash 14.21%													
	1.30	63.40	5.87	11475	.01	0.16	63.40	5.87	11475	.01	0.16	100.00	9.09
1.30	1.40	27.46	10.43	10849	.02	0.20	90.86	7.25	11286	.01	0.18	36.60	14.66
1.40	1.60	7.32	23.92	9424	.02	0.27	98.18	8.49	11151	.01	0.19	9.14	27.37
1.60		1.82	41.23	6213	.05	0.26	100.00	9.09	11061	.01	0.19	1.82	41.23
SINK-FLOAT SIZE 14 MESH x 0													
	1.30	12.29	3.77	11638	.01	0.13	12.29	3.77	11638	.01	0.13	100.00	9.64
1.30	1.40	75.23	7.09	10997	.02	0.18	87.52	6.62	11087	.01	0.17	87.71	10.47
1.40	1.60	9.70	23.60	9969	.04	0.23	97.22	8.32	10975	.01	0.18	12.48	30.83
1.60		2.78	56.04	6015	.13	0.37	100.00	9.64	10837	.01	0.18	2.78	56.04

All results are on Moisture Free Basis.

TABLE XI

Washability Analyses of No. 1 Seam, (UA-106), Ober Creek, Delta Coal Company,
Jarvis Creek Field, Alaska

Raw Coal Bed Moisture = 20.58%

SPECIFIC GRAVITY		ACTUAL PRODUCTS					CUMULATIVE FLOAT					CUMULATIVE SINK	
					SULFUR					SULFUR			
SINK	FLOAT	WT,%	ASH %	BTU/LB.	PYR.	TOT.	WT,%	ASH	BTU/LB.	PYR.	TOT.	WT,%	ASH %
SINK-FLOAT SIZE 1.5" x 100 MESH -100 Mesh Fraction: Weight 0.6 %, Ash 26.92%													
	1.30	25.43	8.02	11546	0.08	0.97	25.43	8.02	11546	0.08	0.97	100.00	11.38
1.30	1.40	61.78	10.09	10882	0.38	1.36	87.21	9.49	11076	0.29	1.25	74.57	12.52
1.40	1.60	10.76	19.96	9388	0.90	1.20	97.97	10.63	10890	0.36	1.24	12.79	24.29
1.60		2.03	47.37	5798	1.11	1.24	100.00	11.38	10787	0.37	1.24	2.03	47.37
SINK-FLOAT SIZE 3/8" x 100 MESH -100 Mesh Fraction: Weight 0.6 %, Ash 26.92%													
	1.30	25.71	7.75	11554	0.08	1.01	25.71	7.75	11554	0.08	1.01	100.00	10.68
1.30	1.40	56.91	9.10	11037	0.29	1.31	82.62	8.68	11198	0.21	1.22	74.29	11.69
1.40	1.60	14.88	16.57	9902	0.86	1.02	97.50	9.88	11000	0.32	1.19	17.38	20.18
1.60		2.50	41.69	6675	1.12	2.32	100.00	10.68	10892	0.34	1.22	2.50	41.69
SINK-FLOAT SIZE 14 MESH x 0													
	1.30	2.57	8.58	12177	0.08	0.88	2.57	8.58	12177	0.08	0.80	100.00	11.09
1.30	1.40	82.29	9.42	11244	0.29	0.90	84.86	9.39	11272	.28	0.98	97.43	11.16
1.40	1.60	12.57	15.70	10169	0.92	1.98	97.43	10.21	11130	.37	1.10	15.14	20.60
1.60		2.57	44.62	6198	1.16	2.62	100.00	11.09	11003	.39	1.14	2.57	44.62

All results are on Moisture Free Basis.

TABLE XII

Washability Analyses of Lower Seam (UA-107), Castle Mountain Mine, Upper Matanuska Valley, Matanuska Coal Field, Alaska

Raw Coal Bed Moisture = 1.78%

SPECIFIC GRAVITY		ACTUAL PRODUCTS					CUMULATIVE FLOAT					CUMULATIVE SINK	
					SULFUR					SULFUR			
SINK	FLOAT	WT,%	ASH %	BTU/LB.	PYR.	TOT.	WT,%	ASH	BTU/LB.	PYR.	TOT.	WT,%	ASH %
SINK-FLOAT SIZE 1.5" x 100 MESH -100 Mesh Fraction: Weight 0.8%, Ash 27.07%													
	1.30	46.49	5.46	14712	0.02	0.51	46.49	5.46	14712	0.02	0.50	100.00	18.63
1.30	1.40	23.95	12.14	13741	0.03	0.48	70.44	7.73	14382	0.02	0.49	53.51	30.07
1.40	1.60	13.46	27.75	11262	0.05	0.43	83.90	10.94	13881	0.03	0.48	29.56	44.60
1.60		16.10	58.71	5254	0.15	0.40	100.00	18.63	12492	0.05	0.47	16.10	58.71
SINK-FLOAT SIZE 3/8" x 100 MESH -100 Mesh Fraction: Weight 2.0%, Ash 23.33%													
	1.30	40.57	7.53	14687	0.02	0.49	40.57	7.53	14687	0.02	0.49	100.00	18.89
1.30	1.40	29.49	9.40	14031	0.02	0.49	70.06	8.32	14411	0.02	0.49	59.43	26.64
1.40	1.60	13.00	25.51	11269	0.03	0.44	83.06	11.01	13919	0.02	0.48	29.94	43.63
1.60		16.94	57.52	5346	0.13	0.29	100.00	18.89	12467	0.04	0.45	16.94	57.52
SINK-FLOAT SIZE 14 MESH x 0													
	1.30	45.49	5.63	14733	0.02	0.47	45.49	5.63	14733	0.02	0.47	100.00	19.42
1.30	1.40	20.17	12.05	13592	0.03	0.49	65.66	7.60	14383	0.02	0.48	54.51	30.93
1.40	1.60	18.52	26.88	10990	0.06	0.43	84.18	11.84	13640	0.03	0.47	34.34	42.02
1.60		15.82	59.73	5017	0.18	0.29	100.00	19.42	12276	0.05	0.44	15.82	59.73

All results are on Moisture Free Basis.

TABLE XIII

Washability Analyses of Big Seam, (UA-108), Moose Creek, Premier Mine, Lower Matanuska Valley, Matanuska Coal Field, Alaska

Raw Coal Bed Moisture = 5.87%

SPECIFIC GRAVITY		ACTUAL PRODUCTS					CUMULATIVE FLOAT					CUMULATIVE SINK	
SINK	FLOAT	WT,%	ASH %	BTU/LB.	SULFUR PYR.	SULFUR TOT.	WT,%	ASH	BTU/LB.	SULFUR PYR.	SULFUR TOT.	WT,%	ASH %
SINK-FLOAT SIZE 1.5" x 100 MESH -100 Mesh Fraction: Weight 1.0 %, Ash 35.37%													
	1.30	45.49	2.82	13847	0.01	0.42	45.49	2.82	13847	0.01	0.42	100.00	15.51
1.30	1.40	21.37	9.65	12676	0.01	0.41	66.86	5.00	13473	0.01	0.42	54.51	26.10
1.40	1.60	17.94	25.29	10304	0.02	0.35	84.00	9.29	12802	0.01	0.40	33.14	36.71
1.60		15.20	50.81	6102	0.10	0.16	100.00	15.51	11784	0.03	0.36	15.20	50.81
SINK-FLOAT SIZE 3/8" x 100 MESH -100 Mesh Fraction: Weight 1.0 %, Ash 37.03%													
	1.30	46.31	3.11	13671	0.02	0.43	46.31	3.11	13671	0.02	0.43	100.00	14.80
1.30	1.40	25.52	7.77	12877	0.01	0.39	71.83	4.77	13389	0.01	0.42	53.69	24.08
1.40	1.60	12.09	20.24	9798	0.02	0.32	84.72	8.33	12843	0.02	0.40	28.77	40.39
1.60		15.28	50.66	6028	0.08	0.16	100.00	14.80	11801	0.03	0.36	15.28	50.66
SINK-FLOAT SIZE 14 MESH x 0													
	1.30	49.18	3.05	13661	0.01	0.42	49.18	3.05	13661	0.01	0.42	100.00	15.07
1.30	1.40	26.09	8.97	12825	0.01	0.42	75.27	5.10	13371	0.01	0.42	50.82	26.70
1.40	1.60	9.97	26.27	10270	0.02	0.30	85.24	7.58	13008	0.01	0.41	24.73	45.41
1.60		14.76	58.32	5359	0.07	0.16	100.00	15.07	11879	0.02	0.37	14.76	58.32

All results are on Moisture Free Basis.

Moose Seam (UA-103) is 21.6 feet thick. The sample was quite low in ash, averaging 8.9 percent. Washing of minus 14-mesh coal at 1.40 specific gravity gave a product with 8.0 percent ash at 96.9 percent yield (Table VIII).

Caribou Seam (UA-104) is 16.6 feet thick and had an ash content of 11.2 percent. Washing minus 14-mesh coal at 1.40 specific gravity yielded 95.6 percent clean coal with 9.7 percent ash and 0.23 percent sulfur (Table IX).

No. 2 Seam. No. 2 Seam (UA-105) is on Healy Creek (Figure 2). This seam is 27.8 feet thick and was mined before the mining of Moose and Caribou Seams. The sampled area of the seam was exposed for 2 years prior to sampling. Although the ash content of the raw coal was quite low, 9.5 percent, improvements were made by washing. Minus 14-mesh raw coal washed at 1.40 specific gravity yielded 87.5 percent clean coal with 6.6 percent ash and 0.17 percent sulfur (Table X).

Jarvis Creek Coal Field

The Jarvis Creek coal field has been mined sporadically for a number of years on a very small scale.

No. 1 Seam. The No. 1 Seam (UA-106) is of primary interest. It is exposed on Ober Creek and is 10 feet thick. It was sampled in an open pit off Ober Creek (Figure 6). The ash content of 14 mesh by 0 raw coal was 11.1 percent on a moisture free basis and could be upgraded by washing at 1.40 specific gravity to give a product containing 9.4 percent ash, 0.28 percent sulfur and 84.9 percent yield on a moisture free basis. The sulfur content of this seam is unusually high for an Alaskan coal, i.e., 1.20 percent. About a third of this sulfur is pyritic sulfur. Only the lowest specific gravity fraction, i.e., 1.30, showed low pyritic sulfur (Table XI).

Matanuska Coal Field

Coal was mined extensively in this area until 1968 when the Evans Jones coal mine ceased operations.

Lower Seam. This seam (UA-107) was mined in this area in the early 1960's, but mining has been discontinued due to lack of knowledge of the continuity of the beds. The sample was collected from an open pit with two exposed seams (Figure 8). It was obtained from the lower bed, which is 7 feet thick, and is probably the best known coking coal in Alaska with a free-swelling index of 8. The raw coal had 19.0 percent ash and 0.45 percent sulfur. Pyritic sulfur in this coal was low (0.05 percent) and washing would not reduce it. However, washing minus 14-mesh coal at 1.40 specific gravity reduced the ash to 7.6 percent with 65.7 percent yield (Table XII).

Big Seam. This seam (UA-108) was collected from the Premier Mine which is the only mine in this coal field that has produced coal during the past decade (Figure 9). Paul Ohmlin has been mining on a small scale to supply a domestic market. One sample was collected from an area where mining has been done within a year prior to sample collection. Since the area was highly deformed, the seam thickness could not be determined, and the sample is not necessarily a true channel sample. The raw coal averaged 15.1 percent ash and could be upgraded to 5.1 percent ash by washing minus 14-mesh coal at 1.40 specific gravity, giving a 75.3 percent yield. The coal was low in total sulfur (0.37 percent). Pyritic sulfur was very low (0.02 percent) and physical beneficiation did not significantly reduce the total sulfur content (Table XIII).

CONCLUSIONS

Subbituminous C coal from the Nenana coal field could be upgraded at high yield to produce low sulfur products ranging from slightly over 10,000 to nearly 12,000 Btu/lb on a moisture free basis. The No. 6 seam of the Usibelli coal mine, 24.8 feet thick, was sampled as three sections and the washability data showed that selective mining would be of benefit since the middle section could be mined and marketed without washing, while the other two sections could be cleaned to reduce the ash content.

The No. 1 seam subbituminous C coal sample obtained from the Jarvis Creek coal field had an unusually high total sulfur content, 1.28 percent; however, appropriate crushing and gravimetric separation could yield a 1 percent sulfur product.

The two samples, a high volatile A and a high volatile B bituminous coal, collected from the Matanuska coal field were low in total sulfur and nearly free of pyritic sulfur; however, appropriate crushing and specific gravity separation would provide significant ash reductions.

The results from this type of study are valuable in understanding and planning the use of Alaskan coals in meeting the energy needs of the nation. It is recommended that similar studies be undertaken on coal seams throughout the state that are considered of potential economic significance.

REFERENCES

1. Barnes, F. F., Coal Resources of Alaska: U.S. Geol. Survey Bull. 1232-B, 1967, p. 89.

2. McGee, D. L., Gasification Prospects and Application in Cook Inlet, Alaska, in Focus on Alaska's Coal '75: University of Alaska, Mineral Industry Research Laboratory, 1976.

3. Tailleur, I. L. and W. P. Brosge, Coal Resources of Northern Alaska May be Nation's Largest, in Focus on Alaska's Coal '75: University of Alaska, Mineral Industry Research Laboratory, 1976, p. 219-226.

4. Wahrhaftig, Clyde, C. A. Hickcox, and Jacob Freedman, Coal Deposits on Healy and Lignite Creeks, Nenana Coal Field, Alaska, in Barnes, F. F. and others, Coal Investigations in Southcentral Alaska, 1944-46: U.S. Geol. Survey Bull. 963-E, 1951, p. 141-165.

5. Wahrhaftig, Clyde, Geology and Coal Deposits of the Western Part of the Nenana Coal Field, Alaska, in Barnes, F. F. and others, Coal Investigations in Southcentral Alaska, 1944-46: U.S. Geol. Survey Bull. 963-E, 1951, p. 169-186.

6. Wahrhaftig, Clyde and Joseph H. Birmon, Stripping Coal Deposits on Lower Lignite Creek, Nenana Coal Field, Alaska: U.S. Geol. Survey Circular 310, 11 pp.

7. Wahrhaftig, Clyde, Jack A. Wolfe, Estella B. Leopold, and Marvin A. Lanphere, The Coal-Bearing Group in the Nenana Coal Field, Alaska: U.S. Geol. Survey Bull. 1274D, 1969, 30 pp.

8. Wahrhaftig, Clyde and C. A. Hickcox, Geology and Coal Deposits, Jarvis Creek Coal Field, Alaska: U.S. Geol. Survey Bull. 989-G, 1955, p. 353-367.

9. Warfield, R. S., Rotary Drilling for Strippable Coal in the Jarvis Creek Coal Field, Alaska: U.S. Bureau of Mines Open File Report 7-73, 1973, 8 pp.

10. Barnes, F. A., Mining and Exploration in 1945 in the Wishbone Hill District, Matanuska Valley, Alaska, in Barnes, F. F. and others, Coal Investigations in Southcentral Alaska, 1944-46: U.S. Geol. Survey Bull. 963-E, 1951, p. 193-201.

11. Barnes, F. F. and Thomas G. Payne, The Wishbone Hill District, Matanuska Coal Field, Alaska: U.S. Geol. Survey Bull. 1016, 1956, 88 pp.

12. Barnes, F. F., Geologic Map of Lower Matanuska Valley, Alaska, Misc. Geological Investigations Map I-359, 1962.

13. Cavallaro, J. A., M. T. Johnston, and A. W. Deurbrouck, Sulfur Reduction Potential of the Coals of the United States: U.S. Bureau of Mines Report of Investigations 8118, 1976, 323 pp.