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CHARACTERIZATION AND EVALUATION OF WASHABILITY OF ALASKAN COALS

Selected Seams from the Northern Alaska, Nulato, Eagle, Nenana, Broad pass, Kenai, Beluga, and Chignik Coal Fields

FINAL TECHNICAL REPORT FOR PHASE III

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

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ABSTRACT

This report is a result of the third part of a continuing study to obtain washability data for Alaskan coals, to supplement the efforts of the U.S. Department of Energy in their ongoing studies on washability of U.S. coals. Washability characteristics were determined for fifteen coal samples from the Northern Alaska, Nulato, Eagle, Nenana, Broad Pass, Kenai, Beluga and Chignik coal fields. The raw coals were crushed to 1-1/2 inches, 3/8 inch and 14 mesh topsizes, and float-sink separations were made at 1.30, 1.40 and 1.60 specific gravities.

The results showed that No. 3 bed coal from the Northern Alaska field can be washed to give an ultraclean product with less than 2 percent ash and 0.25 percent total sulfur for the sample crushed to 1-1/2 inches top size at 98.72 percent yield, whereas the uncorrelated bed coal from Kokolik River gave a procuct with 2.55 percent ash, 0.24 percent sulfur at 81.26 percent yield.

The sampled high volatile "A" bituminous coal seam from the Nulato coal field was only 12 inches thick and contained more than 60% ash. However, the 1.60 specific gravity float product gave a free swelling index of 9.6 and a yield of only 19 percent, containing 10 percent ash and 0.97 percent sulfur.

The sample from the Eagle field had only 0.05 percent pyritic sulfur. The sample from Coal Creek gave 13.7 percent ash at 32.7 percent yield, and the sample from Chicken gave 18.8 percent ash at 76.1 percent yield.

Three subbituminous "C" coal seams were sampled from the Nenana coal field, two of which were from Usibelli Coal Mine. Samples from numbers 1 and 3 seams can be washed at 1.60 specific gravity to give products with 10.9 percent and 9.2 percent ash respectively. Washing coal from Marguerite Creek gave a product with 10.1 percent ash.

High volatile "B" bituminous coal from Yanert Mine, Nenana coal field, gave very low recovery, however, the ash could be reduced from 53.2 to 13.6 percent by crushing to 3/8 inch top size and separating at 1.60 specific gravity.

Coal from Dunkle bed coal, Broad Pass field, gave a product with 9.0 percent ash at 87.87 percent yield.

Two subbituminous coals sampled from Kenai field gave products with acceptable ash. 1.40 specific gravity float product from Ninilchik analyzed 8.16 percent ash whereas the product from Happy Creek analyzed 9.03 percent ash. The total sulfur averaged less than 0.40 percent for both coals.

The Capps bed coal sample from the Beluga field could be upgraded to 7.5 percent and upon crushing to 3/8 inch top size and cleaning at 1.40 specific gravity.

The top 6 feet of Waterfall seam from the Beluga field contained considerable soft clay that accounted for much of the ash in the raw coal, which averaged 37.0 percent. Washing at 1.40 specific gravity gave a product analysing 8.0 percent ash.

Coal from Chignik Bay Coal Mine from the Chignik field contained 36.18 percent ash and could be washed at 1.60 specific gravity to give a product analysing 11.0 percent ash.

ACKNOWLEDGMENTS

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Several organizations helped in making sampling in remote locations possible. A field party of the U.S. Geological Survey, Anchorage, under the direction of James E. Callahan, provided lodging, helicopter support, sampling and transportation of samples. Coal Creek Mines, Inc. provided transportation for the Coal Creek sample. Usibelli Coal Co., Mr. Steve Denton in particular, helped in sampling of Nos. 1 and 3 seams. The Alaska Department of Fish and Game provided lodging and helped in the sampling of the Chignik coal. Cook Inlet Region, Inc. kindly gave permission to sample the Waterfall and Capps seams. Cooperation of Placer Amex, particularly Benno Patsch, in sampling and transportation is appreciated.

Numerous individuals helped in the sampling and transportation of coal samples. The following are the individuals that were actually involved in sampling the beds.

UA-125	Northern Alaska field – P.D. Rao, James E. Callahan, Gary Martin
UA-126	Northern Alaska field – P.D. Rao, James E. Callahan, Gary Martin
UA-128	Nulato field – P.D. Rao, Paul Metz
UA-121	Eagle field – Paul Metz, Ernest N. Wolff
UA-122	Eagle field – Paul Metz, Deborah Delong
UA-129	Nenana field – Paul Metz, Deborah Delong
UA-130	Nenana field – Paul Metz, Deborah Delong

UA-120 Nenana field - P.D. Rao, Paul Metz, Deborah Delong

UA-132 Nenana field - Paul Metz, Deborah Delong

UA-123 Broad Pass field - Paul Metz

UA-122 Kenai field - P.D. Rao, Paul Metz, Deborah Delong, Sreenivas Rao

UA-131 Kenai field - Paul Metz, Deborah Delong

UA-127 Beluga field - P.D. Rao, Benno Patsch

UA-148 Beluga field - P.D. Rao, Edward Ellwanger, Ravishankar Rao

UA-136 Chignik field - P.D. Rao, Alaska Department of Fish and Game personnel

Laboratory investigations were assisted by Edward Ellwanger, Jane Smith, Juliet Cruz, Ju-Ping Chang, John Bennet.

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.

INTRODUCTION

This is a continuing investigation of the washability of Alaskan coals. Parts I and II of the study included twenty samples from the Nenana, Jarvis Creek, Matanuska, Northern Alaska, Little Tonzona, Tramway Bar, Beluga and Kenai fields (1),(2)[1]. The current study includes 15 samples from widely separated areas from the Nenana, Eagle, Broad Pass, Northern Alaska, Beluga, Nulato, Kenai and Chignik coal fields.

Alaska has extensive coal deposits (Figure 1). Barnes (3) (4) estimates identified coal resources at 130 billion tons. Recent estimates based on oil well drill logs in Cook Inlet (5) and the North Slope (6)(7) could place the coal resources of Alaska at several trillion tons, exceeding the resources of the rest of the nation. Alaska, therefore, could possibly supply the energy needs of not only this State but the nation as well.

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 fields, accessible to the Alaska Railroad, or from the Beluga field, accessible to a deep water port. A beginning has been made by the signing of an agreement by Usibelli Coal Co. with Suneel Alaska Corporation to supply 8 million tons of coal for export to Korea between 1982 and 1992. This alone will double current output.

There are three major undesirable substances in coal: sulfur, moisture and ash. Alaskan coals are found in nonmarine formations and this accounts for the low or zero pyritic sulfur content and consequently very low total sulfur. Moisture is the most undesirable of the constituents in Alaska's subbituminous coals and it has been addressed in a separate study (8). The extent to which ash and sulfur can be reduced depends to a large extent on the form 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

Fifteen raw coal channel samples were collected for this phase of the study. In operating mines, samples were obtained from freshly exposed beds; elsewhere, fresh surfaces were exposed on outcrops of weathered coal. Six-hundred-pound samples were transported to the

[1]Underlined numbers in parentheses refer to items in the list of references at the end of this report.

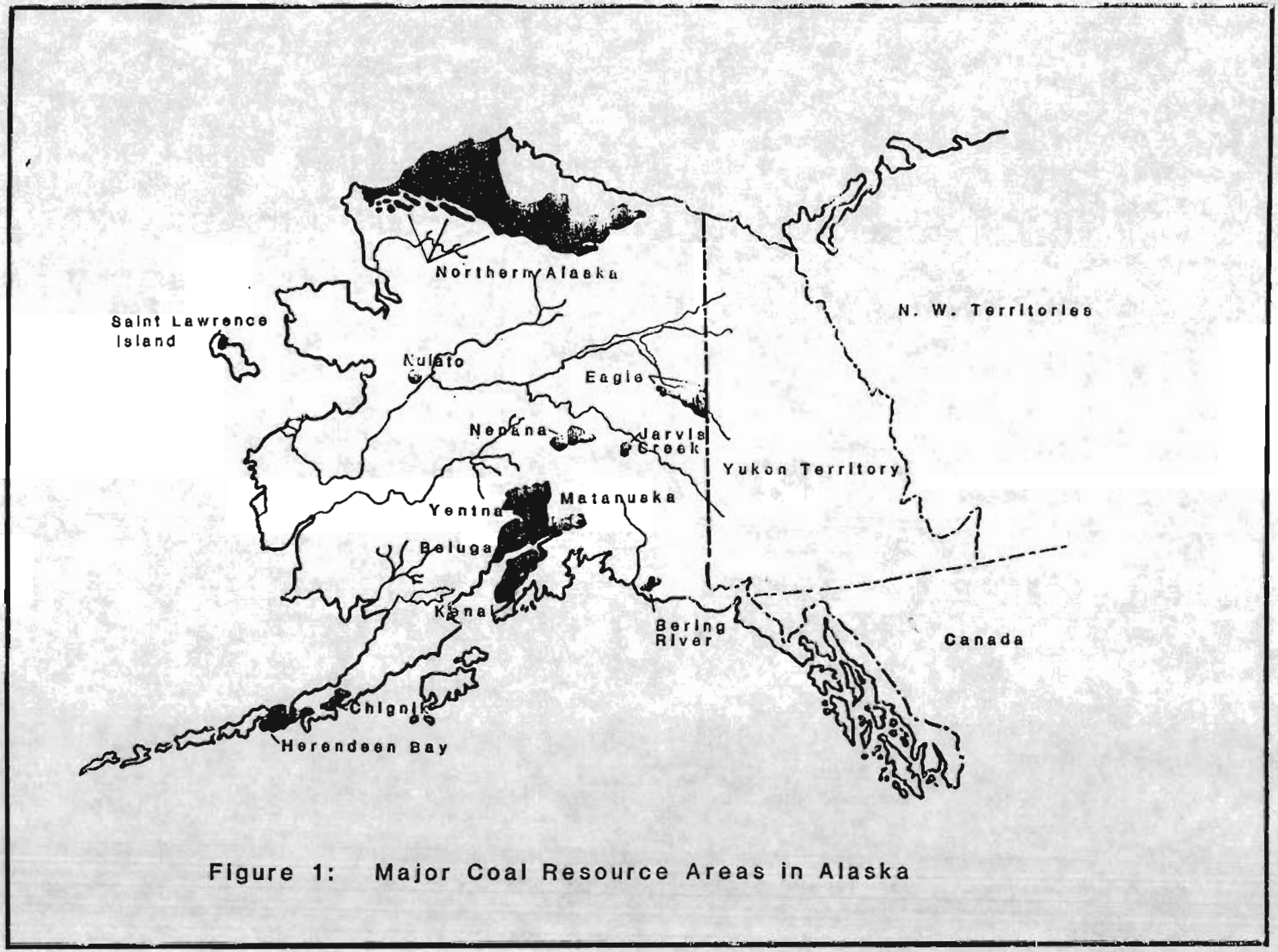

Figure 1: Major Coal Resource Areas in Alaska

laboratory in heavy duty plastic bags inside gunny sacks. The samples were obtained from the Northern Alaska, Nulato, Eagle, Nenana, Broad Pass, Kenai, Beluga and Chignik coal fields.

Northern Alaska Coal Field

The great bulk of Alaska's coal resources lie in the Northern Alaska coal field, north of the Brooks Range. Coal bearing Cretaceous rocks are known or inferred to underlie about 58,000 square miles (3)(4). Figure 2 is a generalized facies diagram by Chapman and Sable (9). They found that the coal beds in the Utukok-Corwin region, particularly those of potential economic significance, are confined almost entirely to the Corwin formation. The Cretaceous rocks include sandstone, conglomerate, siltstone, shale and coal. The Corwin formation consists predominantly of marine coal bearing rocks that intertongue with the Kukpowruk formation consisting of marine rocks. Based on outcrops along river banks, Barnes (3) subdivided the field into six districts.

1. Corwin Bluff - Cape Beaufort district
2. Kukpowruk River district
3. Kokolik - Utukok River district
4. Kuk-Kugrua Rivers district
5. Meade - Ikpikpuk Rivers district
6. Colville River district

Two coal seams were sampled from the Kokolik-Utukok River district, outcropping along the banks of Elusive Creek and Kokolik River.

A sample of coal bed 3 was obtained from the west bank of Elusive Creek (UA-125). The bed is 11.5 feet thick and has 6 feet of overburden. The bed dips away from the creek and is 5 feet above river level at the sampling point (Figures 3, 4, 5, 6).

This is bed 3 of Callahan and Martin (11). Auger samples of this bed collected by them at a depth of 30 feet or greater showed a moisture and ash free heating value of 14,381 to 14,777 Btu/lb (-P7). Assuming equilibrium moisture of say 10%, the ASTM rank of this coal would be between high volatile B and C.

A sample of uncorrelated coal bed (UA-126) was obtained from an outcrop on the west bank of the Kokolik River (Figure's 7, 8, 9, 10). The bed is 11.6 feet thick and the bottom of the bed is approximately ten feet above the river level. The seam has five feet of overburden at the outcrop.

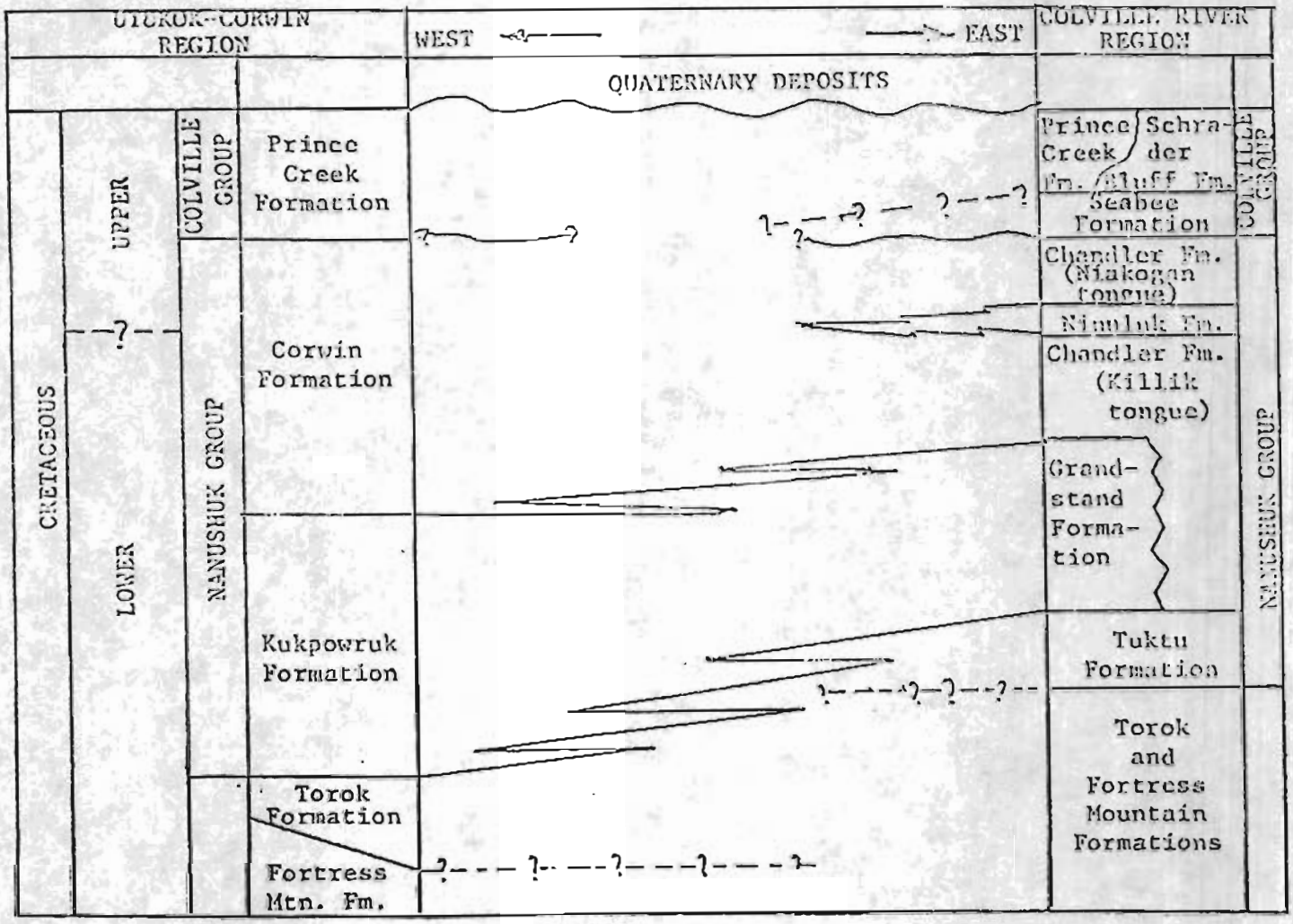

Figure 2: Generalized stratigraphic correlations of Cretaceous rocks of the Northern Alaska Field. Wavy lines represent unconformities. Chapman and Sable (1960, p.70).

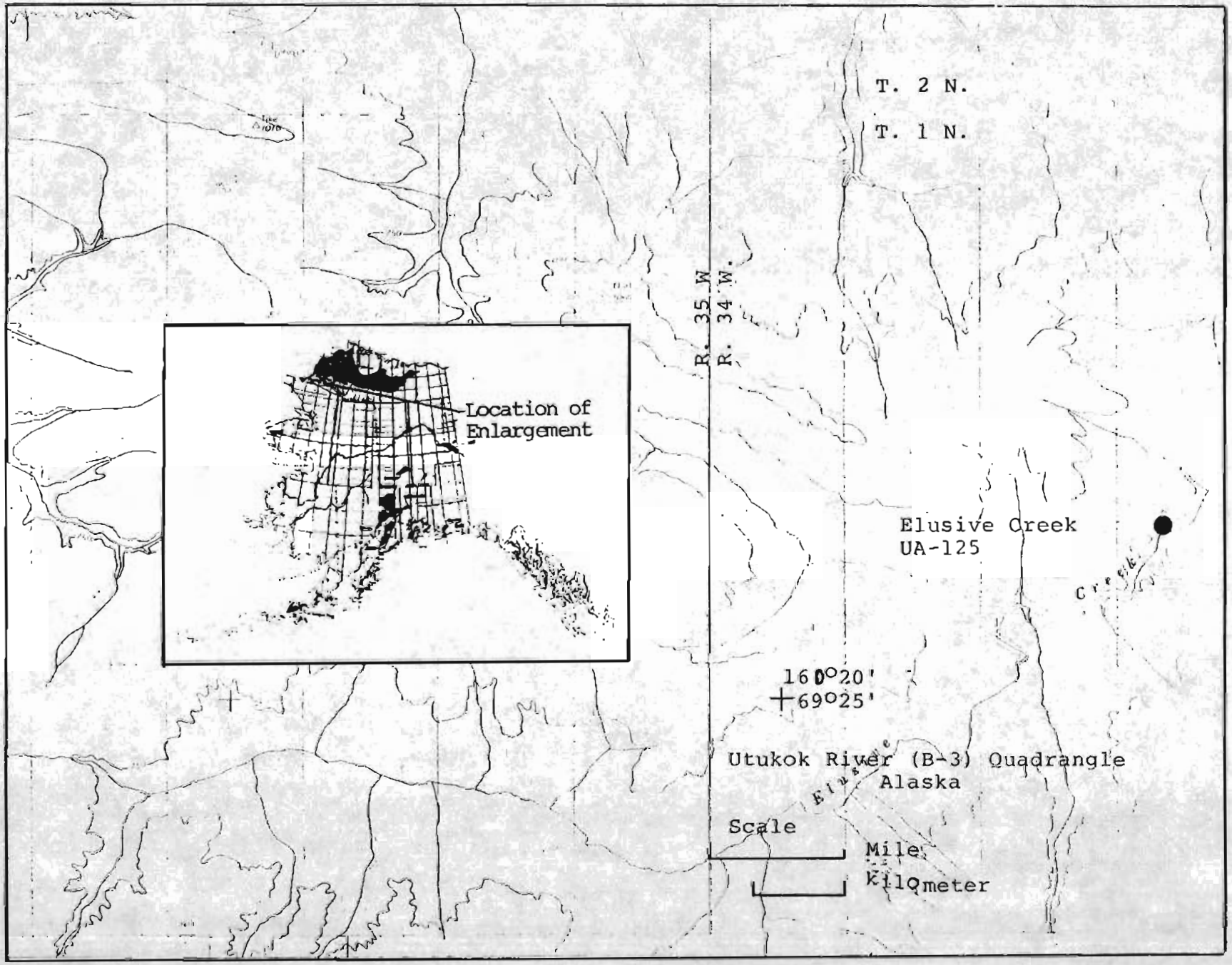

Figure 3 : Location of Sampling Site on the Elusive Creek, Northern Alaska Field

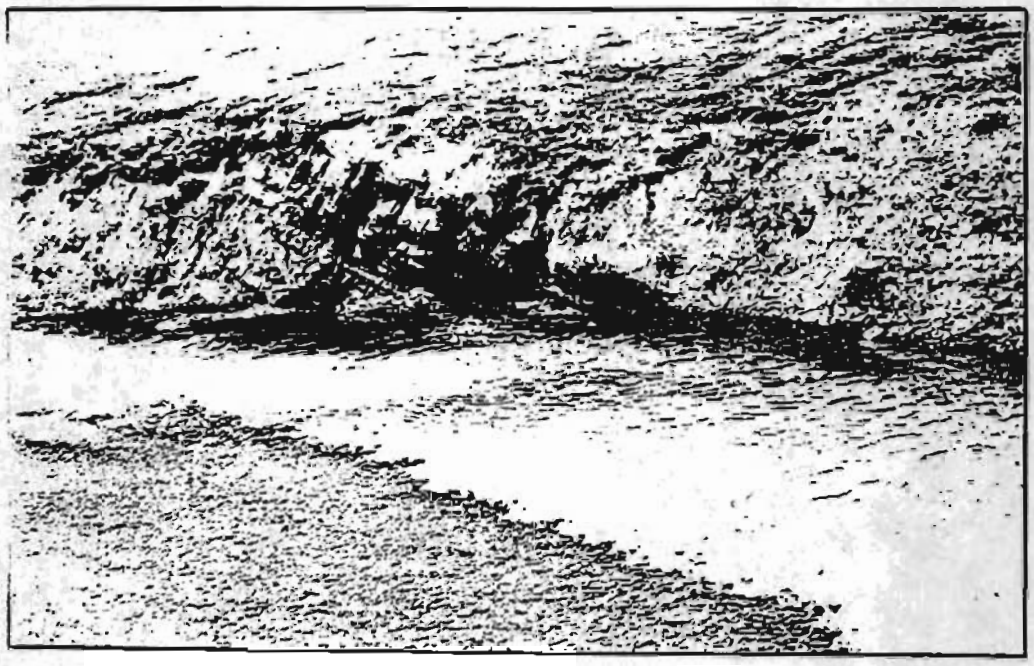

Figure 4. Aerial view of coal outcrop on Elusive Creek.

Figure 5. A closeup view of coal outcrop on Elusive Creek. James E. Callahan (left) and Gary Martin, both of U.S.G.S.

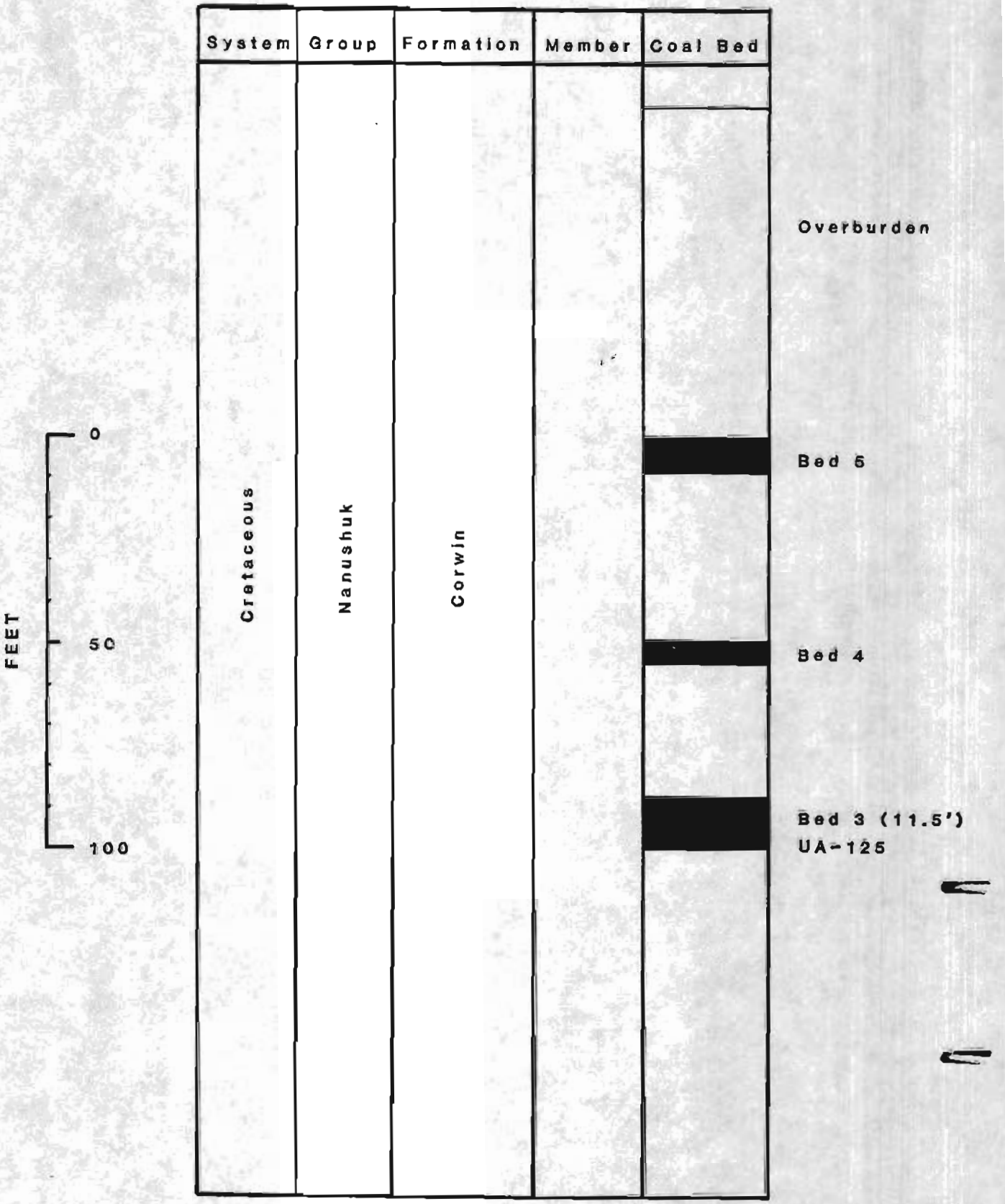

FIGURE 6: Geological column showing mineable coal beds on Elusive Creek, Northern Alaska Field.

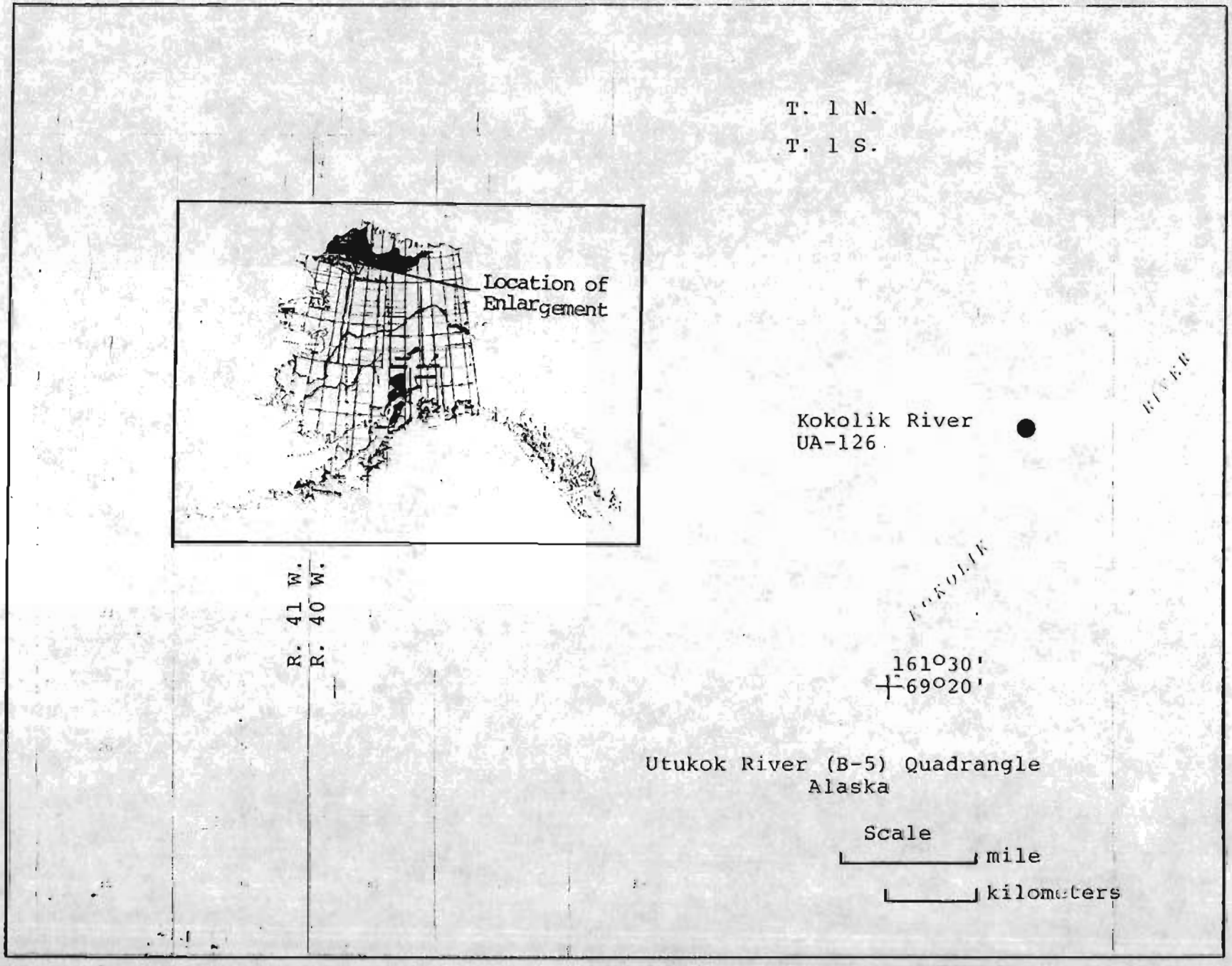

Figure 7 : Location of Sampling Site on the Kokolik River, Northern Alaska Field

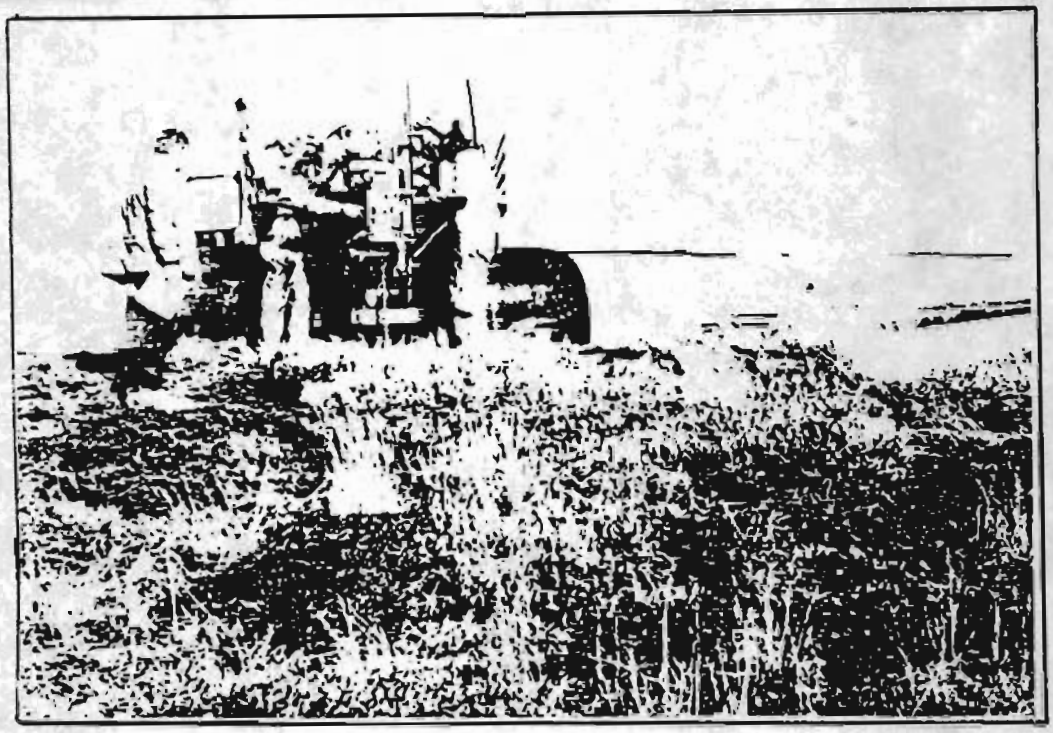

Figure 8. Auger sampling of coal seams by U.S. Geological Surveys crews in the National Petroleum Reserve in Alaska. Coal dug by ground squirrels may be seen in the foreground, and is used to locate outcrops hidden under tundra from air.

Figure 9. A closeup view of coal outcrop on Kokolik River.

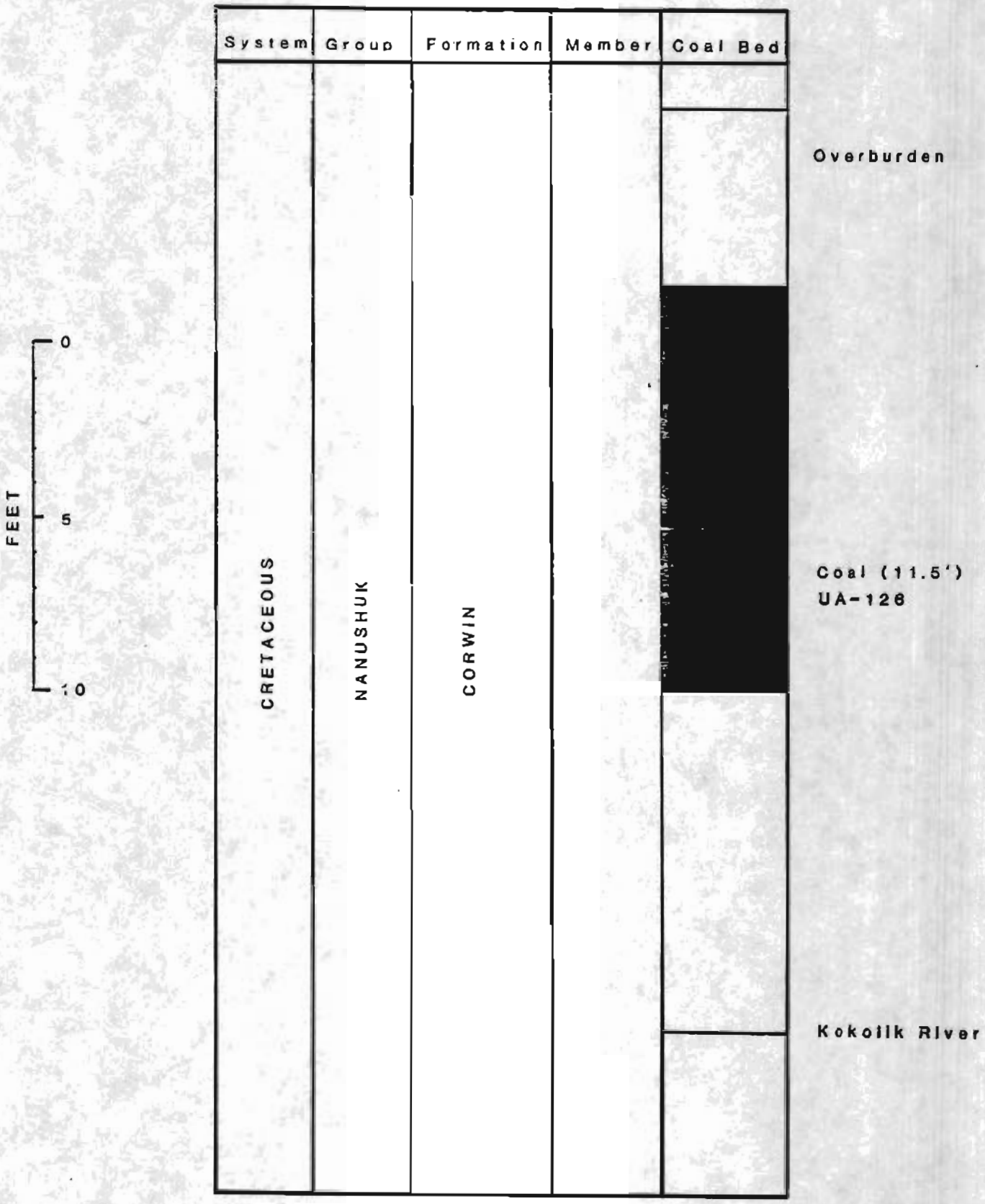

FIGURE 10: Geological column showing mineable coal bed on the Kokolik River, Northern Alaska Field.

The location of this sample is approximately the same as the one used by the U.S. Bureau of Mines in their 1964 sampling and is equivalent to their sample No. 14 (10) and sample No. SS-75-55 of Callahan and Sloan (12 P. 21). Martin and Callahan (13) estimate hypothetical coal resources of the Nanushuk group in the coastal plain and northernmost part of the foothills of the National Petroleum Reserve in Alaska (NPRA) to be 848 billion tons. The estimate does not include resources west of NPRA, and is based on meagre available surface exposures, tracing outcrops with auger holes and seismic record sections.

Nulato Coal Field

Collier was the first to make a systematic study of the coal occurrences along the Yukon River (14), which were subsequently reviewed by Martin (15), Smith and Eakin (16) and Chapman (17). Coal has been mined or identified at several localities along the Yukon River between Ruby and Anvik. Coal is found in the upper unit of the interior facies, which is nonmarine and is equivalent to the Kaltag formation of Martin.

The Pickart mine, one of the earliest mines on the Yukon River, was started by the Pickart Brothers in 1898, it was abandoned in 1902 after the gangway had been extended about 600 feet on account of "rolls" in the floor which cut off the coal. In 1944 Chapman could find neither the coal bed nor evidence of the mine. The senior author of this paper too was unsuccessful in finding any remains of the Pickart mine. However, in the general vicinity, a 12 inch thick coal seam was located on the cliff. This seam was variable in thickness and pinched out laterally. This seam was sampled to provide an indication of quality and rank of the coal (UA-128, Figure 11). Additional geological investigations are needed beyond the river bluffs, although the thick vegetation cover and lack of outcrops makes geological exploration expensive.

Eagle Coal Field

Coal bearing rocks of probable early Tertiary age underlie a two to ten mile wide belt along the Yukon River from the Canadian border northwestward for about 80 miles (Brabb and Churkin, 1964). Coal outcrops at numerous localities in the region. One seam was sampled at coal creek (UA-121, Figure 12). Another seam was sampled at Chicken (UA-124), which is about 50 miles south of Eagle-Circle district proper (Figure 13). The seam is described by Mertie (19) as being 22 feet thick and was opened by a 35 ft. shaft. The mine was caved in and abandoned when Barnes (3) visited in 1956. For the washability program, 5.5 feet of the seam was uncovered and sampled. The rest of the seam was sloughed in and was inaccessible for sampling. The coal bearing rocks at Chicken probably underlie only a few square miles. They have been assigned a Tertiary age on the basis of lithology (Barnes, 3).

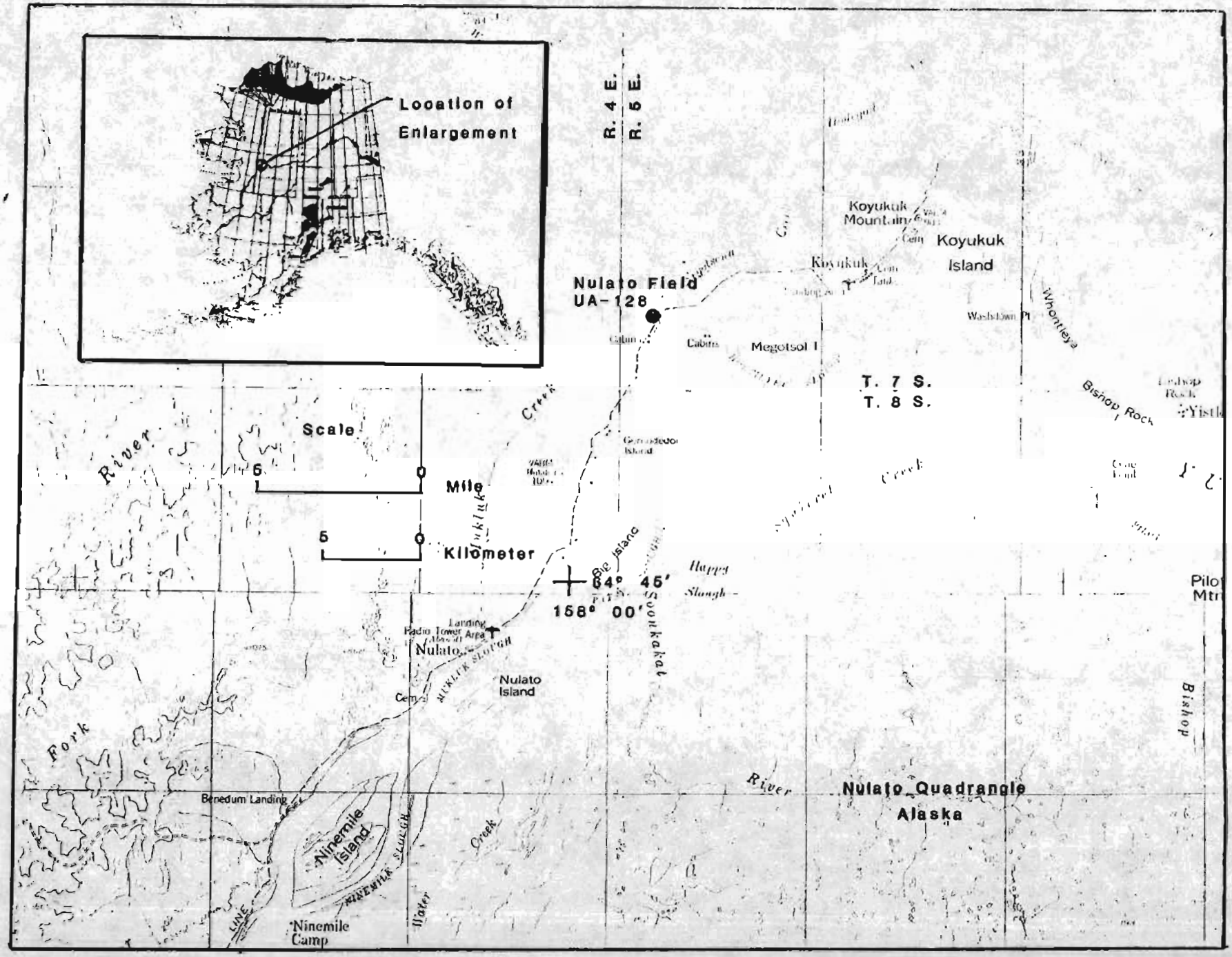

Figure 11: Location of Sampling Site at the Nulato Field

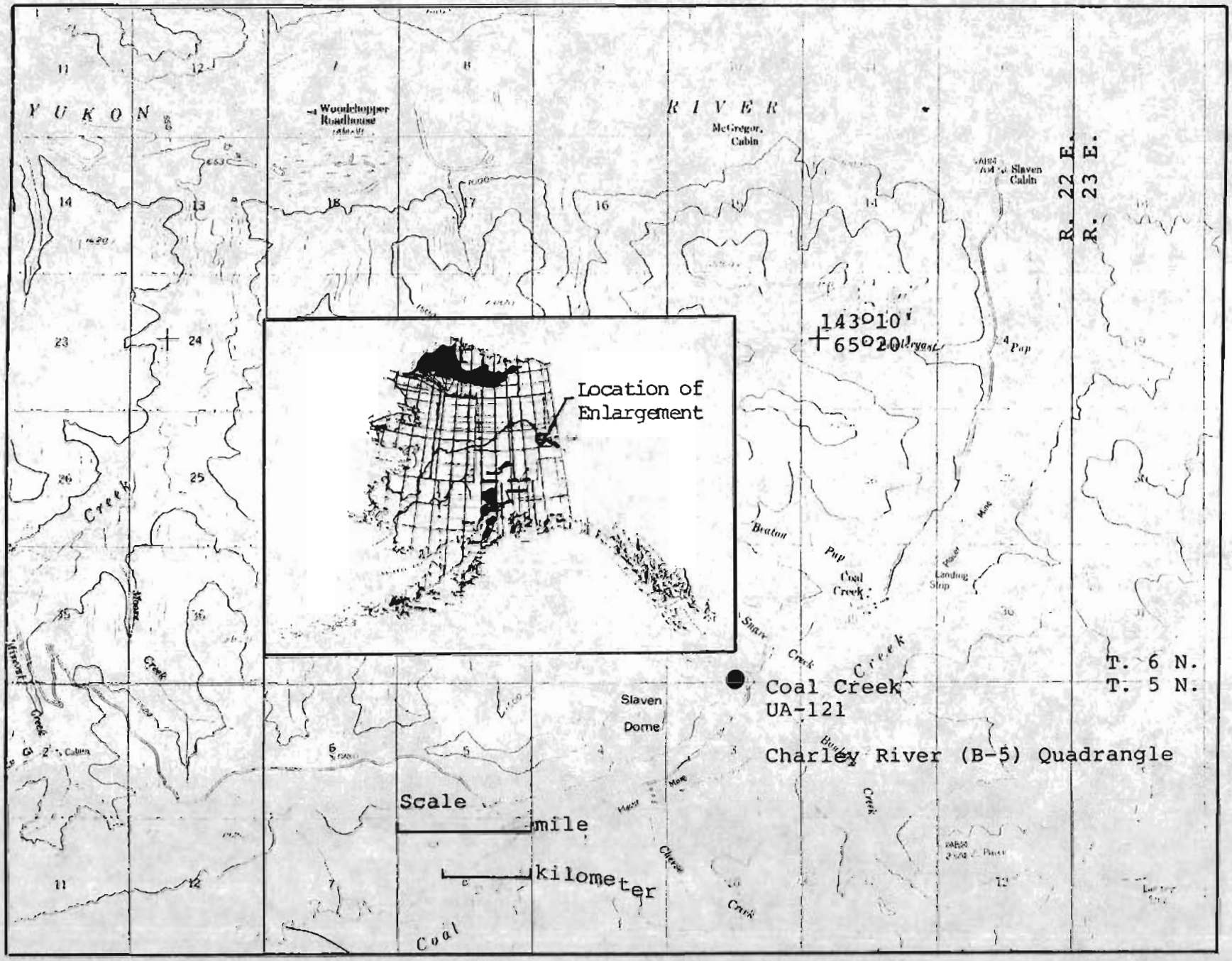

Figure 12 : Location of Sampling Site on Coal Creek in the Eagle Coal Field

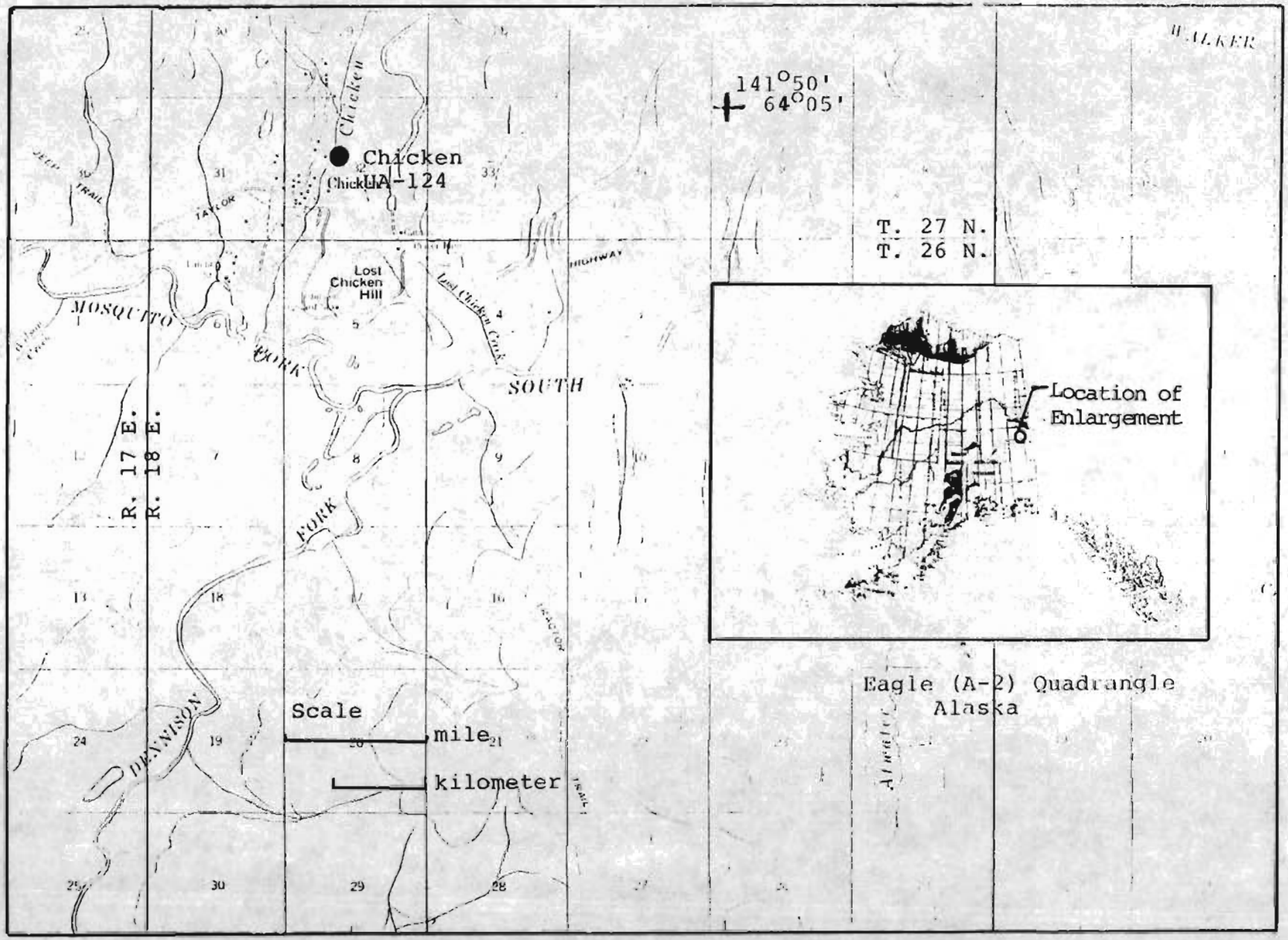

Figure 13 : Location of Sampling Site near Chicken, in the Forty Mile District

Nenana Coal Field

The Nenana coal field is located about 110 miles south of Fairbanks on the Parks Highway at Healy. The field extends 80 miles in an east-west direction and is one to thirty miles wide (20) (21) (22). The coal bearing formation consists of sandstones, siltstones, claystone, shale and numerous thick coal beds, and is divided into five formations by Wahrhaftig et al. (23). Figure 14 is a generalized geological section showing coal beds exposed at Lower Lignite Creek (Figure 15).

Barnes (3) estimates the original resources of the Nenana field at seven billion tons, of which three billion tons are on Lignite Creek. Accurate estimates of recoverable reserves for individual seams are not available. Total proven reserves in the Lower Lignite Creek area are 80 million tons with a resource potential of 250 million tons (24).

The Lower Lignite Creek Basin, which extends three miles in an east-west direction and is three miles wide, is the site of the current mining of Usibelli Coal Mine. Mineable coal beds are restricted to Suntrana formation. The bulk of the coal resources are contained in seams six (21 feet) four (21 feet) and three (17 feet). No. 2 seam is of poor quality and No. 1 seam has clay and bone parting (Denton, 24). Washability studies for seams 6 and 4 have been published (Rao 1,2). Samples of No. 1 seam (UA-129) and No. 3 seam (UA-130) were collected for this study. Sample UA-120 is from a 30.5 feet thick seam outcropping on a bluff (Figure 16) along Marguerite Creek west of Jumbo Dome. Although this seam occurs in the Suntrana formation, correlation to other seams along Lignite Creek has not been established. Sample No. UA-132 was collected from the Yanert mine (Figure 17). This seam has not been correlated with other seams in the Nenana field.

Broad Pass Coal Field

The Broad Pass coal field is located near Broad Pass station, 166 miles south of Fairbanks on the Alaska Railroad and Parks Highway. The field may be divided into two basins. Coal Creek basin is located on the east side of the Alaska Railroad and lies in an area three miles long and one mile wide. About 1-1/2 square miles are known to be underlain by coal bearing rocks. Washability of coal from a seam from this basin has been reported (2). The Costello Creek Basin (25) is on the west side of the railroad and covers about seven square miles. Coal occurs in Tertiary sequences of sandstone and claystones. There are three mineable coal beds in this basin, i.e. the Dunkle bed (5 feet thick) Lower Billie bed (3.4 feet thick) and Upper Billie bed (3.9 feet thick). Coal was mined from this basin until the early 1950's at the Dunkle Mine (Figure 18). Analyses of shipped coal samples reported by Wahrhaftig indicated the coal to be of subbituminous rank. The Dunkle bed was sampled for this study (UA-123).

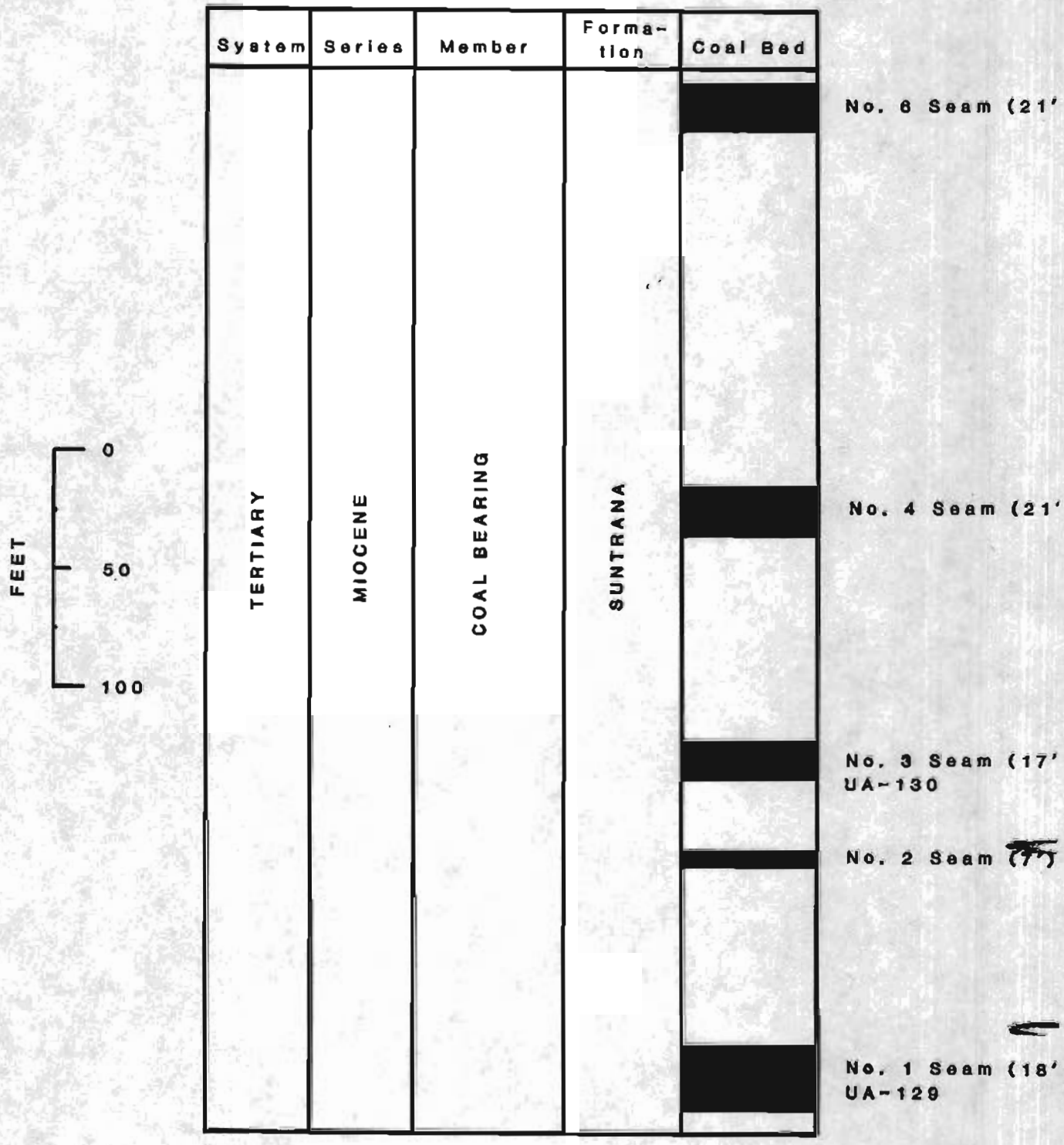

FIGURE 14: Geological column showing mineable coal beds at the Poker Flat Pit, Usibelli Coal Mine, Nenana Coal Field.

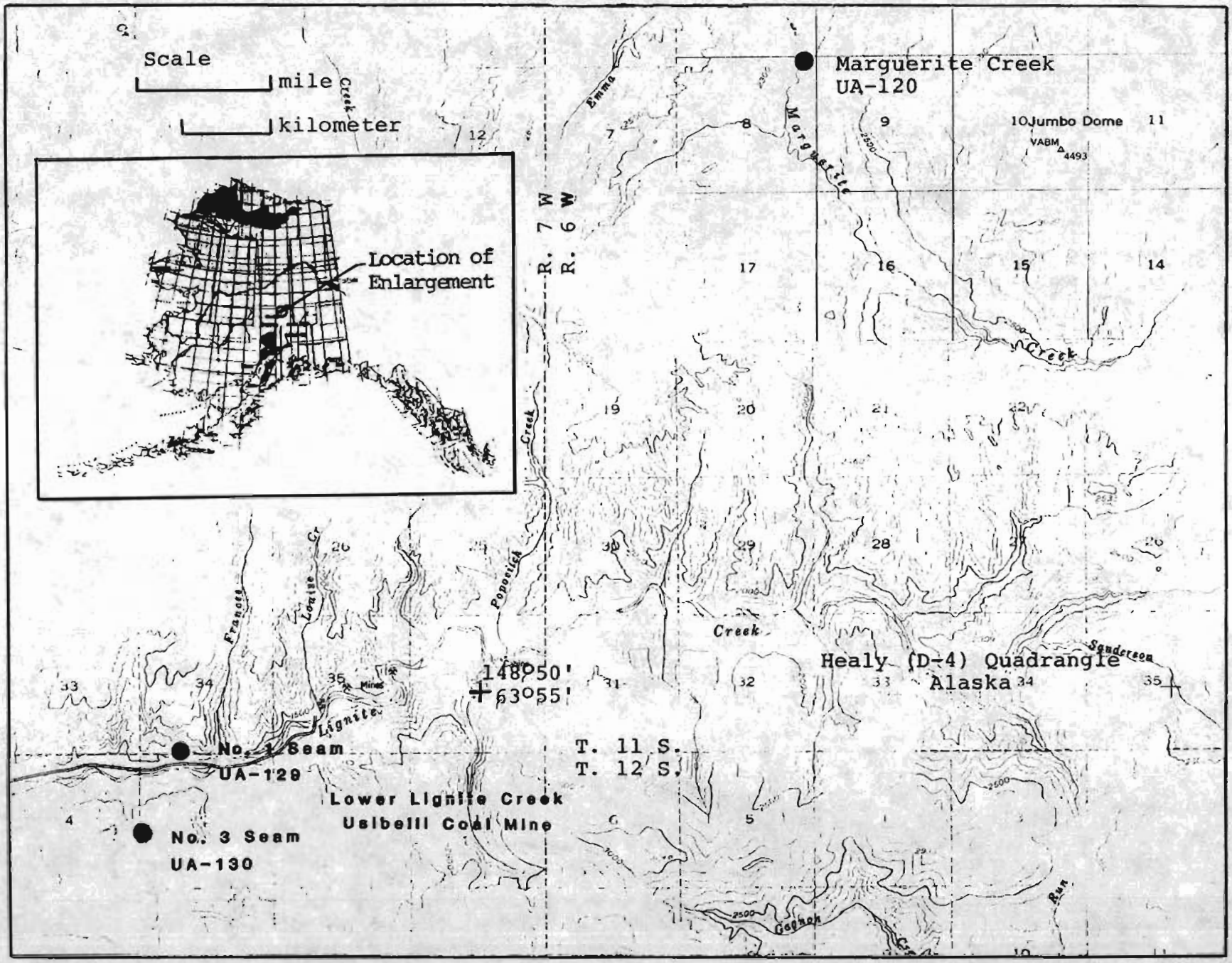

Figure 15 : Location of Sampling Sites on Lignite and Marguerite Creeks, Nenana Coal Field

Figure 16. Outcrop of coal on Marguerite Creek. The outcrop faces Jumbo Dome.

COOK INLET SEDIMENTARY BASIN

Nonmarine sedimentary rocks of the Cook Inlet basin exceed 18,000 feet in thickness, and in some parts of the basin they may extend to 27,000 feet. The rocks outcrop as far north as the Peters Hills and continue south to Homer, forming a belt 200 miles long and 70 miles wide. Although these formations were known to be coal bearing since the early 1900's, recent discoveries of petroleum and gas sparked intensive drilling that resulted in a greater understanding of the geology of these Tertiary rocks.

Figure 19 shows stratigraphic nomenclature as proposed by Calderwood and Fackler (26), and modified and updated by Magoon et al. (27). It will be noted that coal seams of possible commercial value are restricted to the Tyonek and Beluga Formations. Figure 19 also shows approximate updated stages of Seldovian, Homerian and Clamgulchian

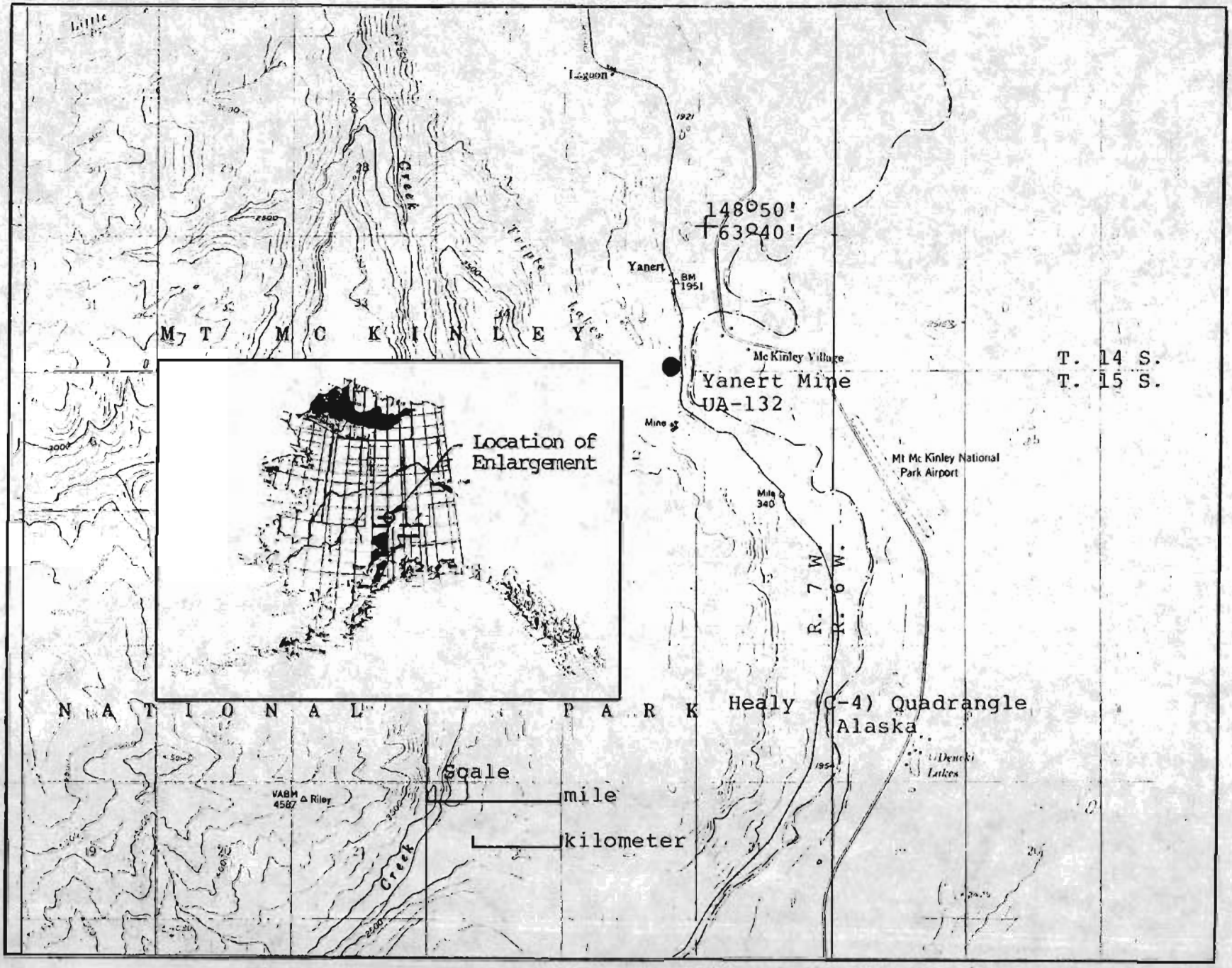

Figure 17 : Location of Sampling Site at the Yanert Mine, Nenana Coal Field

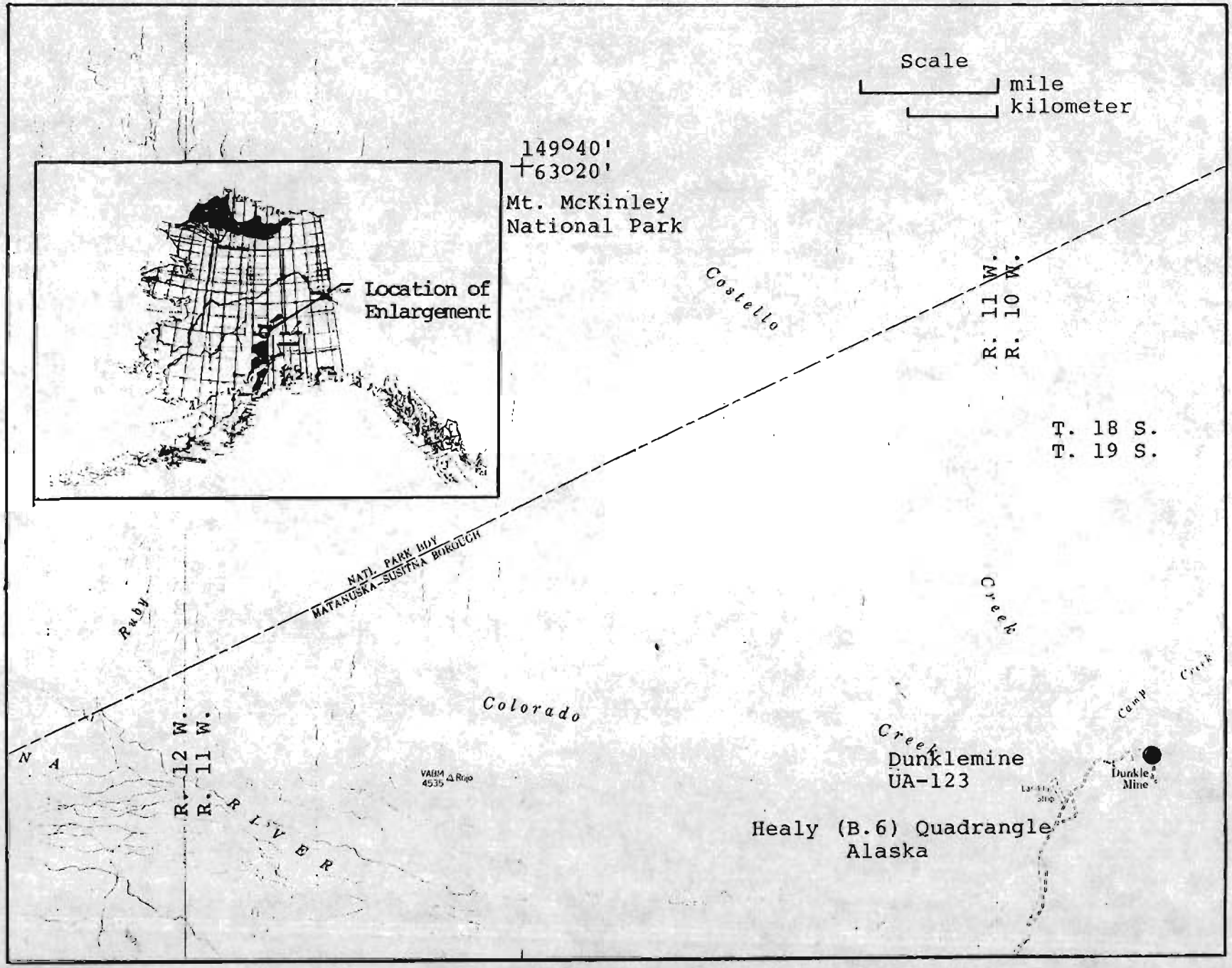

Figure 18 : Location of Sampling Site at the Dunkle Mine, Broad Pass Coal Field

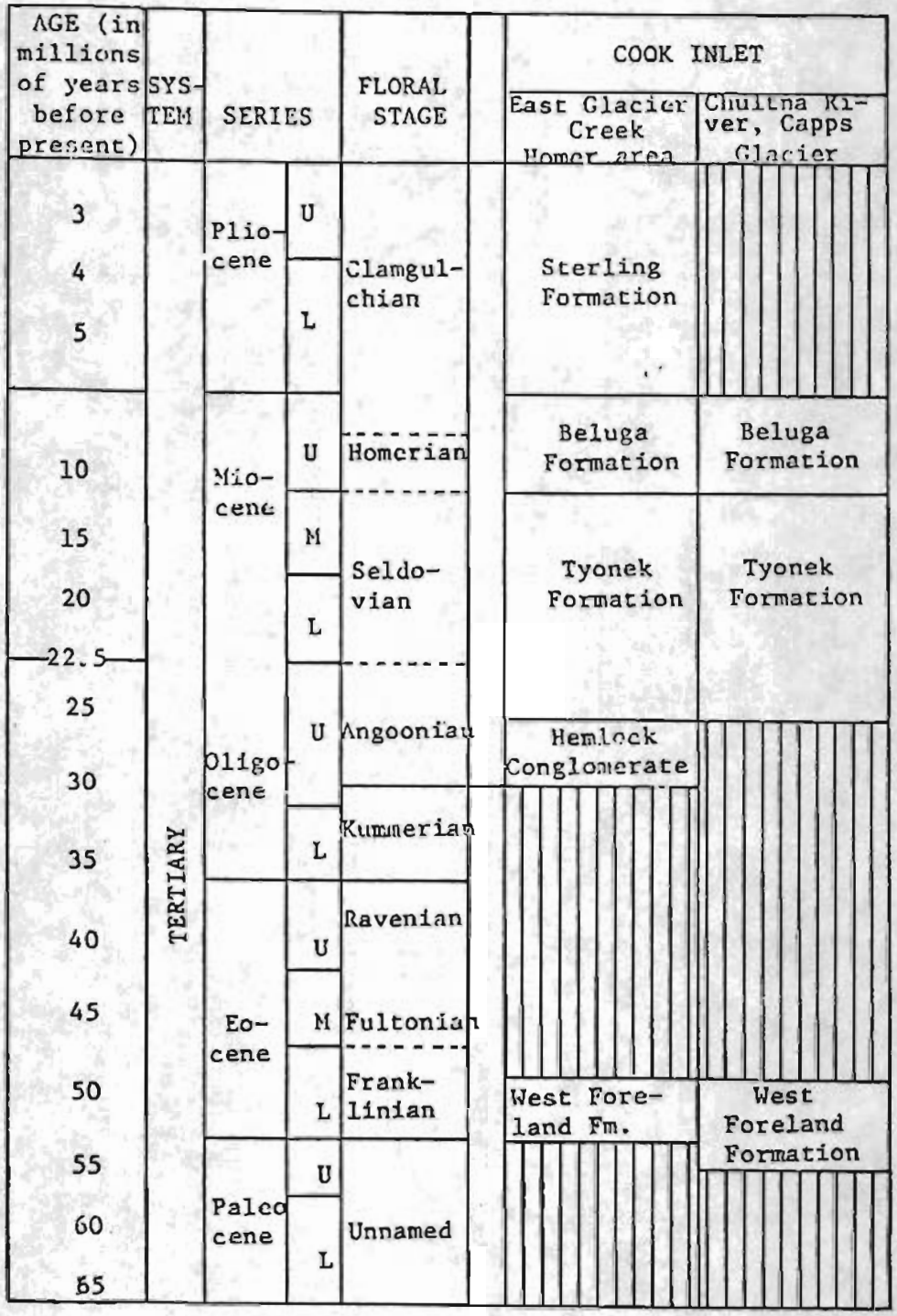

Figure 19: Correlation of Tertiary rocks in the Cook Inlet Basin (Source: Magoon, Adkison and Egbert, 1976)

stages identified by Wolf et al. (28) from paleobotanical and palynological evidence along with age determinations.

From purely geographical considerations, the sedimentary basin is divided into three coal fields: Kenai, Beluga and Yentna.

The coal is of Tertiary age and is limited to the Kenai group (formerly Kenai Formation). Coal is interbedded with coarse to fine grained sandstone, siltstones and occasional conglomerates. The Kenai Group is subdivided into four formations which include the Hemlock Conglomerate, Tyonek, Beluga and Sterling Formations.

Kenai Coal Field

Much of the Kenai lowland is underlain by coal bearing rocks. Coal exposures are found extensively on steep bluffs along the east shore of Cook Inlet, rising at places to 200 feet above the beach (29). Barnes and Cobb (30) made a detailed study of those outcrops and made extensive sections of these exposures. The beds are not massive, however, Barnes identified at least 30 beds ranging in thickness from three to seven feet.

Coal has been mined in the Homer district since 1888. There has been no mining since 1951 when the Homer Coal Corporation ceased operations. Some residents of the Homer area still collect coal from the beach for domestic use, particularly after a severe storm. Two seams were sampled, one at Ninilchik (UA-122, Figure 20) and one at Happy Creek (UA-131), located on Figures 21 and 22.

Beluga Coal Field

Barnes (31) defined the Beluga-Yentna region as the broad lowland west of the lower Susitna River, bounded on the north and west by the Alaska Range and on the south by Upper Cook Inlet and the Chakachatna River. The Beluga coal field is part of the Cook Inlet sedimentary basin and is located approximately 60 miles west of Anchorage on the northwest shore of Cook Inlet. The field can be subdivided into three coal bearing regions. Region 1, the Three Mile Creek Basin, located about six miles from Cook Inlet, contains approximately 22 steeply dipping seams averaging 10 feet in thickness. Region 2, the Chuitna Basin, is located about 17 miles from Cook Inlet. There are five mineable coal beds, one of which exceeds 40 feet in thickness, outcropping along the Chuitna River. Region 3, the Capps Basin, lies 26 miles from Cook Inlet. This area has two beds in the Tyonek formation (Figures 23, 24), the Upper Capps bed (UA-127) with an average thickness of 17 feet, and the Waterfall bed (Capps bed of Barnes) with an aggregate thickness from 20-49 feet (Figure 23). The latter is 36 feet thick at the sampling location (Figure 25). In the bottom 30 feet a relatively lower ash coal has been studied for washability and reported (2). The top 6 feet is dirtier, with a one foot band of clay in the middle, and was therefore sampled separately (UA-148). Figure 26 shows the two portions of the seam, excavated in two benches.

Figure 20. Coal outcrop near Ninilchik, with underclays washed out by wave action, forming a natural cave with coal as resistant roof.

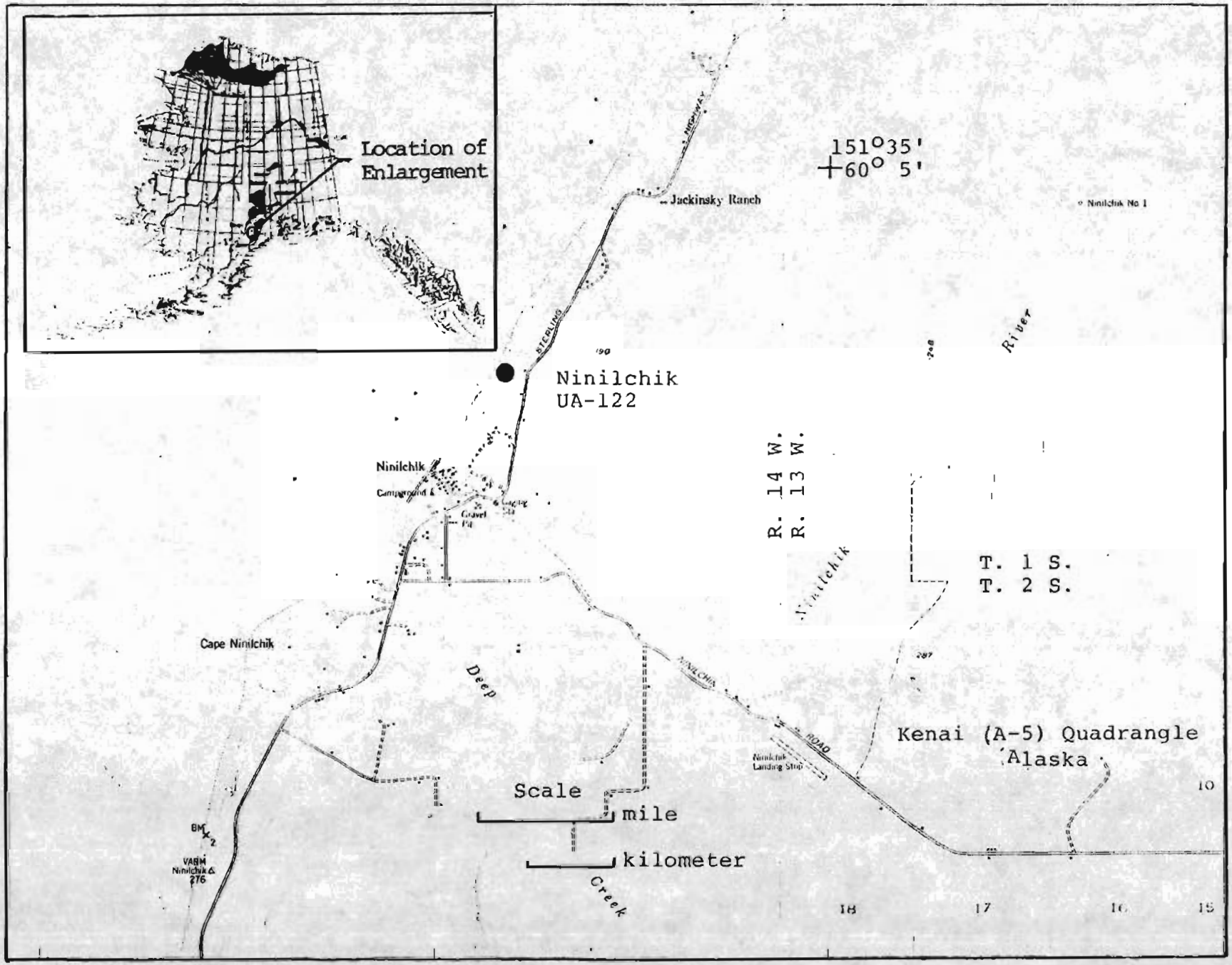

Figure 21 : Location of Sampling Site near Ninilchik, Kenai Coal Field

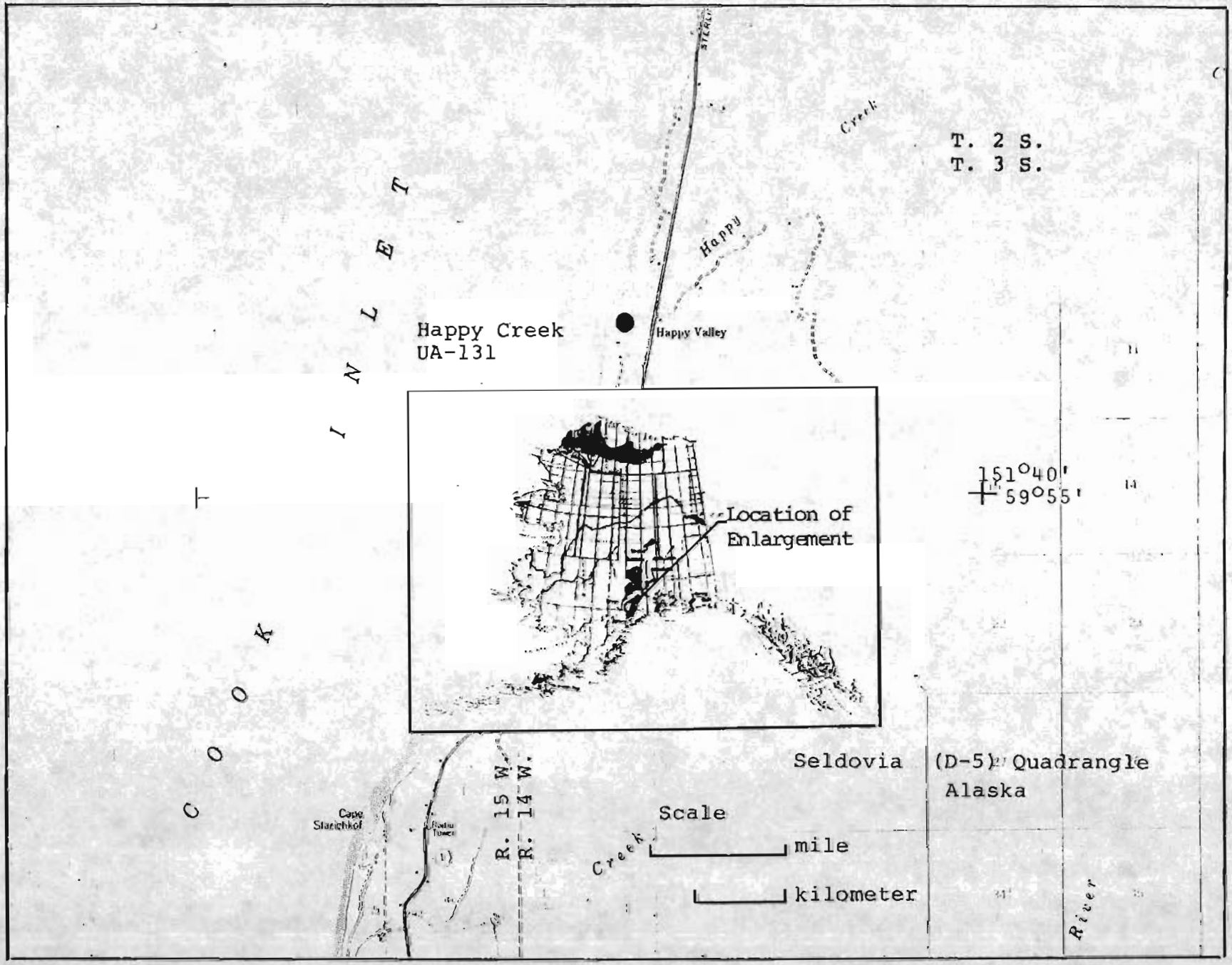

Figure 22 : Location of Sampling Site on Happy Creek, Kenai Coal Field

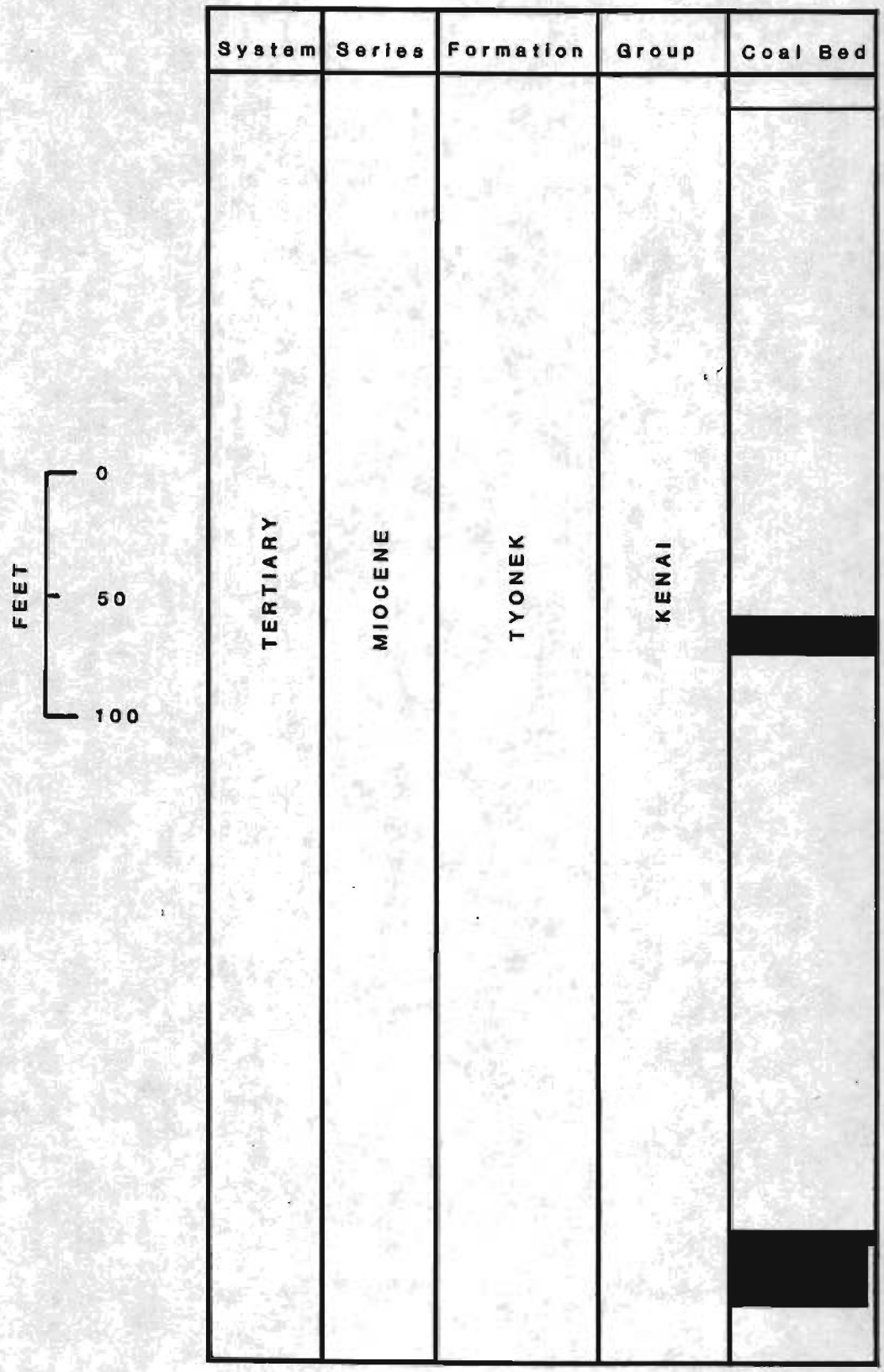

FIGURE 23: Geological column showing mineable coal beds in the Capps Basin of the Beluga Coal Field.

CAPPS AREA

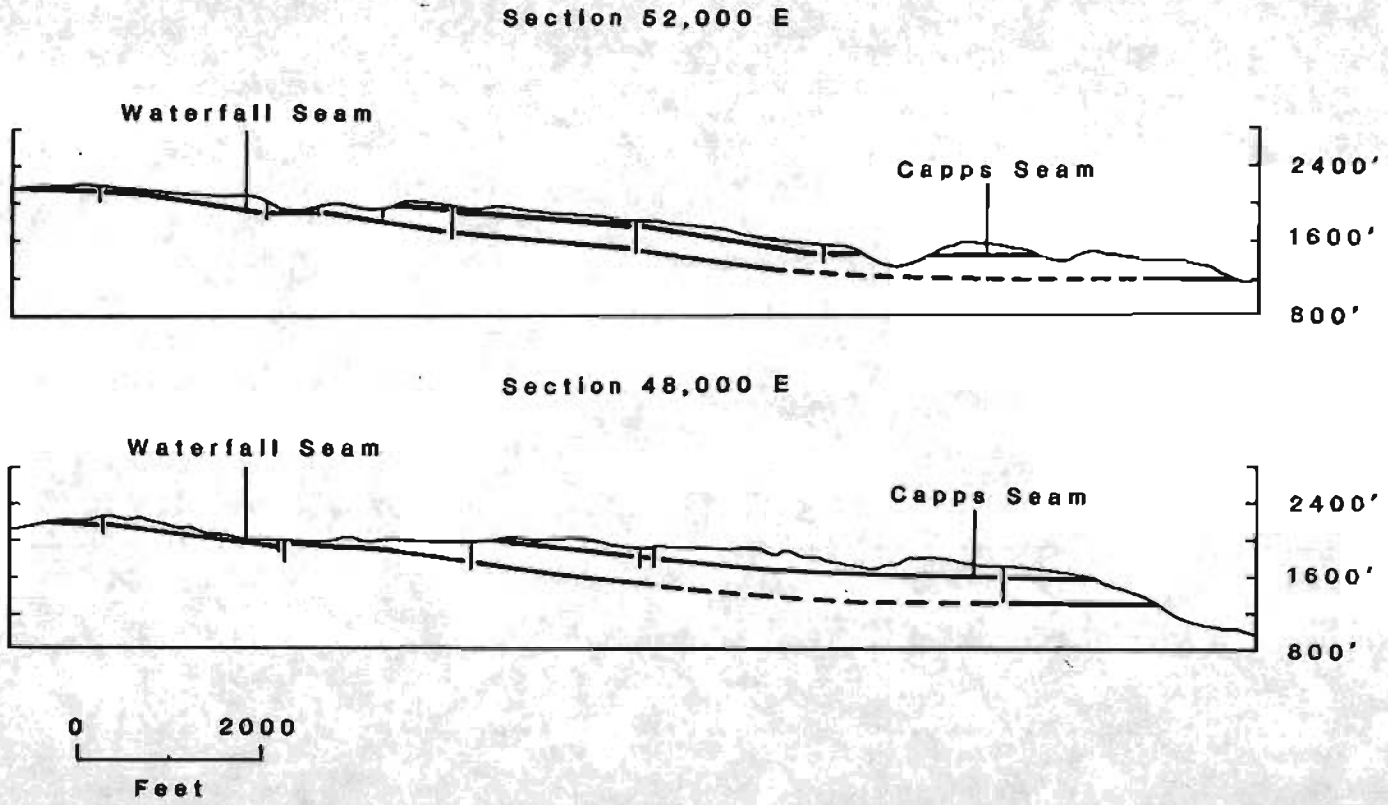

Figure 24 : Capps Coal Field - Cross Section

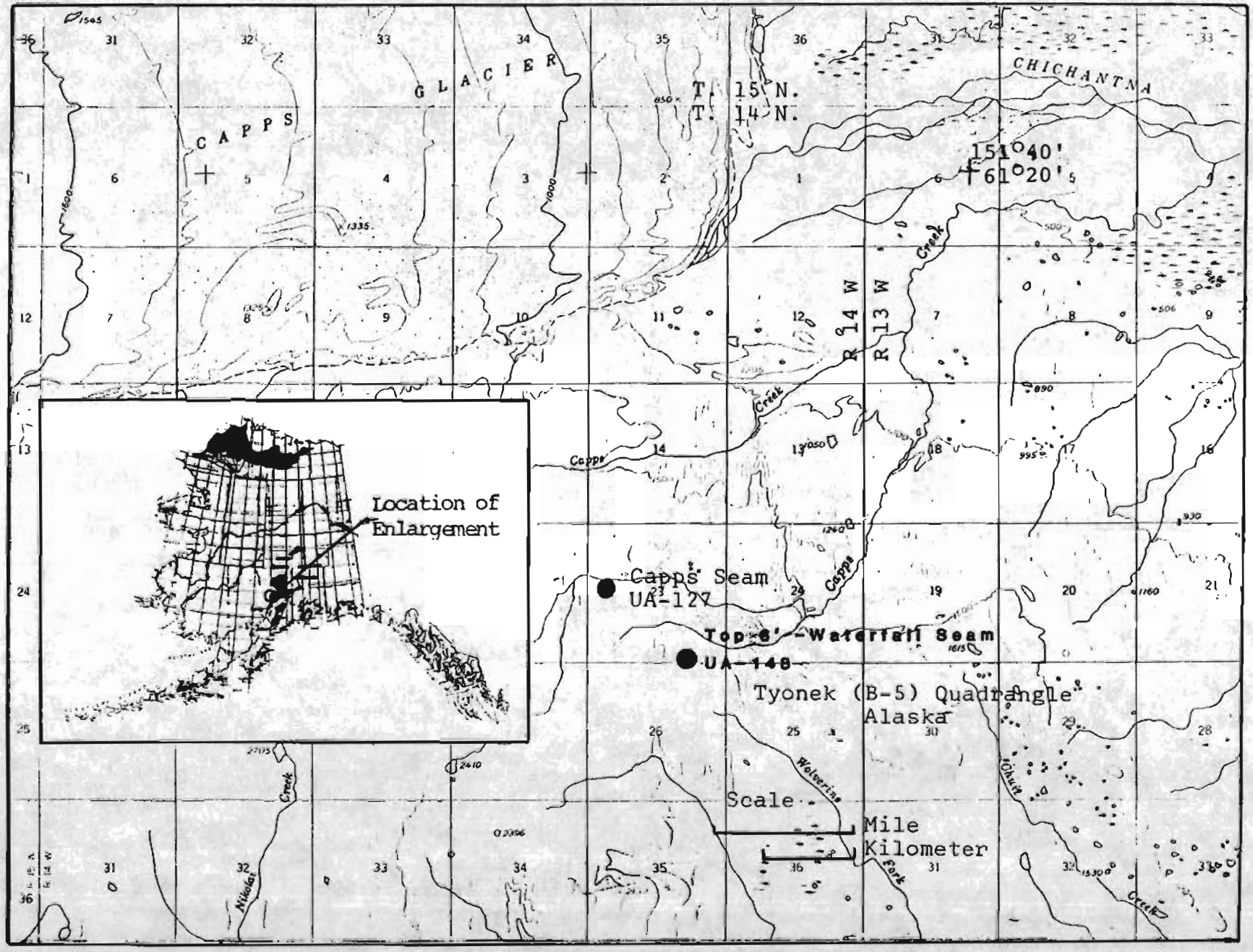

Figure 25 : Location of Sampling Site in the Capps Basin of the Beluga Coal Field

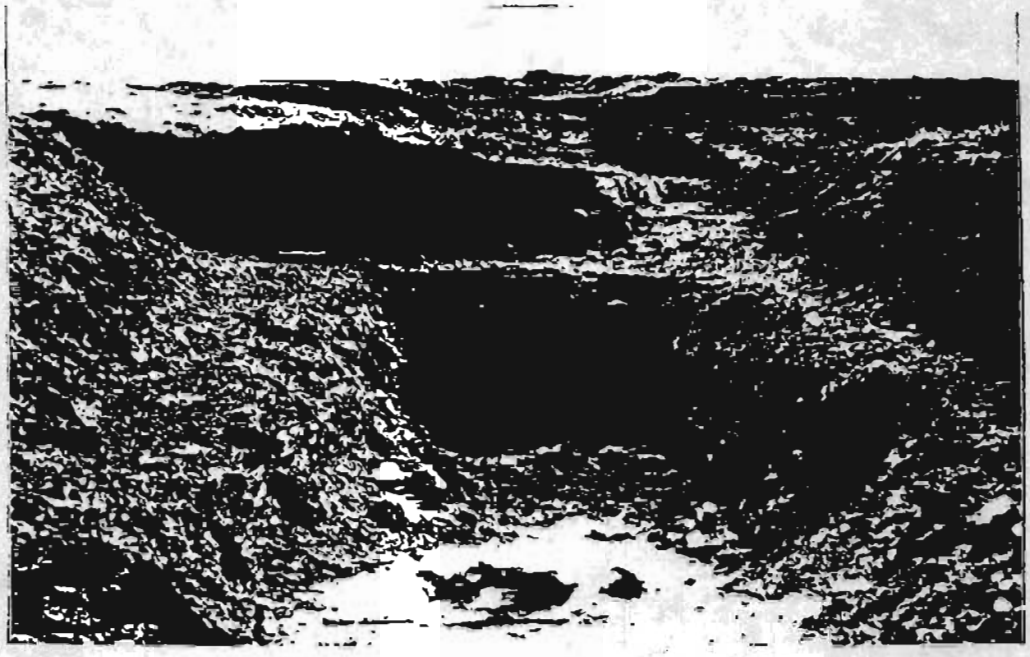

Figure 26. A subcrop of the Waterfall seam opened up in benches by Placer Amex for bulk sampling. The lower 30 foot bench and the upper 6 foot bench are distinguishable.

The Beluga Coal Company, a subsidiary of Placer Amex, holds State of Alaska coal leases in all three basins, for a total area of 400 square miles. Barnes estimates the indicated reserves in the 400 square mile area south of Beluga Lake at 200 million tons.

According to the Beluga Coal Company, mineable reserves in their leased area (32) of the Capps and Waterfall beds are estimated at 200 million tons, at a stripping ratio of 5 to 1.

Alaska Peninsula

Chignik Coal Field

Coal has been reported at several localities in the Alaska Peninsula, and actually mined at Herendeen Bay, Chignik and Unga Island. The sample for this study was collected from the mine tunnel of the Chignik River mine (UA-136, Figure 27) that operated from 1893 to 1911, providing fuel for the nearby Alaska Packers Association Cannery. Coal is found in the Chignik formation of Upper Cretaceous age (Figure 28).

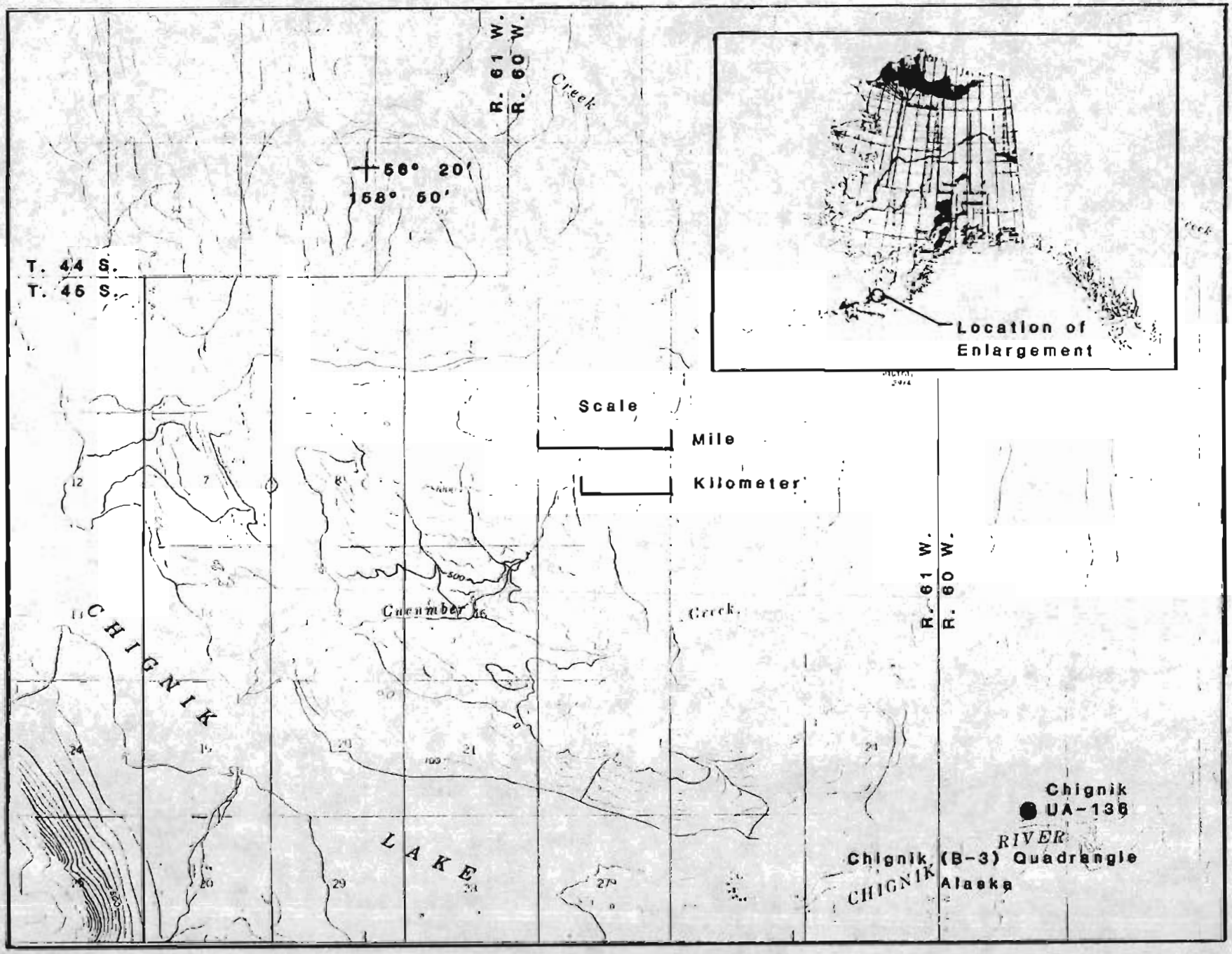

Figure 27 : Location of Sampling Site at the Chignik Field

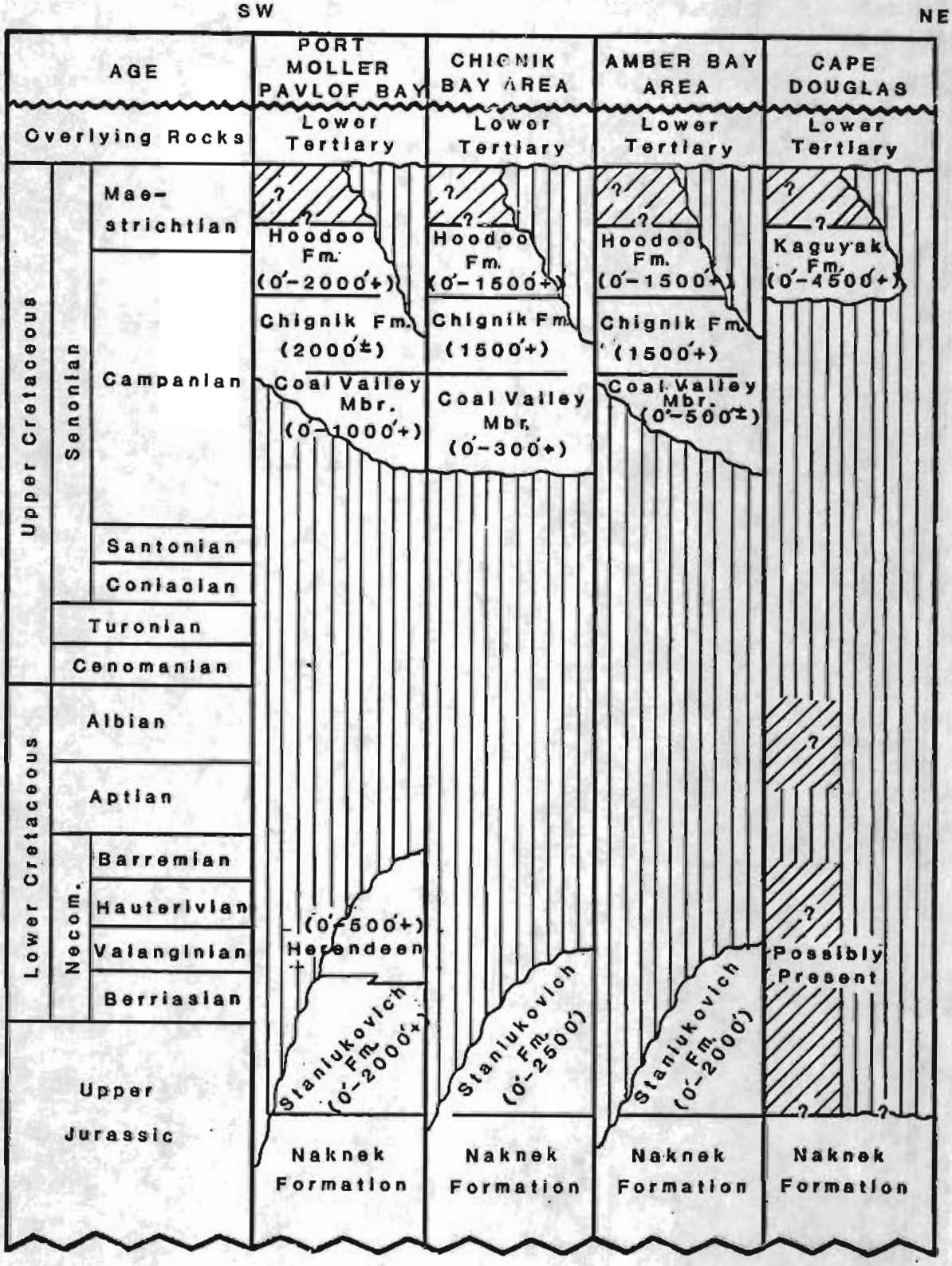

FIGURE 28: Correlation chart of Cretaceous rocks of Alaska Peninsula.

LABORATORY PROCEDURES

This investigation closely followed the laboratory procedures described by Cavallaro et al. (33) and described by the authors in Phase I (1). Figure 29 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. 14 mesh x 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 perchlorethylene-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. The American Society for Testing and Materials (ASTM) standard procedures were used for all analyses.

The Hardgrove Grindability Indexes of the samples were determined with air dried samples as per ASTM designation D409-71, using standards HGI 28, HGI 41, HGI 54, HGI 80 and HGI 92, supplied by ASTM. Table III shows the Hardgrove Grindability and Free Swelling Indexes and the HGI's ranged from 25 to 74. It is felt that samples UA-125, 126 and 136 should have shown some swelling properties; however, since these samples are from the weathered outcrop which reduces their caking characteristics, they did not.

INTERPRETATION OF WASHABILITY DATA

Tables IV through XVIII show washability data for the fifteen 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.

Northern Alaska Coal Field

Two coal beds were sampled, representative of coals in the Kokolik-Utukok River district in the National Petroleum Reserve, Alaska. The coal beds in the region have been extensively investigated by the U.S. Geological Survey, under the direction of J.E. Callahan (11). The study was aided by shallow subsurface data from shot holes, deep

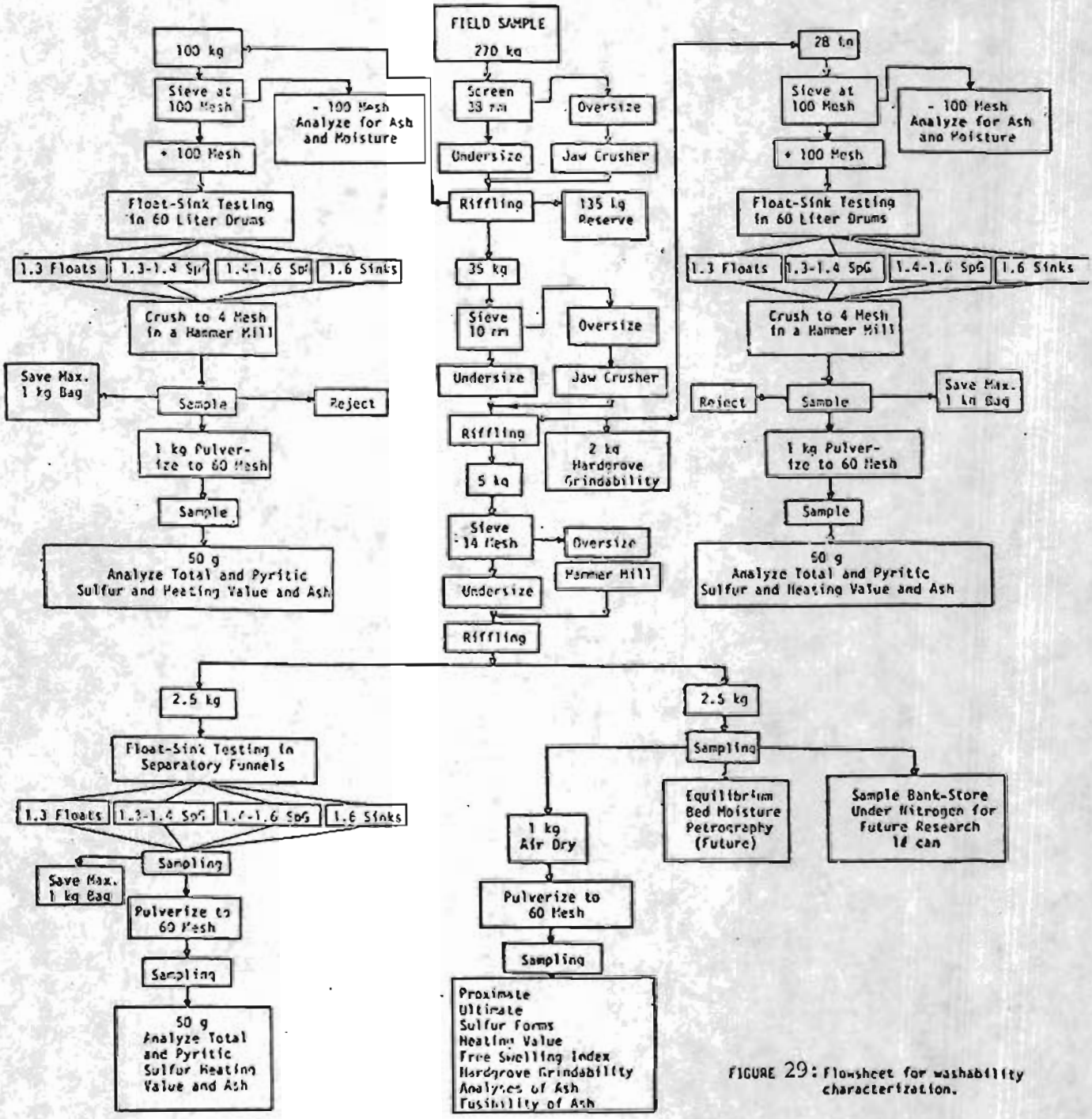

FIGURE 29: Flowsheet for washability characterization.

TABLE I

Proximate and Ultimate Analyses of Raw Coals

Coal Field	ASTM Rank	Thickness (feet)	Sample Numbers	Basis*	Moisture %	Volatile Matter,%	Fixed Carbon,%	Ash %	Heating Value BTU/lb.	C,%	H,%	N,%	O,%	Sulfur Pyritic	Sulfur Total
Nenana Uncorrelated bed Marguerite Creek	Subbit.C	30.5	UA 120	1	29.05	32.03	30.44	8.48	7,445	44.24	6.23	0.50	40.44	0.00	0.11
				2	—	45.14	42.91	11.95	10,493	62.36	4.20	0.71	20.63	0.00	0.15
				3	—	51.27	48.73	—	11,917	70.82	4.77	0.81	23.43	0.00	0.17
Eagle Uncorrelated bed Coal Creek	Subbit.B	30	UA 121	1	24.94	45.93	11.84	17.29	5,717	38.54	4.92	0.77	38.02	0.02	0.46
				2	—	61.19	15.78	23.03	7,616	51.35	2.84	1.02	21.15	0.02	0.61
				3	—	79.50	20.50	—	9,894	66.71	3.69	1.32	27.49	0.03	0.79
Kenai Uncorrelated bed Ninilchik	Subbit.C	6	UA 122	1	23.72	36.01	27.02	13.25	7,437	42.58	6.23	0.66	37.03	0.04	0.25
				2	—	47.21	35.42	17.37	9,750	55.82	4.69	0.87	20.92	0.05	0.33
				3	—	57.13	42.87	—	11,800	67.55	5.68	1.05	25.33	0.06	0.39
Broad Pass Dunkle Bed	Subbit.B	5.3	UA 123	1	33.07	27.63	28.88	10.42	7,305	41.37	6.79	0.56	40.57	0.11	0.29
				2	—	41.28	43.15	15.57	10,915	61.81	4.61	0.83	16.74	0.16	0.44
				3	—	48.89	51.11	—	12,928	73.21	5.46	0.99	19.82	0.19	0.52
Eagle Uncorrelated bed Chicken	Subbit.C	5.5	UA 124	1	23.59	44.22	11.20	20.99	5,474	35.01	5.01	0.58	37.33	0.07	1.08
				2	—	57.87	14.66	27.47	7,164	45.82	3.10	0.76	21.44	0.09	1.41
				3	—	79.79	20.71	—	9,878	63.17	4.27	1.05	28.57	0.12	1.94
Northern Alaska No. 3 Bed Elusive Creek	hvBb	11.5	UA 125	1	11.95	30.36	55.37	2.37	11,242	65.90	5.20	1.31	25.00	0.06	0.27
				2	—	34.48	62.88	2.64	12,768	74.84	4.39	1.49	16.33	0.07	0.31
				3	—	35.42	64.58	—	13,114	76.87	4.51	1.53	16.77	0.07	0.32
Northern Alaska Uncorrelated Bed Kokolik River	hvAb	11.6	UA 126	1	15.58	26.43	52.57	5.42	10,904	63.44	5.63	1.03	24.24	0.04	0.24
				2	—	31.31	62.27	6.42	12,916	75.15	4.61	1.22	12.32	0.05	0.28
				3	—	33.46	66.54	—	13,803	80.31	4.93	1.30	13.17	0.06	0.29
Beluga Capps Bed	Subbit.C	15	UA 127	1	20.87	39.90	27.56	11.67	7,242	47.34	5.77	0.50	34.55	0.08	0.17
				2	—	50.42	34.93	14.75	9,910	59.83	4.34	0.63	20.23	0.10	0.22
				3	—	59.15	40.85	—	11,625	70.08	5.09	0.73	23.74	0.12	0.26

* 1 is Equilibrium bed moisture basis
2 is Moisture-free basis
[illegible]-free basis

TABLE I (continued)

Proximate and Ultimate Analyses of Raw Coals

Coal Field	ASTM Rank	Thickness (feet)	Sample Numbers	Basis*	Moisture %	Volatile Matter,%	Fixed Carbon,%	Ash %	Heating Value BTU/lb.	C,%	H,%	N,%	O,%	Sulfur Pyritic	Sulfur Total
Nulato Uncorrelated Bed	HvAb	1	UA 128	1	3.11	11.21	22.35	63.33	4,762	26.29	2.31	0.49	7.22	0.16	0.36
				2	—	11.57	23.06	65.37	4,915	27.13	2.02	0.51	4.59	0.16	0.38
				3	—	33.41	66.59	—	14,190	78.33	5.83	1.46	13.30	0.47	1.08
Nulato Uncorrelated Bed	HvAb		UA 128 1.60 Specific Gravity Float	1	3.60	29.06	58.14	9.20	11,438	74.99	5.24	0.49	9.04	0.08	1.04
				2	—	30.15	60.31	9.55	11,866	77.79	5.02	0.51	6.06	0.08	1.07
				3	—	33.33	66.67	—	13,118	86.00	5.55	0.56	6.70	0.09	1.19
Nenana No. 1 Bed Usibelli Mine	Subbit.C	18	UA 129	1	24.33	35.09	27.52	13.06	7,464	44.58	5.91	0.52	35.77	0.01	0.16
				2	—	46.37	36.37	17.26	9,864	58.92	4.21	0.69	18.71	0.01	0.21
				3	—	56.04	43.96	—	11,922	71.21	5.09	0.83	22.62	0.02	0.25
Nenana No. 3 Bed Usibelli Mine	Subbit.C	17	UA 130	1	24.54	36.42	29.59	9.44	8,047	46.53	6.05	0.52	37.30	0.01	0.16
				2	—	48.27	39.22	12.51	10,663	61.66	4.38	0.69	20.54	0.01	0.22
				3	—	55.17	44.83	—	12,188	70.47	5.01	0.79	23.48	0.01	0.25
Kenai Uncorrelated Bed Happy Creek	Subbit.C	6	UA 131	1	23.25	35.32	31.74	9.69	8,292	47.86	5.99	0.84	35.33	0.03	0.29
				2	—	46.01	41.35	12.63	10,803	62.36	4.42	1.09	19.12	0.04	0.38
				3	—	52.67	47.33	—	12,365	71.38	5.06	1.25	21.88	0.04	0.43
Nenana Uncorrelated Bed Yanert Mine	hvBb	5	UA 132	1	5.51	17.67	25.22	51.60	5,412	31.73	3.34	0.63	12.52	0.07	0.18
				2	—	18.70	26.69	54.61	5,728	33.58	2.88	0.66	8.08	0.07	0.19
				3	—	41.20	58.80	—	12,660	73.98	6.35	1.46	17.80	0.16	0.41
Chignik Uncorrelated Bed Chignik Bay Mine	hvCb	9	UA 136	1	6.66	30.29	29.28	33.77	8,106	45.70	4.48	0.52	13.89	1.05	1.64
				2	—	32.45	31.37	36.18	8,685	48.96	4.00	0.55	8.55	1.12	1.76
				3	—	50.85	49.15	—	13,609	76.71	6.19	2.88	11.46	1.76	2.76
Beluga Waterfall Bed Top 6'	Subbit.C	6	UA 148	1	22.17	27.60	20.29	29.94	5,960	37.00	5.28	0.44	27.14	0.02	0.20
				2	—	35.46	26.07	38.47	7,658	47.54	3.60	0.56	9.57	0.02	0.26
				3	—	57.63	42.37	—	12,446	77.27	4.76	3.21	14.40	0.03	0.36

* 1 is Equilibrium bed moisture basis
2 is Moisture-free basis
3 is Moisture-ash-free basis

TABLE II

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

Concentration of Major Elements in Coal Ash, percent

Sample No.	SiO_2	Al_2O_3	Fe_2O_3	MgO	CaO	Na_2O	K_2O	TiO_2	SO_3	MnO	P_2O_5
UA-120	44.8	15.8	3.5	4.1	21.3	0.29	1.0	0.8	3.3	0.10	0.10
UA-121	47.5	20.3	5.5	2.9	11.7	0.62	0.7	1.2	5.3	0.12	0.18
UA-122	48.4	19.6	7.7	5.2	7.9	3.06	2.0	0.9	2.6	0.15	0.69
UA-123	44.0	23.4	16.4	1.8	7.2	0.36	0.7	1.1	4.0	0.19	0.56
UA-124	51.0	22.4	6.5	1.5	6.0	0.77	1.4	0.7	8.5	0.08	0.22
UA-125	22.3	26.5	12.3	6.6	15.0	2.14	0.7	0.8	3.0	0.03	1.95
UA-126	42.4	27.1	5.5	3.0	6.1	1.63	1.9	2.2	4.6	0.03	2.02
UA-127	53.8	25.9	2.4	1.4	9.5	0.34	1.7	1.1	2.3	0.04	0.50
UA-128	62.7	21.8	3.8	1.5	0.3	1.88	4.4	1.1	0.8	0.01	0.08
UA-129	47.1	20.8	4.1	2.6	16.4	0.40	1.2	1.1	2.5	0.07	0.98
UA-130	44.4	14.6	5.8	2.6	17.3	0.33	1.1	0.9	2.8	0.17	0.15
UA-131	40.7	15.7	9.2	4.4	18.5	0.93	1.4	0.7	4.7	0.48	0.33
UA-132	64.0	22.7	4.0	1.2	1.1	0.49	2.8	1.0	0.6	0.02	0.32
UA-136	54.2	28.3	4.9	1.2	4.1	0.33	1.1	1.2	3.3	0.04	0.15
UA-148	57.3	29.1	4.2	1.2	2.5	0.27	2.6	0.9	1.2	0.06	0.31

Fusibility of Ash, ^{o}F

Sample No.	Initial Deformation	Softening	Fluid
UA-120	2250	2259	2277
UA-121	2371	2375	2430
UA-122	2218	2246	2286
UA-123	2479	2505	2548
UA-124	2490	2503	2540
UA-125	2454	2514	2572
UA-126	2347	2356	2561
UA-127	2457	2464	2539
UA-128	2468	2593	2723
UA-129	2383	2420	2501
UA-130	2217	2228	2324
UA-131	2240	2243	2272
UA-132	2742	2800+	2800+
UA-136	2794	2800+	2800+
UA-148	2800+	2800+	2800+

TABLE III

Hardgrove Grindability and Free Swelling Indexes of Raw Coals

SAMPLE NUMBER	Air-Dried Samples	
	HGI	FSI
UA-120	38	0
UA-121	70	0
UA-122	25	0
UA-123	38	0
UA-124	62	0
UA-125	74	0
UA-126	56	0
UA-127	42	0
UA-128	56	0
UA-128 (1.60 Sp. G. Float)	—	9.6
UA-129	38	0
UA-130	32	0
UA-131	32	0
UA-132	48	0
UA-136	46	1
UA-148	32	0

exploration wells, and by tracing outcrops buried under the tundra by auger holes. A sure sign of a buried outcrop is the sighting from helicopter of black coal debris dug by ground squirrels (the squirrels find it easier to dig into coal). The auger holes positioned about 50' down dip from the coal debris. Several hundred samples of coals were collected from the region as drill cuttings from seismic shotholes. Auger cuttings, drill cuttings and several deep exploratory wells were sampled, and outcrops and beds were sampled by trenching (Callahan and Martin, 11). The petrology of three hundred of these samples is currently under investigation (Rao 34).

No. 3 coal bed was sampled from an outcrop on Elusive Creek (UA-125). Callahan (11) traced the bed by seismic shotholes to extend for 5 miles in an east-west direction with slight thinning, whereas it maintains a constant thickness in the north-south direction for a distance of over 2.3 miles (11, P. 43). Mean maximum reflectance of vitrinite in oil (R_{om}) was 0.71, clearly placing the rank of the coal at high volatile B bituminous. The raw coal is quite low in ash, 2.6 percent and sulfur, 0.31 percent. Washing of 1-1/2 inch x 100 mesh coal at 1.60 specific gravity can reduce ash to 2.1 percent at a yield of 98.7 percent. Washing 14 mesh x 0 coal at 1.60 specific gravity will further reduce ash to 2.0 percent at 98.7 percent yield, whereas washing at 1.40 would provide a product analyzing 1.6 percent ash at 90.5 percent yield (Table IV).

The second bed sampled was from an outcrop on the Kokolik River. In 1964 the U.S. Bureau of Mines excavated the outcrop by hand digging and blasting. For the current investigation, the surface weathered part of the exposure was removed prior to sampling. However, the depth of the cut is not adequate to reach the unoxidized portion of the seam. Vitrinite reflectance was 0.90 percent, placing the rank at high volatile A bituminous.

The Kokolik River sample (UA-126) contained 6.42 percent ash and 0.28 percent sulfur on a moisture free basis. Washing 1-1/2 inch x 100 mesh coal can give a product with 3.6 percent ash and 0.26 percent total sulfur. Washing at 1.40 specific gravity can give 81.3 percent yield with 2.6 percent ash (Table V).

Nulato Coal Field

An uncorrelated thin bed of coal was sampled from a location ten miles upstream from Nulato, along the north bank of the Yukon River. The seam varied in thickness from six to eighteen inches and pinched out within ten feet of the sampled exposure. The seam was still included in the program since a better seam could not be located, and the sample would give an indication of the quality and rank of the coal in this field. The raw coal sample contains 65.4 percent ash and 0.38 percent sulfur. The coal is high volatile A bituminous rank with vitrinite reflectance of 0.88% (R_{om}). Washing 1-1/2 inches x 100 mesh coal can give 19.1 percent yield with 10.1 percent ash, 0.97 percent sulfur and 13,672 Btu/lb heating value (Table VI). Finer crushing would be of no benefit. More extensive geological

TABLE IV

Washability Analyses of the No. 3 Ced Coal Sample (UA-125)
Northern Alaska Field, Elusive Creek, Alaska

Raw Coal Bed Moisture = 11.95

Product	DIRECT DATA Wt %	Ash %	Btu/lb	Sulfur Percent Pyritic	Total	CUMULATIVE DATA Wt %	Ash %	Btu/lb	Sulfur Percent Pyritic	Total	Pounds of SO_2/MM Btu
Float-Sink Size 1-1/2 inches x 100 Mesh											
Float- 1.30	2.77	1.93	12549	0.03	0.25	2.77	1.93	12549	0.03	0.25	0.4
1.30 - 1.40	89.35	1.77	12535	0.03	0.31	92.12	1.77	12535	0.03	0.31	0.5
1.40 - 1.60	6.58	6.66	11460	0.05	0.27	98.70	2.10	12464	0.03	0.31	0.5
Sink - 1.60	1.30	28.86	6351	0.10	0.21	100.00	2.45	12384	0.03	0.30	0.5
Minus 100 Mesh	0.79	20.42	9489	0.03	0.29	[1]100.00	2.59	12361	0.03	0.30	0.5
Float-Sink Size 3/8 inch x 100 Mesh											
Float- 1.30	3.01	1.57	12590	0.03	0.26	3.01	1.57	12590	0.03	0.26	0.4
1.30 - 1.40	82.46	1.60	12545	0.03	0.27	85.47	1.60	12547	0.03	0.27	0.4
1.40 - 1.60	12.96	4.78	11460	0.05	0.20	98.43	2.02	12404	0.03	0.27	0.4
Sink - 1.60	1.57	30.32	6540	0.10	0.27	100.00	2.46	12311	0.03	0.27	0.4
Minus 100 Mesh	5.97	10.43	10989	0.03	0.20	[1]100.00	2.94	12232	0.03	0.27	0.4
Float-Sink Size 14 Mesh x 0											
Float- 1.30	5.83	1.33	12574	0.03	0.30	5.83	1.33	12574	0.03	0.30	0.5
1.30 - 1.40	84.68	1.58	12565	0.03	0.24	90.51	1.56	12566	0.03	0.24	0.4
1.40 - 1.60	8.21	6.67	11697	0.05	0.29	98.72	1.99	12493	0.03	0.25	0.4
Sink - 1.60	1.28	36.55	8431	0.10	0.25	100.00	2.43	12441	0.03	0.25	0.4

All results are on a Moisture Free Basis.

[1]Cumulative float-sink plus minus 100 mesh material.

TABLE V

Washability Analyses of an Uncorrelated Bed Coal Sample (UA-126)
Northern Alaska Field, Kokolik River, Alaska

Raw Coal Bed Moisture = 15.58

Product	DIRECT DATA Wt %	Ash %	Btu/lb	Sulfur Percent Pyritic	Total	CUMULATIVE DATA Wt %	Ash %	Btu/lb	Sulfur Percent Pyritic	Total	Pounds of SO_2/131 Btu
Float-Sink Size 1-1/2 inches x 100 Mesh											
Float- 1.30	1.93	2.15	13923	0.03	0.18	1.93	2.15	13923	0.03	0.18	0.3
1.30 - 1.40	79.33	2.56	13434	0.03	0.27	81.26	2.55	13446	0.03	0.27	0.4
1.40 - 1.60	13.46	10.23	11076	0.03	0.19	94.72	3.64	13223	0.03	0.26	0.4
Sink - 1.60	5.28	51.53	5489	0.03	0.12	100.00	6.17	12814	0.03	0.25	0.4
Minus 100 Mesh	1.79	23.40	10063	0.03	0.21	[1]100.00	6.46	12765	0.03	0.25	0.4
Float-Sink Size 3/8 inch x 100 Mesh											
Float- 1.30	11.94	2.29	13765	0.03	0.23	11.94	2.29	13765	0.03	0.23	0.3
1.30 - 1.40	72.23	3.30	13451	0.03	0.30	84.17	3.16	13496	0.03	0.29	0.4
1.40 - 1.60	10.18	10.57	11868	0.03	0.10	94.35	3.96	13320	0.03	0.28	0.4
Sink - 1.60	5.65	53.46	5325	0.03	0.14	100.00	6.75	12868	0.03	0.27	0.4
Minus 100 Mesh	2.49	14.55	11307	0.03	0.20	[1]100.00	6.94	12820	0.03	0.27	0.4
Float-Sink Size 14 Mesh x 0											
Float- 1.30	1.59	3.01	14239	0.03	0.31	1.59	3.01	14239	0.03	0.31	0.4
1.30 - 1.40	80.62	3.06	13404	0.03	0.25	82.21	3.06	13420	0.03	0.25	0.4
1.40 - 1.60	12.54	10.49	11840	0.03	0.21	94.75	4.04	13211	0.03	0.25	0.4
Sink - 1.60	5.25	58.81	5087	0.03	0.21	100.00	6.92	12785	0.03	0.24	0.4

All results are on a Moisture Free Basis.

[1]Cumulative float-sink plus minus 100 mesh material.

TABLE VI

Washability Analyses of an Uncorrelated Bed Coal Sample (UA-128)
Nulato Coal Field, Alaska

Raw Coal Bed Moisture = 3.11

Product	DIRECT DATA Wt %	Ash %	Btu/lb	Sulfur Percent Pyritic	Total	CUMULATIVE DATA Wt %	Ash %	Btu/lb	Sulfur Percent Pyritic	Total	Pounds of SO_2/MM Btu
Float-Sink Size 1-1/2 inches x 100 Mesh											
Float- 1.30	5.94	5.73	14368	0.05	0.94	5.94	5.73	14360	0.05	0.94	1.3
1.30 - 1.40	10.42	7.58	14118	0.05	0.94	16.36	6.91	14209	0.05	0.94	1.3
1.40 - 1.60	2.76	28.92	10493	0.08	1.17	19.12	10.09	13672	0.05	0.97	1.4
Sink - 1.60	80.88	72.79	4143	0.05	0.51	[1]100.00	60.60	5965	0.05	0.60	2.0
Minus 100 Mesh	0.68	37.32	8799	0.05	1.26	[1]100.00	60.64	5828	0.05	0.60	2.1
Float-Sink Size 3/8 inch x 100 Mesh											
Float- 1.30	3.57	4.40	14606	0.05	1.01	3.57	4.40	14606	0.05	1.01	1.4
1.30 - 1.40	7.99	7.23	13998	0.05	0.94	11.56	6.36	14186	0.05	0.96	1.4
1.40 - 1.60	4.90	25.48	11020	0.08	0.94	16.46	12.05	13243	0.06	0.96	1.4
Sink - 1.60	83.54	77.40	4259	0.10	0.43	[1]100.00	66.64	5738	0.09	0.52	1.8
Minus 100 Mesh	2.80	41.01	8378	0.05	1.25	[1]100.00	65.90	5814	0.09	0.52	1.8
Float-Sink Size 14 Mesh x 0											
Float- 1.30	0.70	4.38	14734	0.05	0.91	0.70	4.38	14734	0.05	0.91	1.2
1.30 - 1.40	2.43	4.48	14402	0.05	0.91	3.13	4.46	14476	0.05	0.91	1.3
1.40 - 1.60	5.61	14.13	12083	0.08	0.81	8.74	10.67	12940	0.07	0.85	1.3
Sink - 1.60	91.26	69.79	4540	0.10	0.58	100.00	64.62	5274	0.10	0.60	2.3

All results are on a Moisture Free Basis.

[1]Cumulative float-sink plus minus 100 mesh material.

exploration is needed to uncover seams of economic value, which would be of particular significance to the village of Nulato and other communities along the Yukon River now burdened with the high cost of liquid fuels.

Eagle Coal Field

Two coal seams were sampled from this field, both from an area with a history of established placer gold mining activity.

A coal bed sampled from Coal Creek (UA-121) had vitrinite reflectance of 0.44 (R_{om}). This places the rank of coal at subbituminous B and the low heating value (7,616 Btu/lb) of the coal is attributable to the severely oxidized condition of the outcrop sample. The raw coal sample contained 23.0 percent ash and 0.61 percent sulfur. Washing 1-1/2 inches x 100 mesh coal at 1.40 specific gravity can give 22.0 percent yield with 9.6 percent ash. Washing at 1.60 specific gravity can improve yield to 82.7 percent with 13.7 percent ash (Table VII). Washing at finer sizes did not indicate any additional improvement in yield or ash content of the products.

The uncorrelated coal bed sample (UA-124) from Chicken was from a weathered outcrop. The vitrinite reflectance (R_{om}) was 0.36 percent equivalent to subbituminous C rank. The sample contained 27.5 percent ash and 1.41 percent sulfur on a moisture free basis. Washing 1-1/2 inches x 100 mesh at 1.30 specific gravity gave 40.6 percent yield with 10.0 percent ash and 1.35 percent sulfur. This is one of the few high sulfur coals in Alaska. Very little of the sulfur is in pyritic form and thus no reduction in sulfur is possible by washing (Table VIII).

Nenana Coal Field

Samples of No. 1 bed coal (UA-129) and No. 3 bed coal (UA-130) were collected from the Lower Lignite Creek, Poker Flat Pit, Usibelli Coal Mine. The coals are subbituminous C rank. No. 1 bed is not being mined at this time and is the lowest bed in the Suntrana Formation. The raw coal analyzed 17.3 percent ash and 0.21 percent sulfur on a moisture free basis. Washing 1-1/2 inches x 100 mesh coal at 1.40 specific gravity gave 83.4 percent yield with 10.0 percent ash, and 10,858 Btu/lb. Washing at 1.60 specific gravity gave 93.7 percent yield with 12.3 percent ash and 10,531 Btu/lb (Table IX).

No. 3 bed is the lowest of the three beds being mined by Usibelli Coal Mine, and is the lowest of the seams extractable at this time. The raw coal contained 12.5 percent ash and 0.22 percent sulfur on a moisture free basis. Washing the coal at 1.6 specific gravity gave a 91.8 percent yield with 6.9 percent ash, 0.13 percent sulfur and 10,774 Btu/lb on a moisture free basis (Table X). No significant improvement in recovery or ash content can be achieved by crushing to a finer size.

TABLE VII

Washability Analyses of an Uncorrelated Bed Coal Sample (UA-121)
Coal Creek, Eagle Field, Alaska

Raw Coal Bed Moisture = 24.94

Product	DIRECT DATA Wt %	Ash %	Btu/lb	Sulfur Percent Pyritic	Total	CUMULATIVE DATA Wt %	Ash %	Btu/lb	Sulfur Percent Pyritic	Total	Pounds of SO_2/MM Btu
Float-Sink Size 1-1/2 inches x 100 Mesh											
Float- 1.30	0.04	7.81	11141	0.03	0.27	0.04	7.81	11141	0.03	0.27	0.5
1.30 - 1.40	21.92	9.58	8949	0.03	0.55	21.96	9.58	8953	0.03	0.55	1.2
1.40 - 1.60	60.72	15.20	8392	0.06	0.58	82.68	13.71	8541	0.05	0.57	1.3
Sink - 1.60	17.32	71.58	1989	0.04	0.17	100.00	23.73	7406	0.05	0.50	1.4
Minus 100 Mesh	0.91	30.03	6445	0.03	0.34	[1]100.00	23.79	7397	0.05	0.50	1.4
Float-Sink Size 3/8 inch x 100 Mesh											
Float- 1.30	0.03	3.82	11025	0.03	0.24	0.03	3.82	11025	0.03	0.24	0.4
1.30 - 1.40	22.99	10.34	9454	0.04	0.64	23.02	10.33	9456	0.04	0.64	1.4
1.40 - 1.60	60.05	15.99	8483	0.06	0.62	83.07	14.42	8753	0.05	0.63	1.4
Sink - 1.60	16.93	69.53	2321	0.04	0.20	100.00	23.75	7664	0.05	0.55	1.4
Minus 100 Mesh	2.00	32.47	6415	0.03	0.39	[1]100.00	23.92	7639	0.05	0.55	1.4
Float-Sink Size 14 Mesh x 0											
Float- 1.30	0.16	2.94	11002	0.03	0.29	0.16	2.94	11002	0.03	0.29	0.5
1.30 - 1.40	9.98	10.56	9642	0.03	0.61	10.14	10.44	9663	0.03	0.60	1.2
1.40 - 1.60	73.88	13.85	8675	0.06	0.60	84.02	13.44	8794	0.06	0.60	1.4
Sink - 1.60	15.98	71.55	2086	0.06	0.17	100.00	22.72	7722	0.06	0.53	1.4

All results are on a Moisture Free Basis.

[1]Cumulative float-sink plus minus 100 mesh material.

TABLE VIII

Washability Analyses of an Uncorrelated Bed Coal Sample (UA-124)
Chicken, Eagle Coal Field, Alaska

Raw Coal Bed Moisture = 23.59

	DIRECT DATA					CUMULATIVE DATA					
				Sulfur Percent					Sulfur Percent		Pounds of
Product	Wt %	Ash %	Btu/lb	Pyritic	Total	Wt %	Ash %	Btu/lb	Pyritic	Total	SO_2/MM Btu
Float-Sink Size 1-1/2 inches x 100 Mesh											
Float- 1.30	12.57	7.03	10266	0.03	1.26	12.57	7.03	10266	0.03	1.26	2.5
1.30 - 1.40	28.08	11.27	9250	0.03	1.39	40.65	9.96	9564	0.03	1.35	2.8
1.40 - 1.60	35.43	27.51	7103	0.04	1.29	76.08	18.13	8418	0.03	1.32	3.1
Sink - 1.60	23.92	66.05	4337	0.06	2.49	100.00	29.59	7442	0.04	1.60	4.3
Minus 100 Mesh	1.46	49.19	4475	0.04	1.29	[1]100.00	29.88	7399	0.04	1.60	4.3
Float-Sink Size 3/8 inch x 100 Mesh											
Float- 1.30	4.95	6.41	10940	0.03	1.26	4.95	6.41	10940	0.03	1.26	2.3
1.30 - 1.40	30.88	8.81	9388	0.03	1.28	35.83	8.48	9602	0.03	1.28	2.7
1.40 - 1.60	37.67	24.92	7452	0.03	1.20	73.50	16.91	8500	0.03	1.24	2.9
Sink - 1.60	26.50	66.31	4286	0.06	2.45	100.00	30.00	7384	0.04	1.56	4.2
Minus 100 Mesh	2.82	48.62	4783	0.04	0.84	[1]100.00	30.52	7311	0.04	1.54	4.2
Float-Sink Size 14 Mesh x 0											
Float- 1.30	3.18	5.52	10520	0.03	1.20	3.18	5.52	10520	0.03	1.20	2.3
1.30 - 1.40	28.62	6.73	9888	0.03	1.26	31.80	6.61	9951	0.03	1.25	2.5
1.40 - 1.60	44.17	27.67	7152	0.04	1.24	75.97	18.85	8324	0.04	1.25	3.0
Sink - 1.60	24.03	66.17	7987	0.06	2.50	100.00	30.22	7282	0.04	1.55	4.3

All results are on a Moisture Free Basis.

[1]Cumulative float-sink plus minus 100 mesh material.

TABLE IX

Washability Analyses of the No. 1 Bed Coal Sample (UA-129)
Usibelli Coal Mine, Nenana Coal Field, Healy, Alaska

Raw Coal Bed Moisture = 24.33

Product	DIRECT DATA Wt %	Ash %	Btu/lb	Sulfur Percent Pyritic	Total	CUMULATIVE DATA Wt %	Ash %	Btu/lb	Sulfur Percent Pyritic	Total	Pounds of SO_2/MM Btu
Float-Sink Size 1-1/2 inches x 100 Mesh											
Float- 1.30	7.06	6.89	11405	0.01	0.17	7.06	6.89	11405	0.01	0.17	0.3
1.30 - 1.40	76.34	10.27	10807	0.01	0.16	83.40	9.98	10858	0.01	0.16	0.3
1.40 - 1.60	10.26	31.21	7875	0.03	0.27	93.66	12.31	10531	0.01	0.17	0.3
Sink - 1.60	6.34	73.19	3956	0.03	0.15	100.00	16.17	10114	0.01	0.17	0.3
Minus 100 Mesh	1.20	49.21	6203	0.03	0.42	[1]100.00	16.57	10067	0.01	0.17	0.3
Float-Sink Size 3/8 inch x 100 Mesh											
Float- 1.30	59.28	9.94	11186	0.01	0.19	59.28	9.94	11186	0.01	0.19	0.3
1.30 - 1.40	26.94	14.95	9646	0.01	0.21	86.22	11.51	10705	0.01	0.20	0.4
1.40 - 1.60	6.83	26.27	8442	0.03	0.26	93.05	12.59	10539	0.01	0.20	0.4
Sink - 1.60	6.95	66.43	4387	0.03	0.19	100.00	16.33	10111	0.01	0.20	0.4
Minus 100 Mesh	2.55	17.24	9544	0.04	0.24	[1]100.00	16.35	10096	0.01	0.20	0.4
Float-Sink Size 14 Mesh x 0											
Float- 1.30	10.83	6.91	11562	0.01	0.17	10.83	6.91	11562	0.01	0.17	0.3
1.30 - 1.40	64.36	9.43	10455	0.01	0.19	75.19	9.07	10614	0.01	0.19	0.4
1.40 - 1.60	15.87	19.77	9116	0.03	0.23	91.06	10.93	10353	0.01	0.19	0.4
Sink - 1.60	8.94	70.09	4349	0.03	0.12	100.00	16.22	9817	0.01	0.19	0.4

All results are on a Moisture Free Basis.

[1]Cumulative float-sink plus minus 100 mesh material.

TABLE X

Washability Analyses of the No. 3 Bed Coal Sample (UA-130)
Usibelli Coal Mine, Nenana Coal Field, Healy, Alaska

Raw Coal Bed Moisture = 24.54

Product	DIRECT DATA Wt %	Ash %	Btu/lb	Sulfur Percent Pyritic	Total	CUMULATIVE DATA Wt %	Ash %	Btu/lb	Sulfur Percent Pyritic	Total	Pounds of SO_2/MM Btu
Float-Sink Size 1-1/2 inches x 100 Mesh											
Float- 1.30	16.09	4.63	11466	0.01	0.09	16.09	4.63	11466	0.01	0.09	0.2
1.30 - 1.40	69.12	6.81	10881	0.04	0.13	85.21	6.40	10991	0.03	0.12	0.2
1.40 - 1.60	6.62	13.44	7973	0.01	0.28	91.83	6.91	10774	0.03	0.13	0.2
Sink - 1.60	8.17	68.75	6194	0.01	0.29	100.00	11.96	10400	0.03	0.15	0.3
Minus 100 Mesh	1.37	36.80	7049	0.01	0.22	[1]100.00	12.30	10354	0.01	0.15	0.3
Float-Sink Size 3/8 inch x 100 Mesh											
Float- 1.30	12.65	4.40	11556	0.01	0.16	12.65	4.40	11556	0.01	0.16	0.3
1.30 - 1.40	73.11	6.78	10852	0.03	0.21	85.76	6.43	10956	0.03	0.20	0.4
1.40 - 1.60	4.77	23.54	8259	0.01	0.26	90.53	7.33	10814	0.03	0.21	0.4
Sink - 1.60	9.47	66.33	4634	0.01	0.12	100.00	12.56	10229	0.02	0.21	0.4
Minus 100 Mesh	3.16	24.45	8557	0.01	0.17	[1]100.00	12.94	10176	0.02	0.21	0.4
Float-Sink Size 14 Mesh x 0											
Float- 1.30	15.31	4.60	11659	0.01	0.15	15.31	4.60	11659	0.01	0.15	0.3
1.30 - 1.40	68.45	9.12	10924	0.03	0.16	83.76	8.29	11058	0.03	0.16	0.3
1.40 - 1.60	9.06	17.87	9023	0.01	0.23	92.82	9.23	10860	0.02	0.17	0.3
Sink - 1.60	7.18	70.92	3988	0.01	0.10	100.00	13.66	10366	0.02	0.16	0.3

All results are on a Moisture Free Basis.

[1]Cumulative float-sink plus minus 100 mesh material.

The uncorrelated bed coal outcrop on Marguerite Creek west of Jumbo Dome was sampled (UA-120). This area of the Nenana coal field is undeveloped. Amax Coal Company has done preliminary coal exploration. The coal is subbituminous C rank and has 12.0 percent ash and 0.15 percent sulfur on a moisture free basis. Washing of 1-1/2 inches x 100 mesh material at 1.40 specific gravity gave a product with 8.3 percent ash, 0.12 percent sulfur and 10,535 Btu/lb on a moisture free basis at a yield of 82.9 percent. Washing at 1.60 specific gravity gave 96.9 percent yield with 10.8 percent ash and 10,171 Btu/lb (Table XI).

Coal was mined at the Yanert mine until 1924. The mine is located in Denali National Park (Formerly Mt. McKinly National Park). The coal has a vitrinite reflectance of 0.76 (R_{om}) indicating that unweathered coal shows a high volatile 'B' bituminous rank. The raw coal analyzed 54.6 percent ash and 0.19 percent sulfur on a moisture free basis. Washing 1-1/2 inches x 100 mesh coal at 1.60 specific gravity gave a product with 18.6 percent ash at 35.3 percent yield. Washing 3/8 inch x 100 mesh coal at 1.60 specific gravity gave an improved product with 14.2 percent ash at 37.6 percent yield on a moisture free basis (Table XII).

Broad Pass Coal Field

Coal production from this field to meet local needs dates back to 1929. Production has increased with the transfer of a coal prospecting permit to W.E. Dunkle in 1941. In the period 1940-54 about 64,000 tons of coal were produced. Mr. Dunkle installed a prototype reactor for steam drying of coal from Dunkle Mine and shipped twenty tons of processed coal to the Fairbanks Exploration Company power plant in 1958 for testing, and that appears to be the last reported activity of the mine. The Dunkle bed sample (UA-123) had 15.6 percent ash and 0.44 percent sulfur. Washing the 1-1/2 inches x 100 mesh coal at 1.60 specific gravity gave 87.9 percent yield analyzing 9.0 percent ash, 12,016 Btu/lb and 0.46 percent sulfur. Crushing to 14 mesh and washing at 1.60 specific gravity will give a product analyzing 7.8 percent ash, 12,218 Btu/lb, with 87.1 percent yield (Table XIII).

COOK INLET SEDIMENTARY BASIN

Kenai Coal Field

Numerous coal beds are exposed on the beach cliffs along the western shore of Kenai Peninsula. Coal was and is mined near Homer on a small scale for domestic use. There is no coal mining in the Kenai field at this time. A coal bed was sampled about a mile northeast of Ninilchick (UA-122). A natural cave is formed on the beach due to differential erosion of sediments underlying the coal seam by the action of the waves. Approach to the sampling site is through Ninilchik and along the beach by truck. The coal is subbituminous 'C' rank and has 17.4 percent ash and 0.33 percent sulfur. Washing 1-1/2

TABLE XI

Washability Analyses of an Uncorrelated Bed Coal Sample (UA-120)
Marguerite Creek, Nenana Field, Alaska

Raw Coal Bed Moisture = 29.05

Product	DIRECT DATA Wt %	Ash %	Btu/lb	Sulfur Percent Pyritic	Total	CUMULATIVE DATA Wt %	Ash %	Btu/lb	Sulfur Percent Pyritic	Total	Pounds of SO_2/MM Btu
Float-Sink Size 1-1/2 inches x 100 Mesh											
Float- 1.30	59.68	7.05	10833	0.04	0.11	59.68	7.05	10833	0.04	0.11	0.2
1.30 - 1.40	23.23	11.47	9769	0.04	0.14	82.91	8.29	10535	0.04	0.12	0.2
1.40 - 1.60	14.02	25.94	8017	0.03	0.17	96.93	10.84	10171	0.04	0.13	0.3
Sink - 1.60	3.07	67.77	3142	0.01	0.12	100.00	12.59	9955	0.04	0.13	0.3
Minus 100 Mesh	0.69	31.58	7563	0.03	0.20	[1]100.00	12.72	9938	0.04	0.13	0.3
Float-Sink Size 3/8 inch x 100 Mesh											
Float- 1.30	52.13	6.55	11051	0.04	0.10	52.13	6.55	11051	0.04	0.10	0.2
1.30 - 1.40	31.72	10.50	9901	0.04	0.16	83.85	8.04	10616	0.04	0.12	0.2
1.40 - 1.60	10.62	27.46	7924	0.03	0.16	94.47	10.23	10313	0.04	0.13	0.3
Sink - 1.60	5.53	62.00	3736	0.02	0.13	100.00	13.09	9950	0.04	0.13	0.3
Minus 100 Mesh	4.42	29.22	7801	0.03	0.13	[1]100.00	13.80	9855	0.04	0.13	0.3
Float-Sink Size 14 Mesh x 0											
Float- 1.30	40.60	6.59	11032	0.03	0.10	40.60	6.59	11032	0.03	0.10	0.2
1.30 - 1.40	38.87	8.95	10312	0.03	0.13	79.47	7.74	10680	0.03	0.11	0.2
1.40 - 1.60	16.19	21.70	8630	0.03	0.18	95.66	10.11	10333	0.03	0.13	0.3
Sink - 1.60	4.34	61.66	3890	0.03	0.12	100.00	12.34	10053	0.03	0.13	0.3

All results are on a Moisture Free Basis.

[1]Cumulative float-sink plus minus 100 mesh material.

TABLE XII

Washability Analyses of an Uncorrelated Bed Coal Sample (UA-132)
Yanert Mine, Nenana Coal Field, Alaska

Raw Coal Bed Moisture = 5.51

Product	DIRECT DATA Wt %	Ash %	Btu/lb	Sulfur Percent Pyritic	Total	CUMULATIVE DATA Wt %	Ash %	Btu/lb	Sulfur Percent Pyritic	Total	Pounds of SO_2/Mil Btu
Float-Sink Size 1-1/2 inches x 100 Mesh											
Float- 1.30	0.07	6.39	13004	0.03	0.38	0.07	6.39	13004	0.03	0.38	0.6
1.30 - 1.40	10.75	6.81	12895	0.03	0.35	10.82	6.81	12896	0.03	0.35	0.5
1.40 - 1.60	24.48	23.87	10298	0.03	0.33	35.30	18.64	11094	0.03	0.34	0.6
Sink - 1.60	64.70	71.29	4234	0.09	0.14	[1]100.00	52.70	6656	0.07	0.21	0.6
Minus 100 Mesh	1.44	44.36	6940	0.03	0.26	[1]100.00	52.58	6660	0.07	0.21	0.6
Float-Sink Size 3/8 inch x 100 Mesh											
Float- 1.30	6.44	3.97	13609	0.03	0.41	6.44	3.97	13609	0.03	0.41	0.6
1.30 - 1.40	13.89	7.35	12763	0.03	0.45	20.33	6.28	13031	0.03	0.44	0.7
1.40 - 1.60	17.23	23.60	10373	0.03	0.35	37.56	14.22	11812	0.03	0.40	0.7
Sink - 1.60	62.44	77.00	3837	0.07	0.12	[1]100.00	53.42	6832	0.05	0.22	0.6
Minus 100 Mesh	3.07	53.80	4540	0.03	0.48	[1]100.00	53.43	6762	0.05	0.23	0.7
Float-Sink Size 14 Mesh x 0											
Float- 1.30	0.00	0.00	00000	0.00	0.00	0.00	0.00	00000	0.00	0.00	0.0
1.30 - 1.40	3.03	4.02	13529	0.03	0.41	3.03	4.02	13529	0.03	0.41	0.6
1.40 - 1.60	23.22	17.54	11099	0.03	0.37	26.25	15.98	11379	0.03	0.37	0.7
Sink - 1.60	73.75	67.74	4445	0.06	0.12	100.00	54.15	6265	0.05	0.19	0.6

All results are on a Moisture Free Basis.

[1]Cumulative float-sink plus minus 100 mesh material.

TABLE XIII

Washability Analyses of Dunkle Bed Coal Sample (UA-123)
Broad Pass Field, Alaska

Raw Coal Bed Moisture = 33.07

Product	DIRECT DATA Wt %	Ash %	Btu/lb	Sulfur Percent Pyritic	Total	CUMULATIVE DATA Wt %	Ash %	Btu/lb	Sulfur Percent Pyritic	Total	Pounds of SO_2/MM Btu
Float-Sink Size 1-1/2 inches x 100 Mesh											
Float- 1.30	42.10	4.62	12823	0.03	0.45	42.10	4.62	12823	0.03	0.45	0.7
1.30 - 1.40	33.98	9.21	11921	0.03	0.52	76.08	6.67	12420	0.03	0.48	0.8
1.40 - 1.60	11.79	24.05	9406	0.11	0.34	87.87	9.00	12016	0.04	0.46	0.8
Sink - 1.60	12.13	70.81	2381	0.11	0.11	100.00	16.50	10847	0.05	0.42	0.8
Minus 100 Mesh	1.22	56.12	5286	0.03	0.35	[1]100.00	16.98	10779	0.05	0.42	0.8
Float-Sink Size 3/8 inch x 100 Mesh											
Float- 1.30	46.88	4.22	12832	0.03	0.53	46.88	4.22	12832	0.03	0.53	0.8
1.30 - 1.40	31.48	9.18	11874	0.03	0.49	78.36	6.21	12447	0.03	0.51	0.8
1.40 - 1.60	9.56	24.47	9573	0.11	0.38	87.92	8.20	12135	0.04	0.50	0.8
Sink - 1.60	12.08	68.93	2578	0.10	0.12	100.00	15.53	10980	0.05	0.45	0.8
Minus 100 Mesh	6.16	27.74	9421	0.03	0.42	[1]100.00	16.28	10884	0.05	0.45	0.8
Float-Sink Size 14 Mesh x 0											
Float- 1.30	30.68	4.13	12886	0.03	0.49	30.68	4.13	12886	0.03	0.53	0.8
1.30 - 1.40	46.52	6.82	12301	0.03	0.44	77.20	5.75	12533	0.03	0.46	0.7
1.40 - 1.60	9.86	23.53	9746	0.11	0.37	87.06	7.76	12210	0.04	0.45	0.7
Sink - 1.60	12.94	67.22	2563	0.06	0.13	100.00	15.46	10968	0.04	0.41	0.7

All results are on a Moisture Free Basis.

[1]Cumulative float-sink plus minus 100 mesh material.

inches x 100 mesh coal at 1.40 specific gravity will give a product with 8.2 percent ash, 10,684 Btu/lb, and 0.28 percent sulfur with a yield of 63.3 percent. Crushing to 14 mesh and washing at 1.60 specific gravity gave an acceptable product with 10.6 percent ash at a yield of 85.0 percent on a moisture free basis (Table XIV).

A coal sample was obtained from an outcrop on Happy Creek along the beach bluff (UA-131). The raw coal had 12.6 percent ash and 0.38 percent sulfur. Washing at 1.40 specific gravity gave a product with 9.0 percent ash, 11,074 Btu/lb and 0.39 percent sulfur with 86.8 percent yield on a moisture free basis. Washing coal crushed to 14 mesh at 1.60 specific gravity gave a product with 10.0 percent ash while improving the yield to 95.0 percent (Table XV). The advantages of crushing to a finer size for ash reduction are obvious.

Beluga Coal Field

There are two mineable coal beds in the Capps basin, the Lower Waterfall bed and Upper Capps bed. The Upper Capps bed sample (UA-127) contained 14.8 percent ash and 0.22 percent sulfur. Washing 1-1/2 inches x 100 mesh coal at 1.40 specific gravity gave a product analyzing 8.0 percent ash, 10,658 Btu/lb and 0.19 percent sulfur with 72.7 percent yield. Washing at 1.60 specific gravity gave a product with 12.3 percent ash and 94.0 percent yield on a moisture free basis (Table XVI). The lower 30 feet of the Waterfall bed is low in ash (10.23 percent on a moisture free basis) and was therefore sampled separately. The results have been reported in Phase II (2). The top six feet of the seam (UA-148) is high in ash principally due to a twelve inch thick clay parting. The raw coal contained 38.5 percent ash and 0.26 percent sulfur. Washing 1-1/2 inches x 100 mesh coal at 1.40 specific gravity gave a product analyzing 9.4 percent ash, 10,598 Btu/lb and 0.28 percent sulfur with 39.3 percent yield (Table XVII). Crushing to 3/8 inch top size and separating at 1.60 specific gravity would provide a 59.2 percent yield of coal analyzing 13.2 percent ash, 9,902 Btu/lb and 0.29 percent sulfur.

Alaska Peninsula

Chignik Field

The coal seam from the Chignik Bay coal mine was sampled at the entrance to the tunnel. The mine was abandoned nearly 70 years ago. The sample contained 36.2 percent ash and 1.12 percent sulfur. Washing 1-1/2 inches x 100 mesh coal at 1.60 specific gravity gave a product that contained 11.0 percent ash, 12,340 Btu/lb and 1.9 percent sulfur with 50.2 percent yield (Table XVIII). Although half of the total sulfur is in pyritic form, reduction in sulfur by washing at a finer size was only moderate.

TABLE XIV

Washability Analyses of an Uncorrelated Bed Coal Sample (UA-122)
Ninilchik, Kenai Field, Alaska

Raw Coal Bed Moisture = 23.72

Product	DIRECT DATA Wt %	Ash %	Btu/lb	Sulfur Percent Pyritic	Total	CUMULATIVE DATA Wt %	Ash %	Btu/lb	Sulfur Percent Pyritic	Total	Pounds of SO_2/MM Btu
Float-Sink Size 1-1/2 inches x 100 Mesh											
Float- 1.30	13.62	5.21	11192	0.04	0.23	13.62	5.21	11192	0.04	0.23	0.4
1.30 - 1.40	49.72	8.97	10545	0.06	0.30	63.34	8.16	10684	0.06	0.28	0.5
1.40 - 1.60	28.10	32.80	7627	0.06	0.34	91.44	15.73	9745	0.06	0.30	0.6
Sink - 1.60	8.56	61.18	3843	0.08	0.14	100.00	19.62	9239	0.06	0.29	0.6
Minus 100 Mesh	1.03	59.05	4575	0.06	0.23	[1]100.00	21.90	8948	0.06	0.28	0.6
Float-Sink Size 3/8 inch x 100 Mesh											
Float- 1.30	17.97	5.18	11332	0.03	0.24	17.97	5.18	11332	0.03	0.24	0.4
1.30 - 1.40	49.62	7.74	10661	0.06	0.29	67.59	7.06	10839	0.05	0.28	0.5
1.40 - 1.60	21.73	34.32	7384	0.06	0.36	89.32	13.69	9999	0.05	0.30	0.6
Sink - 1.60	10.68	61.29	3881	0.08	0.19	100.00	18.77	9345	0.06	0.29	0.6
Minus 100 Mesh	3.60	38.98	7019	0.06	0.22	[1]100.00	19.50	9261	0.06	0.29	0.6
Float-Sink Size 14 Mesh x 0											
Float- 1.30	4.93	5.72	11647	0.03	0.24	4.93	5.72	11647	0.03	0.24	0.4
1.30 - 1.40	63.16	6.47	10796	0.05	0.26	68.09	6.42	10858	0.05	0.26	0.5
1.40 - 1.60	16.93	27.45	8225	0.05	0.35	85.02	10.61	10334	0.05	0.28	0.5
Sink - 1.60	14.98	66.09	4044	0.07	0.20	100.00	18.92	9392	0.05	0.27	0.6

All results are on a Moisture Free Basis.

[1]Cumulative float-sink plus minus 100 mesh material.

TABLE XV

Washability Analyses of an Uncorrelated Bed Coal Sample (UA-131)
Kenai Field, Happy Creek, Alaska

Raw Coal Bed Moisture = 23.25

Product	DIRECT DATA Wt %	Ash %	Btu/lb	Sulfur Percent Pyritic	Total	CUMULATIVE DATA Wt %	Ash %	Btu/lb	Sulfur Percent Pyritic	Total	Pounds of SO_2/MM Btu
Float-Sink Size 1-1/2 inches x 100 Mesh											
Float- 1.30	7.57	5.34	11875	0.03	0.32	7.57	5.34	11875	0.03	0.32	0.5
1.30 - 1.40	79.22	9.38	10997	0.04	0.40	86.79	9.03	11074	0.04	0.39	0.7
1.40 - 1.60	9.40	31.55	7701	0.06	0.42	96.19	11.23	10744	0.04	0.40	0.7
Sink - 1.60	3.81	73.33	7633	0.10	0.12	100.00	13.59	10625	0.04	0.39	0.7
Minus 100 Mesh	1.01	53.37	5174	0.04	0.22	[1]100.00	13.99	10570	0.04	0.39	0.7
Float-Sink Size 3/8 inch x 100 Mesh											
Float- 1.30	15.96	5.43	11801	0.04	0.38	15.96	5.43	11801	0.04	0.38	0.6
1.30 - 1.40	72.13	8.76	11021	0.04	0.44	88.09	8.16	11162	0.04	0.43	0.8
1.40 - 1.60	7.83	31.47	8125	0.05	0.42	95.92	10.06	10914	0.04	0.43	0.8
Sink - 1.60	4.08	75.33	3564	0.10	0.14	100.00	12.72	10614	0.04	0.42	0.8
Minus 100 Mesh	4.15	48.59	6173	0.03	0.21	[1]100.00	14.21	10430	0.04	0.41	0.8
Float-Sink Size 14 Mesh x 0											
Float- 1.30	12.07	5.85	11811	0.03	0.36	12.07	5.85	11811	0.03	0.36	0.6
1.30 - 1.40	76.19	9.06	10950	0.03	0.41	88.26	8.62	11068	0.03	0.40	0.7
1.40 - 1.60	6.79	27.68	9580	0.05	0.46	95.05	9.98	10961	0.03	0.41	0.7
Sink - 1.60	4.95	76.89	4366	0.12	0.19	100.00	13.29	10635	0.04	0.40	0.8

All results are on a Moisture Free Basis.

[1]Cumulative float-sink plus minus 100 mesh material.

TABLE XVI

Washability Analyses of Capps Bed Coal Sample (UA-127)
Beluga Coal Field, Alaska

Raw Coal Bed Moisture = 20.87

Product	DIRECT DATA Wt %	Ash %	Btu/lb	Sulfur Percent Pyritic	Total	CUMULATIVE DATA Wt %	Ash %	Btu/lb	Sulfur Percent Pyritic	Total	Pounds of SO_2/MM Btu
Float-Sink Size 1-1/2 inches x 100 Mesh											
Float- 1.30	0.86	5.93	10447	0.03	0.24	0.86	5.93	10447	0.03	0.24	0.5
1.30 - 1.40	71.81	7.98	10661	0.03	0.19	72.67	7.96	10658	0.03	0.19	0.4
1.40 - 1.60	21.35	27.29	8069	0.03	0.16	94.02	12.35	10070	0.03	0.18	0.4
Sink - 1.60	5.98	56.48	5047	0.03	0.13	100.00	14.99	9770	0.03	0.18	0.4
Minus 100 Mesh	1.83	42.27	6194	0.04	0.15	[1]100.00	15.49	9704	0.03	0.18	0.4
Float-Sink Size 3/8 inch x 100 Mesh											
Float- 1.30	26.61	3.78	11115	0.03	0.19	26.61	3.78	11115	0.03	0.19	0.3
1.30 - 1.40	47.03	9.61	10125	0.03	0.15	73.64	7.50	10483	0.03	0.16	0.3
1.40 - 1.60	19.65	25.43	8242	0.03	0.10	93.29	11.28	10011	0.03	0.15	0.3
Sink - 1.60	6.71	54.07	4699	0.03	0.11	100.00	14.15	9654	0.03	0.15	0.3
Minus 100 Mesh	1.88	36.41	6956	0.04	0.15	[1]100.00	14.57	9603	0.03	0.15	0.3
Float-Sink Size 14 Mesh x 0											
Float- 1.30	19.54	3.84	11782	0.03	0.17	19.54	3.84	11782	0.03	0.17	0.3
1.30 - 1.40	24.81	7.60	10860	0.01	0.17	44.35	5.94	11266	0.02	0.17	0.3
1.40 - 1.60	51.86	21.54	8937	0.03	0.19	96.21	14.35	10011	0 .02	0.18	0.4
Sink - 1.60	3.79	46.62	5072	0.03	0.17	100.00	15.57	9824	0.03	0.18	0.4

All results are on a Moisture Free Basis.

[1]Cumulative float-sink plus minus 100 mesh material.

TABLE XVII

Washability Analyses of the Top Six Feet of Waterfall Bed Coal Sample (UA-148)
Capps Basin, Beluga Field, Alaska

Raw Coal Bed Moisture = 22.17

	DIRECT DATA					CUMULATIVE DATA					
				Sulfur Percent					Sulfur Percent		Pounds of
Product	Wt %	Ash %	Btu/lb	Pyritic	Total	Wt %	Ash %	Btu/lb	Pyritic	Total	SO_2/MM Btu
					Float-Sink Size 1-1/2 inches x 100 Mesh						
Float- 1.30	13.93	4.09	11436	0.01	0.23	13.93	4.09	11436	0.01	0.23	0.4
1.30 - 1.40	25.36	12.26	10138	0.04	0.30	39.29	9.36	10598	0.03	0.28	0.5
1.40 - 1.60	19.75	31.31	7502	0.07	0.33	59.04	16.70	9562	0.04	0.29	0.6
Sink - 1.60	40.96	72.33	2708	0.05	0.13	100.00	39.49	6755	0.05	0.23	0.7
Minus 100 Mesh	1.10	57.96	4154	0.04	0.20	[1]100.00	39.69	6726	0.05	0.23	0.7
					Float-Sink Size 3/8 inch x 100 Mesh						
Float- 1.30	11.64	3.59	11486	0.01	0.24	11.64	3.59	11486	0.01	0.24	0.4
1.30 - 1.40	29.31	11.29	10526	0.02	0.29	40.95	9.10	10799	0.02	0.28	0.5
1.40 - 1.60	18.25	22.26	7891	0.08	0.31	59.20	13.16	9902	0.04	0.29	0.6
Sink - 1.60	40.80	68.22	3088	0.02	0.14	100.00	35.62	7122	0.03	0.23	0.6
Minus 100 Mesh	2.50	50.80	3848	0.05	0.19	[1]100.00	36.00	7040	0.03	0.23	0.7
					Float-Sink Size 14 Mesh x 0						
Float- 1.30	0.00	0.00	00000	0.00	0.00	0.00	0.00	11099	0.02	0.25	0.5
1.30 - 1.40	10.45	5.11	11099	0.02	0.25	10.45	5.11	11099	0.02	0.25	0.5
1.40 - 1.60	51.39	25.09	8045	0.05	0.36	61.84	21.71	8561	0.04	0.34	0.8
Sink - 1.60	38.16	57.29	4189	0.04	0.22	100.00	35.29	6893	0.04	0.30	0.9

All results are on a Moisture Free Basis.

[1]Cumulative float-sink plus minus 100 mesh material.

TABLE XVIII

Washability Analyses of an Uncorrelated Bed Coal Sample (UA-136)
Chignik Mine, Chignik Field, Alaska

Raw Coal Bed Moisture = 6.66

Product	DIRECT DATA Wt %	Ash %	Btu/lb	Sulfur Percent Pyritic	Total	CUMULATIVE DATA Wt %	Ash %	Btu/lb	Sulfur Percent Pyritic	Total	Pounds of SO_2/MM Btu
Float-Sink Size 1-1/2 inches x 100 Mesh											
Float- 1.30	5.76	4.06	13793	0.29	1.54	5.76	4.06	13893	0.29	1.54	2.2
1.30 - 1.40	29.80	7.65	12738	0.54	1.92	35.56	7.07	12909	0.50	1.86	2.9
1.40 - 1.60	14.69	20.49	10962	1.01	2.02	50.25	10.99	12340	0.65	1.91	3.1
Sink - 1.60	49.75	59.53	4635	1.22	1.51	100.00	35.14	8507	0.93	1.71	4.0
Minus 100 Mesh	1.58	41.21	7408	0.93	1.97	[1]100.00	35.24	8490	0.93	1.71	4.0
Float-Sink Size 3/8 inch x 100 Mesh											
Float- 1.30	4.63	3.31	13847	0.22	1.48	4.63	3.31	13847	0.22	1.48	2.1
1.30 - 1.40	28.25	6.56	13243	0.46	1.82	32.88	6.10	13328	0.43	1.77	2.7
1.40 - 1.60	16.80	22.96	10405	0.81	2.02	49.68	11.80	12340	0.56	1.86	3.0
Sink - 1.60	50.32	60.16	4425	1.22	1.68	100.00	36.14	8357	0.89	1.77	4.2
Minus 100 Mesh	3.20	35.24	8564	0.82	1.92	[1]100.00	36.11	8364	0.89	1.77	4.2
Float-Sink Size 14 Mesh x 0											
Float- 1.30	4.19	2.75	13711	0.16	1.34	4.19	2.75	13711	0.16	1.34	2.0
1.30 - 1.40	31.34	8.00	12856	0.36	1.67	35.53	7.38	12957	0.34	1.63	2.5
1.40 - 1.60	16.00	20.69	10971	0.81	1.82	51.53	11.51	12340	0.48	1.69	2.7
Sink - 1.60	48.47	59.34	4704	1.32	1.68	100.00	34.69	8639	0.89	1.69	3.9

All results are on a Moisture Free Basis.

[1]Cumulative float-sink plus minus 100 mesh material.

CONCLUSIONS

Washability studies showed that coals from Elusive creek and Kokolik river can be cleaned to produce premium quality low ash, low sulfur products.

High volatile A bituminous coal from Nulato has high ash content and could be cleaned to give a product with 10.1 percent ash and F.S.I. of 9.6 and ranks as one of the best coking quality coals in Alaska. However, economically recoverable seams have not yet been identified.

Subbituminous 'B' coal from Coal creek can be washed to give a product less than 10.0 percent ash at low yields.

Coal from Chicken gave acceptable ash in washed coal at low yields. The sulfur content in the sample is high. Much of the sulfur was organic and no significant reduction in sulfur is possible by cleaning.

No. 1 bed coal from Nenana field can be washed to give a product with 10.0 percent ash. No. 3 bed is low in ash and can be washed to give a premium quality low ash, low sulfur product.

The coal bed on Marguerite creek is low in ash and can be washed to give lower ash product.

The coal bed from the Yanert mine is high in ash. Cleaning will give poor yield at higher than acceptable ash levels in the product.

Coal from the Dunkle Mine in the Broad Pass field can be washed to obtain an acceptable product. Finer crushing improved liberation of ash forming in purities.

Coal beds from Ninilchik and Happy creek in the Kenai field can be washed to give low sulfur products with acceptable ash.

The Capps bed and the top 6 feet of the Waterfall bed which is high in ash, can be washed to give a low sulfur product with acceptable ash content.

The coal bed from the Chignik Bay coal mines can be washed to give an acceptable product at low yields.

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