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ALASKA COAL SUMMARY - 1983

By

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Geological and Geophysical Surveys

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"Coal in truth stands not beside but entirely above all other commodities. It is the material energy of the country---the universal aid---the factor in everthing we do. With coal almost any feat is possible or easy. Without it we are thrown back into the laborious poverty of early times."

JEVONS

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INTRODUCTION

Within the past several years, an awareness of Alaska's coal and energy potential has increased, and several more firms have developed exploration and development programs on the coal fields of the 49th State. This is the first of annual updates on the coal resources and coal industry of Alaska planned by the Division of Geological and Geophysical Surveys (DGGS).

In general, the state has looked favorably on this increased activity in the belief that coal development will ultimately prove advantageous. Government leaders hope future coal mining will not only result in a productive trade economy between Pacific-rim nations and Alaska but will create stable, long-term employment opportunities for Alaskans and allow both for diversification of the economy within the state and the development of parallel-growth industries. They also point to the probability that an improvement in rail and other land-based transportation systems will occur as new industry levels support it, and that this increased infrastructure will be used efficiently for multiresource development. (Harbor facilities such as

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those being built at Seward, for instance, could spur the creation of an export market for Alaskan agricultural products.) In addition to the economic aspects relating to coal development, the state is also concerned with environmental issues, permitting, and the enforcement of mining and reclamation regulations.

As a part of its geologic and resource data-gathering responsibilities in Alaska, DGGS will monitor the future activities of industry in coal exploration and development and will summarize recent events annually, In addition, coal-resource estimates will be reviewed and refined or altered as exploration drilling and geologic mapping progress into the more remote areas of the state. So that these reports may serve the needs of a hroad spectrum, comments on the accuracy of information and suggestions to improve future editions are sought.

ALASKA COAL OVERVIEW

Coal is found in all physiographic regions of Alaska. 'Black diamond' deposits underlie literally millions of acres of the 'Last Frontier.' The total Btu equivalent of the coal in Alaska exceeds by several magnitudes that present in all the oil that ultimately will flow from the state.

Coal is known to occur in over half of Alaska's 153 quarter-million scale quadrangles of Alaska (fig. 1). They occur in several fields or basins and in many relatively isolated locations (fig. 2), including offshore beneath the Chukchi Sea, Cook Inlet, and Norton Sound. Some areas in Alaska near tidewater may have the greatest coal-bearing potential of any undeveloped coal 'property' in the United States. A summary of Alaska's various coal-bearing areas and their relative development potential is given in table 1.

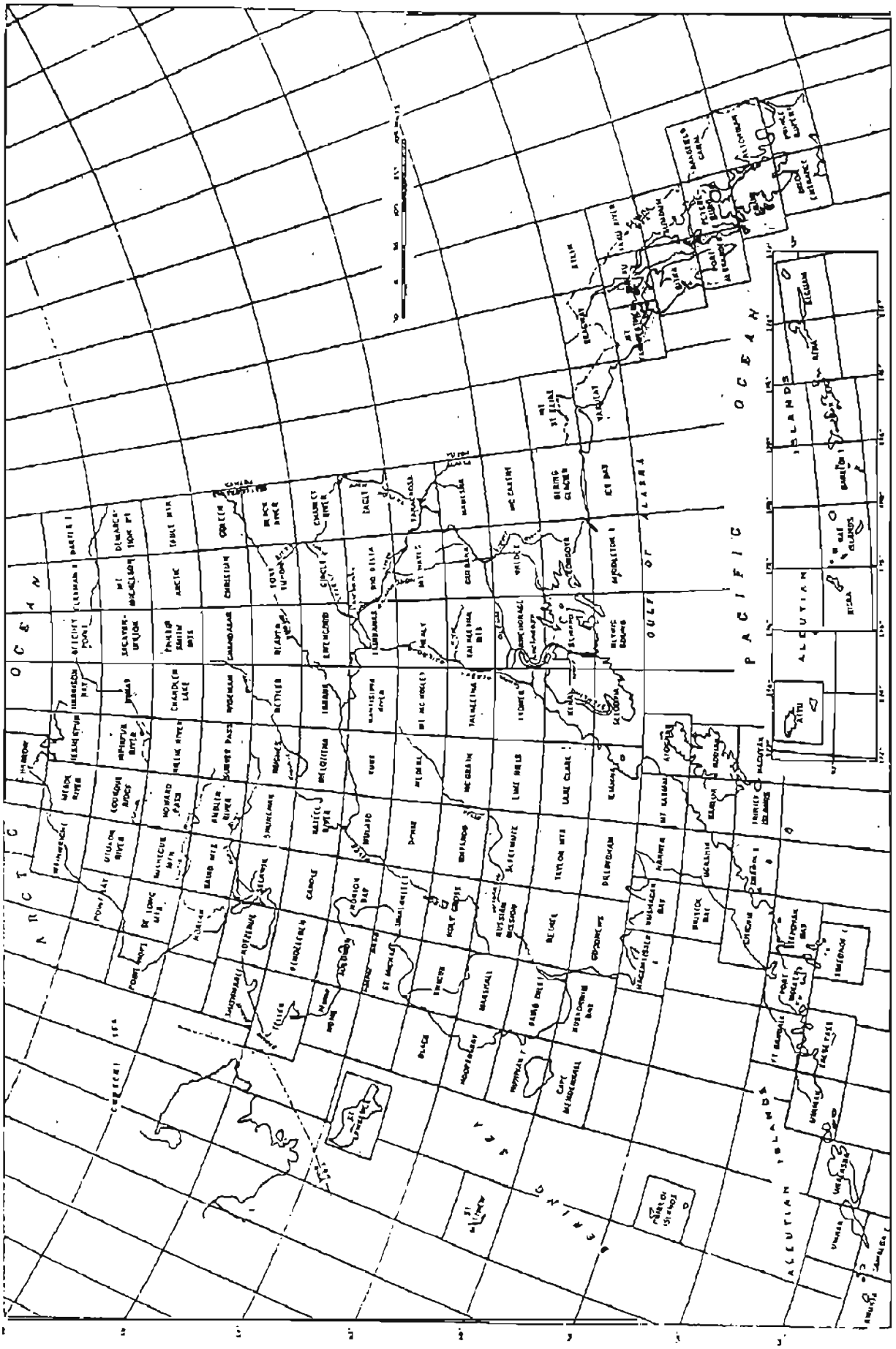

Figure , Alaska's 1:250,000-scale quadrangles with known coal occurrences.

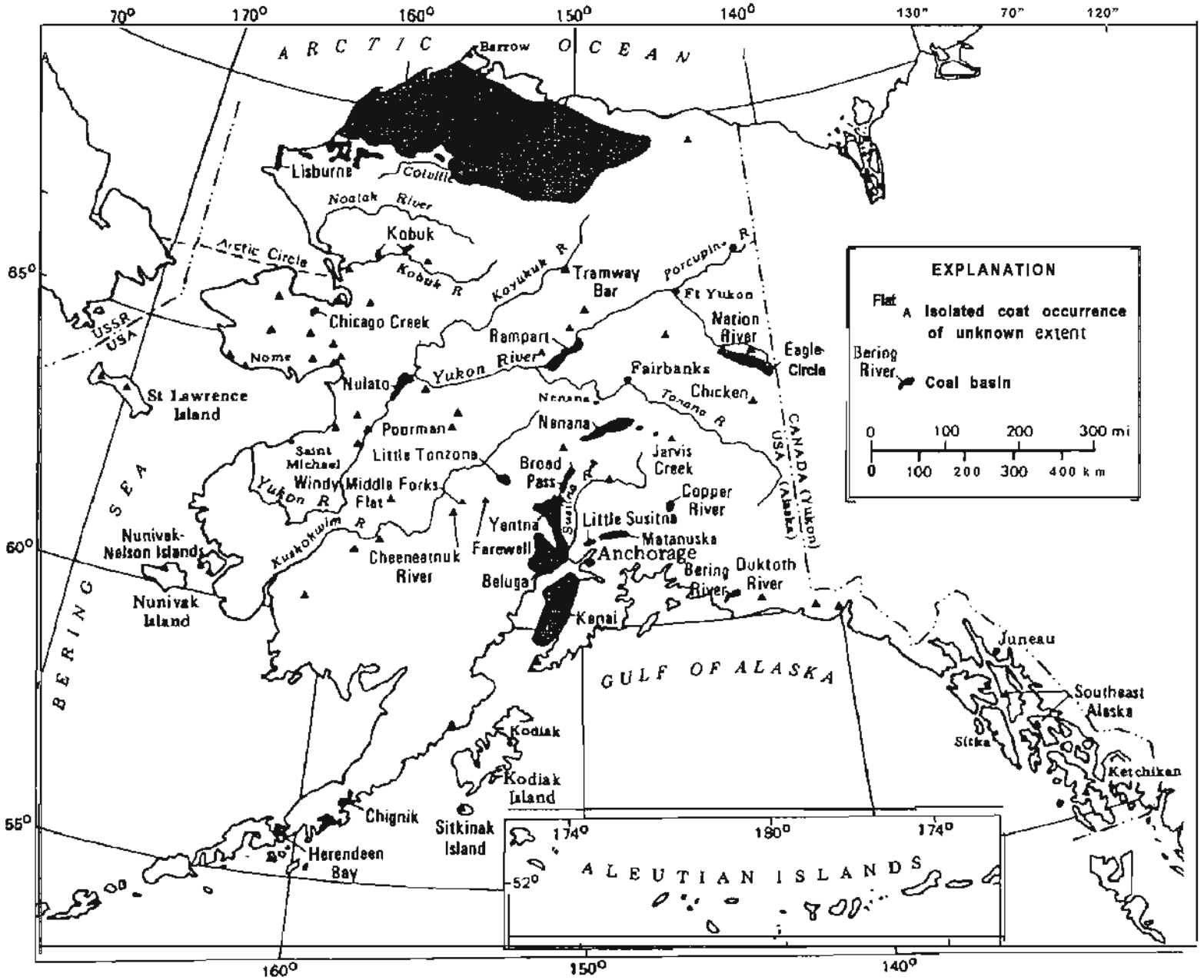

Figure 2. Alaska's coal basins, fields, and isolated occurrences.

'Table 1. Relative rankings of coal development potential for various areas in Alaska.

Coal area	Quadrangle	Coal formation/age	Coal potential[a]
Northern Alaska (Arctic Coastal Plain and Foothills provinces	Various	Nanushuk Group/ Cretaceous	1
Lisburne (Point Hope) field	Point Hope	Mississippian	
Kobuk field	Baird Mountains	Cretaceous	?
Chicago Creek	Bendeleben	Tertiary	1
Seward Peninsula (other)	Various	Tertiary	3
Tramway Bar (northeast of Bettles)	Wiseman	Cretaceous	2
Nulato (Lower Yukon) field	Nulato, Kateel River	Kaltag/ Cretaceous	2
Poorman	Ruby	Creraceous	3
Flat	Iditarod	Cretaceous	3
Rampart (Yukon-Tanana) field	Livengood, Tanana	Cretaceous	3
Nation River	Charley River	Paleozoic(?)	3
Eagle-Circle (Upper Yukon) field	Charley River, Eagle	Tertiary	3
Chicken	Eagle	Tertiary	3
Nenana field	Healy, Fairbanks, Mt. Hayes	Healy Creek, Suntrana, and Lignite Creek/Tertiary	1
Jarvis Creek	Mt. Hayes	Healy Creak/ Tertiary	1

[a] 1 = high potential; 2 = moderate potential; and 3 = low potential, as ranked by author.

Table 1. (Con.)

Little Tonzona River-Farewell	McGrath	Tertiary	2
Cheeneetnuk River, Windy-Middle Forks of Kuskokwim River	McGrath, Lime Hills	Tertiary	3
Nunivak-Nelson Islands (Etolin Strait)	Nunivak Island-Baird Inlet	Tertiary	3
Broad Pass	Healy, Talkeetna Mountains	Tertiary	3
Susitna Lowland (Beluga, Yentna fields)	Talkeetna, Talkeetna Mountains, Tyonek, Anchorage	Kenai Group/ Tertiary	1
Matanuska field	Anchorage	Chickaloon/ Tertiary	1
Little Susitna (Houston)	Anchorage	Tertiary	3
Kenai field	Seldovia, Kenai, Tyonek	Kenai Group/ Tertiary	2
Bering River field	Bering Glacier, Cordova	Kushtaka/ Tertiary	1
Duktoth River (Robinson Mountains)	Fering Glacier	Kultieth/ Tertiary	3
Sitkinak Island	Trinity Islands	Tertiary	3
Chfgnik Field	Chignik	Chignik/ Cretaceous	1
Herendeen Bay field	Port Miller	Cretaceous, Tertiary	1
Southeastern Alaska	Various	Tertiary	3

Alaska probably contains half of the coal resources of the United States and 15 percent of the total world coal resources (table 2). Hypothetical coal resource estimates for the state range from 2.0 to >5.5 trillion short tons. Including the deposits offshore, the higher figure is probably more accurate. Only the Soviet Union, the People's Republic of China, and the contiguous United States contain as much coal as Alaska (table 3). Alaska probably has 10 percent of the technically and economically recoverable reserves of the world.

The measured coal reserves and demonstrated coal reserve base of Alaska are currently over 6.0 billion short tons, indicated and inferred resources are over 15 billion short tons, and identified resources are about 170 billion short tons (fig. 3).[2]

Averitt (1973) ranked Alaska fifth among the states in terms of total remaining coal resources (table 4). The three largest coal provinces of the state are northern Alaska, the Cook Inlet-Susitna Lowland, and the Nenana trend (table 5). Geologists estimate that 75 to 90 percent of Alaska's coal underlies the 23-million-acre National Petroleum Reserve on the North Slope.[3] The North Slope province (including offshore extensions) could very well be the largest single coal deposit on earth, particularly in terms of total-Btu content.

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[2] The degree of assurance of accuracy decreases from measured resources to indicated and inferred resources to identified resources. Identified resources in general occupy a position of intermediate assured accuracy between measured and hypothetical resources. Hypothetical resource estimates span a broad range of possible error, Appendix A is a glossary of commonly used coal-classification terms.

[3] Based on modified calculation made by McGee and Emmel (1979) but not stated.

Table 2. Alaska coal resources compared to contiguous United States and world. Modified from McConkey and others (1977).

	Total coal resources (trillion short tons)	Amount in Alaska (%)	Probable amount in Alaska (%)
Alaska	2.0 - 5.5	we-	---
United States	4.5 - 9.0	44 - 61	50
World	20.0 - 25.0	10 - 22	15

Table 3. World coal resources (percent total resource basis).[a]

Country	Geological resources		T echnfcally and economically recoverable reserves	
Soviet Union	40.0		16.5	
People's Republic of China	16.0		15.0	
Contiguous United States	15.0		15.0	
Alaska	15.0		10.0	
Total United States		30.0		25.0
Australia	4.5		5.0	
Canada	2.5		0.5	
Federal. Republic of Germany	2.0		5.0	
United Kingdom	1.5		4.5	
Poland	1.0		8.0	
India	0.5		2.0	
Republic of South Africa	0.5		6.5	
Other countries	1.5		10.0	
World total	100.0		100.0	

[a]Data from various sources (including Wilson, 1980) and reflect magnitude percentage of total only.

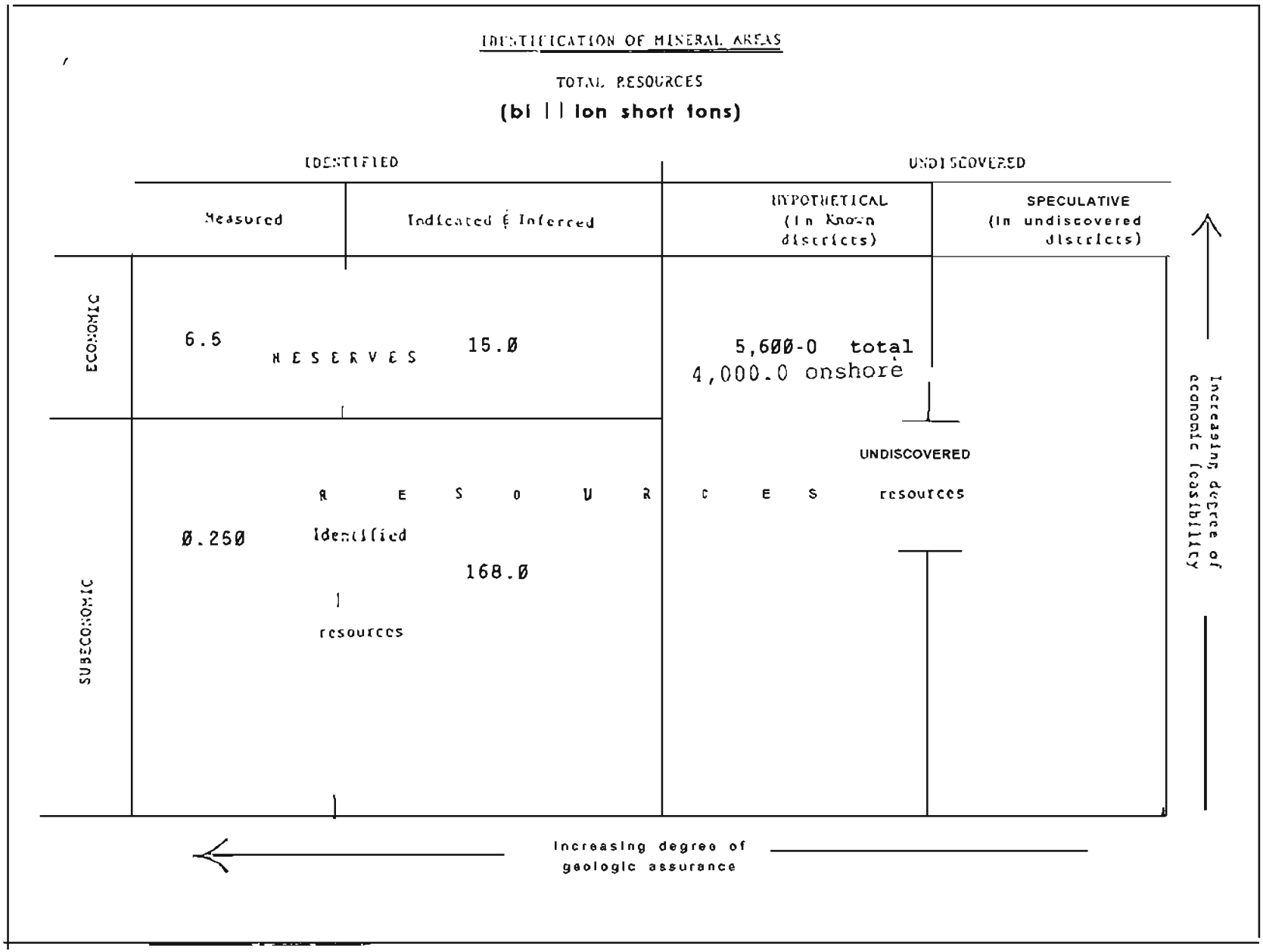

Figure 3. Alaska coal-resource estimates according to the coal classification system used by the U.S. Bureau of Mines and U.S. Geological Survey (classification scheme only modified after the U.S. Geological Survey, 1976).

Table 4. Total estimated remaining coal resources (to 6,000-ft-depth) of major coal-resource states of U.S. Modified from Averitt (1973). Rankings are not based on energy equivalency.

State	Coal resources (billion short tons)	Type
Wyoming	546	Subbituminous
North Dakota	531	Lignite
Montana	379	Subbituminous, lignite
Colorado	372	Bituminous
Alaska	1.65	Bituminous, subbituminous
Illinois	239	Bituminous
Kentucky	117	Bituminous
New Mexico	109	Subbituminous, bituminous
West Virginia	101	Bituminous
Pennsylvania	a7	Bituminous, antbracite

Table 5, Summary of the coal resources of Alaska (in millions of short tons). Modified from McGee and Emmel (1979).

Region	Identified resources	Hypothetical resources
Northern Alaska coal province	150,000	to 4,000,000
Cook Inlet-Susitna Lowland coal province	11,000	over 1,600,000
a. Beluga and Yentna fields	10,000	to 30,000
b. Kenai field (including offshore deposits)	320	to 150,000[a] to 1,500,000[b]
c. Matanuska field	120	to 500
d. Broad Pass field	50	to 500
Nenana trend coal province[c]	8,000	to 20,000
Jarvis Creek field	75	to 175
Other interior coal occurrences (total)	---	to 5,000
Bering River field	100	to 3,500
Chignik Bay-Herendeen Bay fields	200	to 3,000
Alaska (total)	170,000	ever 5,600,000

[a] Includes offshore deposits to 2,000-ft depth
[b] Includes offshore deposits to 10,000-ft depth.
[c] Includes Farewell-Little Tonzona field.

Additionally, there is coal in remote areas of Alaska that hasn't been 'counted' yet. New discoveries are being made almost every year. Coal may underlie large areas of the Yukon Flats Cenozoic basin (Barker, 1981), and deposits along the Nenana trend have been extended up to 200 mi southwestward (Player, 1976). Surficial expression of existent coal deposits in many areas of Alaska known to contain large quantities of coal is poor to absent.

Geologically, Alaskan coals are chiefly of Cretaceous and Tertiary age (table 6). However, coals of the Lisburne field are Carboniferous (Mississippian), and coal at Nation River, originally thought to be Devonian, is probably late Paleozoic (Pennsylvanian?). The coals range in rank from lignite to anthracite, but roughly 60 percent of Alaska coal is bituminous and 40 percent subbituminous (Martin and Callahan, 1978); only minor amounts are anthracite and lignite. Semianthracite to meta-anthracite occurs locally in the Bering River and Matanuska fields. Alaska coals are comparable in quality with other western U.S. coals (table 7).

In addition to the vast resource base and wide distribution, the extremely low sulfur contents and near proximity to coastal access in certain areas are important selling points for Alaska coal. Exploration, technology, and economics will ultimately determine the marketability of Alaska's coal resources. Large-scale exploration programs have been conducted in most of Alaska's coal fields for the past decade by private industry and by the state and federal governments. Technologically, the mining of coals in areas of the state underlain by permafrost may present the most formidable challenge. Northern Alaska and much of western Alaska is underlain by continuous permafrost. Southeastern Alaska, the Alaska Peninsula, and parts of south-central Alaska surrounding Cook Inlet are generally free of permafrost, whereas interior Alaska has discontinuous permafrost (Ferrians, 1965).

Table 6. Geologic characteristics of Alaskan coal deposits. Modified from Schaff, in COACMAR (1980).

Region	Basin	Field	Age of strata	Rank of coal	Geologic structure	Probable mining method	Thickness of coal seams
Arctic	North Slope	Arctic coastal plain fields: Meade River, Colville River, etc.	Mainly Cretaceous; minor Tertiary	Subbituminous	Flat lying	Surface mining, possible underground mining in permafrost	10-ft beds common; 20- to 40-ft beds known; most beds greater than 3½ ft
		Foothills fields		Bituminous	Broad folds		
	Other	Point Hope	Mississippian	Bituminous	Highly deformed	Surface mining	Maximum known thickness 6 ft
Interior	Nenana	Healy Creek Lignite Creek Jarvis Creek Wood River Tatlanika Teklanika	Tertiary (Oligocene-Miocene)	Subbituminous	Moderately dipping fault blocks and gentle folds	Surface mining, possible underground mining	Considerable variation between 2½ and 60 ft
	Other[a]	Eagle-Circle	Tertiary	Subbituminous to bituminous	Open folds	Surface and underground mining	One bed 27 ft thick
South-central	Cook Inlet	Broad Pass Yentna Beluga Susitna	Tertiary	Lignite Subbituminous to lignite	Narrow graben Flat-lying to gentle broad folds, minor faulting	Surface mining Surface mining	5 to 10 ft 6 to 50 ft Several beds over 20 ft
		Matanuska		Anthracite to subbituminous	Complexly folded and faulted	Surface and underground mining	2 to 23 ft
		Kenai Kenai Offshore		Lignite to subbituminous	Predominantly flat lying	Surface mining, underground mining in selected areas	2% to 10 ft

Table 6. (Con.)

South-central	Bering River	Tertiary	Bituminous to semianthracite	Extremely deformed	Surface and underground mining	Unknown. Thick podlike masses that thin rapidly
Other	Chignik Herendeen Bay	Late Cretaceous and Tertiary	Bituminous and subbituminous	Moderately folded and faulted	Small underground mines; local small surface mines	Numerous beds less than 2 ft thick. Composite zones of coal and thin shale interbeds in excess of 8 ft

aNOTE: Includes coal occurrences at Nulato, Rampart, etc. Little is known of the extent of these resources; they are late Cretaceous or Tertiary, bituminous and subbituminous.

Table 7. Representative analyses of Alaskan coals on as-received basis. Compiled from various sources.

Coal area	Moisture(%)	Volatile matter(%)	Fixed carbon(%)	Ash(%)	Sulfur(%)	Heating value (Btu/lb)	Rank[a]
Arctic Slope							
Foothills	2-10	31-36	53-58	4-15	0.1-0.3	10,000-13,500	hvCb
Coastal Plain	8-20	30-36	38-50	3-20	0.2-0.8	7,700-10,700	subB
Nulato	I-10	25-40	47-65	3-22	0.2-0.6	9,100-9,750	hvCb
Eagle	2-15	20-45	40-55	2-22	0.2-0.6	10,900-11,500	mvb
Nenana	10-31	21-43	24-45	3-30	0.2-1.2	6,200-9,800	subC
Jarvis Creek	20-25	35-45	25-35	5-15	0.3-1.5	7,800-9,500	subC
Broad Pass	20-35	27-35	20-28	10-20	0.2-0.4	5,500-7,100	lig
Susitna Lowland	10-30	28-40	25-45	3-30	0.1-0.7	6,200-9,500	subC
Kenai	20-27	30-38	25-35	3-25	0.2-0.4	6,500-8,500	subC
Matanuska Valley							
Wishbone Hill	3-9	32-45	38-51	4-22	0.2-1.0	10,400-13,200	hvBb
Chickaloon	1-5	14-24	60-72	5-20	0.4-0.7	11,960-14,400	lvb
Anthracite Ridge	3-9	7-11	65-81	7-20	0.2-0.7	10,720-14,000	sa
Bering River	1-8	13-17	65-91	2-18	0.1-1.0	11,000-15,000	lvb
Chignik-Herendeen	7-8	32-35	45-51	7-12	0.2-0.4	11,300-11,800	hvBb

[a] sa = semianthracite, lvb = low-volatile bituminous, mvb = medium volatile bituminous, hvBb = high-volatile B bituminous, hvCb = high-volatile C bituminous, subB = subbituminous B, subC = subbituminous C, lig = lignite.

Pacific-rim countries are potential markets for large-scale coal exports. Alaska is closer to these markets than other possible coal-exporting countries--- Canada, Australia, and South Africa (fig. 4). Orientals typically view Alaska as a veritable 'treasure house' of energy and mineral resources and seek to obtain equity interests in the state. Test shipments of Alaska coal to Korean utilities have been made in hopes of establishing long-term contracts. Production at the Usibelli Coal Mine in the interior is slated to double by 1985 to meet the terms of the first Far Eastern contract for Alaska coal. Shipments from the mine near Healy will travel via the Alaska Railroad (fig. 5) to seward on the Gulf of Alaska and thence by cargo ships to Korea. Harbor facilities and dredging operations are being completed at Alaska's first coal port. Once dredging is completed, the port of Seward will be able to handle 65,000-ton cargo vessels. In addition to exports, Alaskan coals can be substituted for expensive and uncertain supplies of fuel oil in many Alaskan towns and villages. Mine-mouth power plants and the generation of synthetic fuels (as methanol) are other options.

Although there has recently been a substantial interest in Alaska's coal, it has in fact been studied and mined for over a century. The first coal mine in Alaska was opened by the Russian-American Company in 1855 near Port Graham on the Kenai Peninsula (table 8); coal has since had a rich end colorful history. Coals have been used for local use, for powering river steamers, whaling ships, railroad, and as the major fuel source for some communities.

Coal was mined near the village of Atkasuk on the Meade River in northwest Alaska and was extracted for use by ships and freighters at Corwin

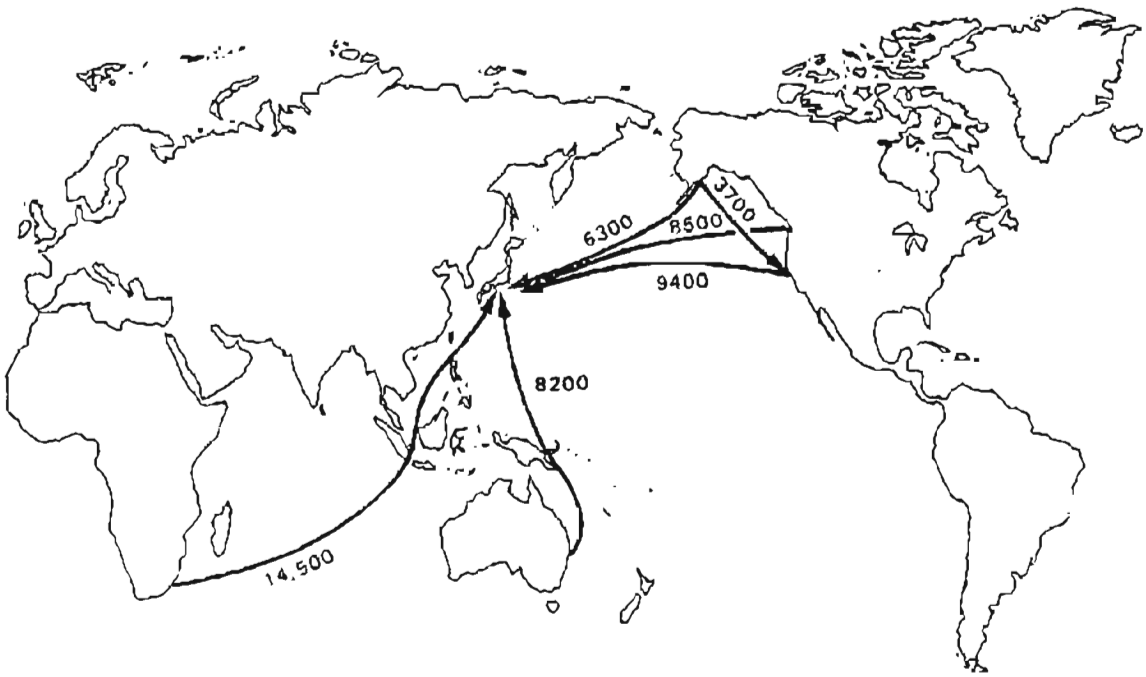

Figure 4. Round-trip ocean freight distances. Alaska coal-shipping points to Pacific markets (in nautical miles). Modified from Swift and others 11981).

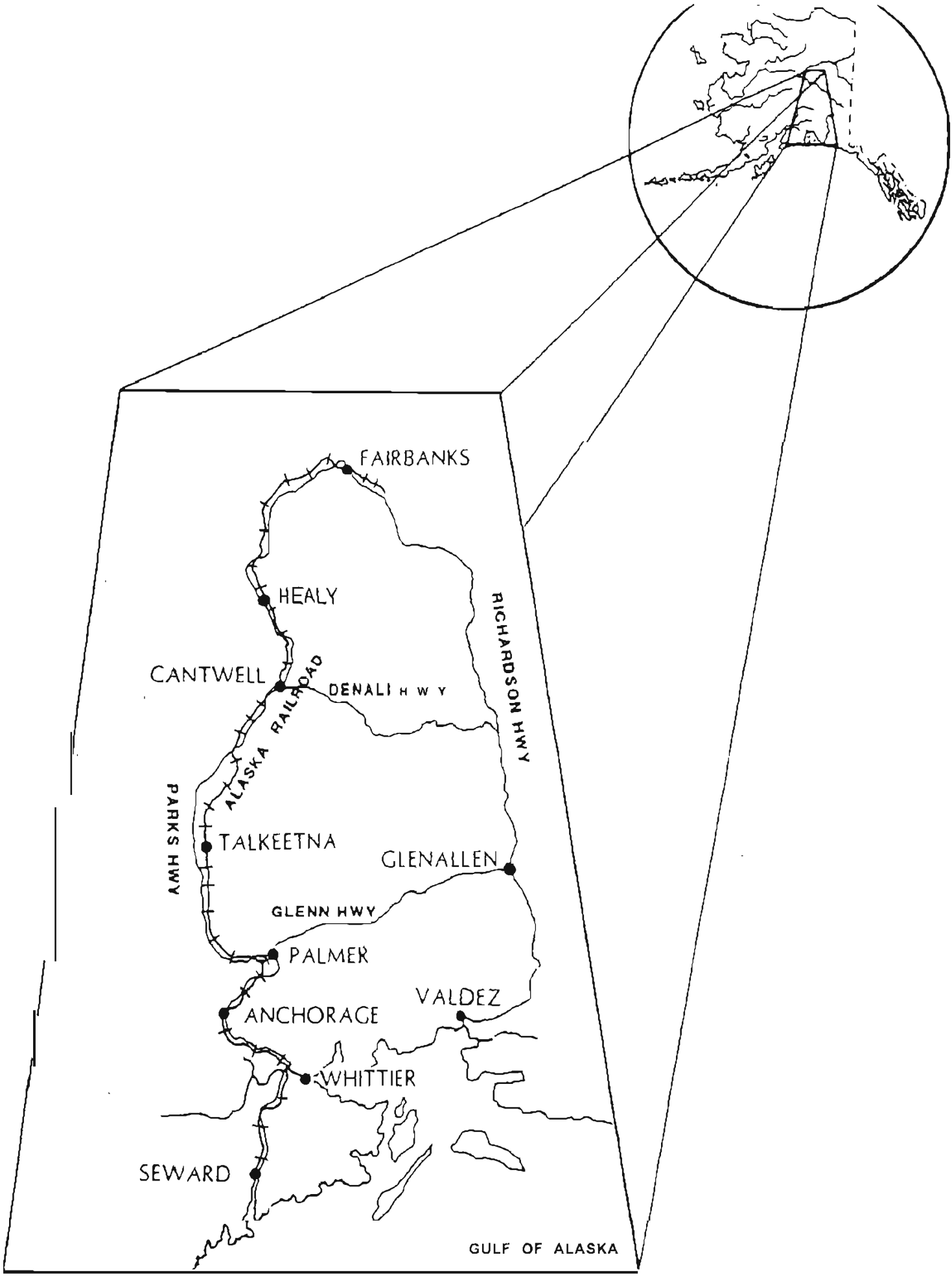

Figure 5. Generalized location map of Alaska rail-belt region. Modified from PJ angraphics, Inc. (1983).

Table 8. Chronology of coal development and production in Alaska, 1786-1977. Modified from McConkey and others (1977).

1786	Captain Nathaniel Portlock, English trader, finds coal at Coal Cove (now Port Graham) on the Kenai Peninsula.
1855	First Alaska coal mine opened by the Russian-American Company at Coal Cove.
1862	First coal mined in southeastern Alaska at Sepphagen Mine, Kootznahoo Bay, Admiralty Island.
1879	Whaling ships and U.S. Revenue cutters start using coal from the Corwin mines along the Arctic coast.
1898	Yukon sternwheelers use coal as fuel to transport gold seekers to gold fields.
1900	Coal laws of U.S. extended to Territory of Alaska.
1902	Yukon River steamers convert coal and wood burners to petroleum engines.
1904	Coal Act ratified; allows coal claim locations without previous surveys.
1906	President Theodore Roosevelt closes Alaska public land to entry under coal laws because of Pinchot-Ballinger feud.
1911	Cordova 'Coal Party'---imported coal shoveled into the harbor in protest of federal coal policies; Gifford Pinchot burned in effigy.
1912	U.S. Navy investigates Bering River coal.
1914	U.S. Congress passes Alaska Coal Leasing Act; Chickaloon coal tested aboard the U.S.S. Maryland.
1916	Alaska Railroad is built to the Matanuska coal field.
1919	Alaska Railroad reaches Nenana coal field.
1972	Railroad spur (4.4 miles long) up Healy Creek to Suntrana Mine completed.
1924	U.S. Navy begins converting coal-burning ships to oil.
1940	Coal used to power dredges at large placer mining operations near Fairbanks.
1942	Alaska Railroad reopens Eska Mine (Matanuska field). Coal needed for new army posts and military airfields.
1943	Traditional underground coal mining in Alaska gives way to surface-mining methods.
1946	Alaska Railroad begins converting from coal-burning engines to diesels; Eska Mine closes.
1968	Fort Richardson and Elmendorf Air Force Base convert coal-fired steam power plants to natural gas. Matanuska field shuts down except for small mines filling local needs.
1973	OPEC oil embargo and severe winter cause oil and gas shortage.
1977	President Carter's energy policy includes conversion of utilities and industry to coal, prompting interest in the Beluga and Jarvis Creek coal field; Surface Mining Control and Reclamation Act passes.

Bluff on the Chukchi Sea coast. Captain C.L. Hooper reportedly took on 20 tons of coal here for his ship, the Cot-win, in 1881. Coals have been used for years by placer miners of the Dutch and Peters Hills areas of the northern Susitna Lowland. Cache Creek Dredging operated the Short Creek Mine on a small tributary of the Yentna River beginning in 1916 to supply power for its gold dredge. The underground coal mine at Suntrana, which operated from 1922 to 1962, was the largest coal mine in the Alaskan Territory around 1940. The Gold Run Pass Mine, now operating intermittently as an ancillary pit of the Usibelli Mine, opened in 1955 south of Sanderson Creek, a tributary to Lignite Creek. Several hundred tons of coal were produced from a small operation in the Jarvis Creek field in 1958 (fig. 6).

Early coal production in Alaska was dominated by underground mining, but today's production is entirely by surface mining (fig. 7). More coal was produced in the mid-1960's---when the Anchorage area military bases used it---than now. The Usibelli Coal Mine (fig. 8) annually produces about 800,000 short tons of coal from the Poker Flats pit of the Lignite Creek field.

RESOURCE SUMMARY BY AREA

NORTHERN ALASKA

In terms of area and resource base, the northern Alaska coal fields form by far the largest coal-resource province of the nation. Basically, the deposits consist of a largely bituminous subprovince to the south near the

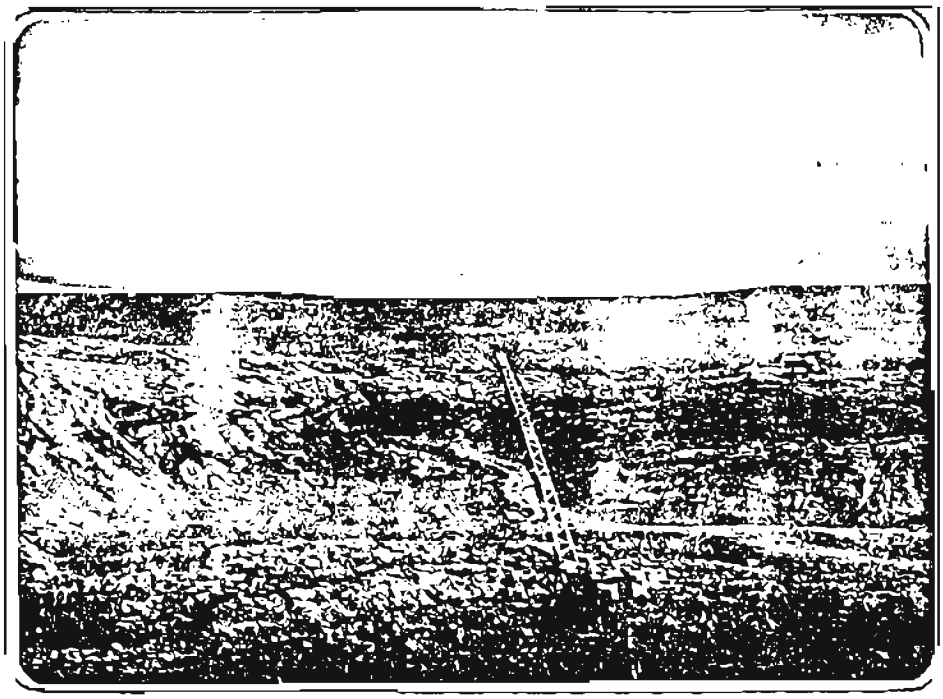

Figure 6. Old mine site, Jarvis Creek coal field. Coal beds of Healy Creek Formation crop out near left margin of photo (July 1983).

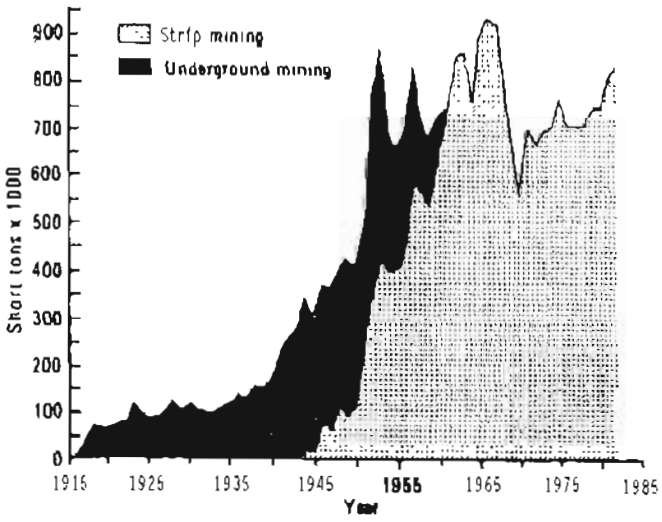

Figure 7. Coal production in Alaska, 1915-82. From Eakins and others (1983).

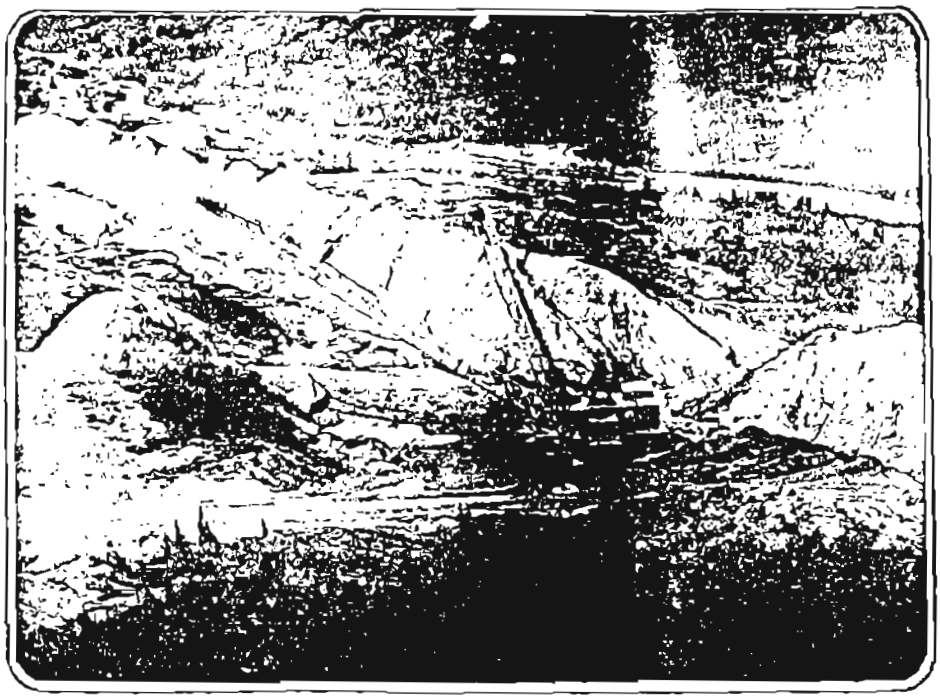

Figure 8. Usibelli Coal Mine's 'Ace-in-the-Hole' dragline (July 1982).

north flank of the Brooks Range and a wide belt of predominantly subbituminous coals farther north. The coals of the entire province occur mainly within the Corwin Formation of the Cretaceous Nanushuk Group and its equivalent units; this group attains its greatest thickness, about 11,000 ft, in the southwestern part of the province near Cape Lisburne. Coal beds 15 to 40 ft thick are characteristic of the group. Callahan and Martin (1981) developed a deltaic sedimentation model to explain the lithofacial relationships and depositional environments of the Corwin and Kukpowruk Formations, which compose the Nanushuk Group on the Arctic Coastal Plain and in the foothills of the western North Slope. Major coal resources are found within the National Petroleum Reserve - Alaska (NPRA) (which in energy terms is a misnomer) and both west and east of it. Mississippian coals of the Lisburne field are the oldest in Alaska. The coal-bearing unit extends north-south for about 40 mi from Cape Dyer to Cape Thompson. Identified resources of the northern Alaska coal fields range up to 150 billion short tons, and hypothetical resources range upward to 4 trillion short tons.

COOK INLET-SUSITNA LOWLAND

The second largest coal resource base in Alaska, the Cook Inlet-Susitna Lowland coal province, is composed of several major subbasins or fields. These include the Beluga, Yentna, Little Susitna, Matanuska, Broad Pass, and Kenai coal fields and the deposits offshore in Cook Inlet. The coals of the Beluga and Yentna fields of the Susitna Lowland[3] occur within three formations of the nonmarine Tertiary Kenai Group. Most of the major minable seams (over 20 ft thick) of the Kenai Group are restricted to the Tyonek

Formation, whereas relatively thin lignite and subbituminous coal beds occur in the Beluga and Sterling Formations. The coal-bearing strata are relatively flat-lying, and seams over 50 ft thick may have less than 150 ft of overburden.

The Capps field contains a localized coal deposit 7 to 8 mi^2 in which two major beds, the Capps and Waterfall seams of 55- and 25-ft maximum thicknesses (respectively), occur (Patsch, 1976). The Chuitna Bed (Brown Seam) of the Belupa field crops out along the Chuitna River. It averages 28 ft thick and is underlain by five other minable seams: the Yellow, Green, Blue, Orange, and Red seams (Ramsey, 1981). Over 20 steeply dipping seams of the Belupa Formation crop out along the lower Beluga River. Minor outcrops of Tertiary coal-bearing rocks also occur along coastal areas, as at Beshta Bay on Cook Inlet. Along the western side of the Susitna Lowland, an 8-ft-thick bed crops out along Saturday Creek, and six coal beds (ranging up to 7 ft in thickness) crop out at Fairview Mountain. Coal occurrences in the Fairview Mountain region were first described by Capps (1913). Major coal deposits are also located in the Canyon Creek and Johnson Creek areas of the northwestern Susitna Lowland.

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[4] The southern part of the Susitna Lowland is generally referred to as the Beluga field; the northern portion is called the Yentna field (fig. 2).

The Susitna Lowland contains the largest reserves of coal recoverable by surface mining in southern Alaska. Identified resources of the Beluga and Yentna fields are about 10 billion short tons, of which over one-fifth are measured reserves; hypothetical resources range up to over 30 billion short tons.

Coals also underlie much of the Kenai Peninsula. Along the southern coast of the Kenai Peninsula, 37 reported coal beds of the Sterling Formation of the Kenai Group are exposed. Several of these beds can be observed on the north side of Kachemak Bay near Homer. Identified resources of the Kenai field are approximately 300 million short tons. Hypothetical resources including offshore deposits to a depth of 2,000-ft are around 150 billion short tons; to a 10,000-ft depth, they range up to 1.5 trillion short tons.

The Chickaloon Formation of the Matanuska field contains at least 30 separate coal beds in the upper half of the 3,000-ft-thick unit. The three districts of this field are Wishbone Hill, Chickaloon, and Anthracite Ridge. The seams in the Wishbone Hill area occur in the Jonesville, Premier, Eska, and Burning Bed coal groups. Coals of the Chickaloon district are of coking quality. Coals along the southern flank of Anthracite Ridge have been upgraded to semianthracite and anthracite because of igneous intrusives and regional deformation. Over 100 million tons of coal have been identified for the Matanuska field, and hypothetical resources range up to 500 million short tons. Mining in the Matanuska field was active from 1914 to 1967; maximum production was 340,000 short tons in 1962. The conversion from coal to gas by the military near Anchorage In 1967 effectively closed the coal mines in the region.

NENANA FIELD

The Nenana coal trend forms the third largest coal resource base in Alaska. Most of the favorable deposits are concentrated in the Nenana field, which trends east-west along the north-central flank of the Alaska Range for 140 mi. The important coal-bearing areas of the Nenana field include Healy Creek, Lignite Creek (now producing), Rex Creek, Tatlanika Creek, Mystic Creek, Wood River, and Jarvis Creek. The Jarvis Creek field, east of the Delta River, is essentially at the easternmost extent of the trend, but its western margin is extended farther and farther west as field mapping and exploration progress. Deposits are also found along the Little Tonzona River and even as far west as near Farewell, at Windy and Middle Forks of the Kuskokwim River, and at the Cheeneetnuk River.

Essentially all of Alaska's coal production today comes from the Nenana field near Healy. The approximately 3,000-ft-thick coal-bearing Tertiary sedimentary sequence rests directly on Precambrian or Paleozoic metamorphic rocks. The Suntrann Formation contains the bulk of the coal resources of the Nenana field. The Usibelli Mine at Poker Flats in the lower Lignite Creek basin presently is mining the 3, 4, and 6 seams, which average about 20-ft thick each. Coal seams in the Nenana field may attain thicknesses up to 60 ft. Major coal deposits occur to the south and west of Jumbo Dome, particularly along the Marguerite Creek drainage basin and upper Lignite Creek region. At least 16 significantly thick coal seams with an aggregate thickness over 100 ft are exposed along Coal Creek on the northeast side of Mystic Mountain in the Wood River Coal Basin. Identified resources of the Nenana field range to 8 billion short tons (of which nearly half are measured reserves), with 20 billion short tons of hypothetical resources; the latter estimate includes the deposits of the Little Tonzona River area.

BERING RIVER FIELD

The distribution of the coal deposits of the Bering River coal field is delineated by the outcrop extent of the Kushtaka Formation. In general, the coals increase in rank from the western part of the field to the eastern part. Coals on the west are medium-volatile bituminous; these grade eastward into low volatile bituminous, anthracite, and meta-anthracite (Sanders, 1976a; personal commun., 1983). The structure of the coal-bearing formation is complex, with the coals occurring in pod- or lense-shaped thickenings (6 to 30 ft); they are discontinuous laterally and either pinch out or are truncated by faults. Identified resources for the field are about 100 million tons, but hypothetical resources range up to over 3.5 billion short tons. The U.S. Bureau of Mines conducted extensive studies on the Bering River coals for the Navy during the early 1900's.

ALASKA PENINSULA BAYS

Two relatively unexplored coal occurrences are Chignik Bay and Herendeen Bay on the Alaska Peninsula. The Cretaceous bituminous and subbituminous coals of the Coal Valley Member of the Chignik Formation are typically less than 7 ft thick. Up to 17 beds crop out at Mine Harbor on Herendeen Bay, but most are less than 2 ft thick. Minor and thin coal seams are also found on Unga Island. Identified resources for Chignik and Herendeen Bay coal fields range up to 200 million short tons, and hypothetical resources range from <1 to over 3 billion short tons.

RECENT COAL ACTIVITY IN ALASKA

Private industry has been engaged in large-scale coal exploration drilling programs and in engineering and premine studies in several areas of Alaska in the past few years. Much of this activity has been on existing state, federal, and Native coal lease tracts (table 9), mostly in the south-central and interior regions:

1. Valley Coal and Rocky Mountain Energy completed an extensive exploration drilling program west and southwest of Wishbone Hill in the Matanuska coal field during the summer of 1983. Figure 9 shows drill equipment setup on one site and the special cyclone sample-retrieval system.

2. Four South Korean firms (KADCO, Inc.!, in cooperation with the Chugach Natives, Inc., completed drilling in the Bering River field, about 70 mi east of Cordova. Exploration In 1981 proved a 62-million-ton economically minable reserve of high-grade bituminous (averaging 12,500 Btu) and anthracite (averaging 15,800 Btu) coal. A new 10-ft-thick seam of anthracite was discovered and defined during the program.

3. Mobil Oil continued exploration on its leases in the Yentna basin ---Canyon Creek and Johnson Creek area. To date, they have completed over 25,000 ft of prospect drilling.

Table 9. Major coal leases in Alaska.

Leaseholder	Coal field	Lease type
Reluga Coal Company (Placer Amex)	a. Beluga b. Capps c. Matanuska	a. State/Native b. State c. State
Delta Coal Company	Jarvis Creek	U.S. Bureau of Land Management
Diamond-Alaska Coal Company (Diamond Shamrock)	Reluga	State
Meadowlark Farms (AMAX Coal Company)	a. Nenana b. Beluga	a. State b. State
Mobil Oil Corporation	Yentna	State
Morgan Coal Company	Northern	U.S. Bureau of Land Management
Usibelli Coal Company	Nenana	State
Valley Coal Company	Matanuska	State

Figure 9. Valley Coal Company and Rocky Mountain Energy drilling on west side of Wishbone Hill, Matanuska coal field (June 1983).

4. Diamond-Alaska Coal completed over 50,000 ft of exploration drilling on its Beluga area leases. This has involved about 150 holes and included 6,000 ft of coring. They also completed bulk-coal sampling operations on their state leases, and extracted a 500-ton sample for shipment to Japan. Figure 10 shows the Blue Pit bulk sampling site in the Beluga coal field. The company indicated that they may submit a mine-permit application this year, and tentatively plans to be in production by 1988 (assuming a market is found), with the first shipment of coal by early 1990. Their preliminary mine plan calls for an eventual production of 6 to 13 million short tons per year.

5. Beluga Coal (a Placer Amex subsidiary) essentially completed exploration of its Beluga leases in the Susitna Lowland west of Anchorage. The company plans to eventually produce up to 10 million short tons of coal per year for export. In the summer of 1982, they made a coal-test shipment to Japan; the 1,200-ton bulk sample passed shipping and long-term storage tests in the open and in silos, and did not spontaneously combust. Their plan to construct a coal-to-methanol conversion plant near the proposed mine has been temporarily shelved because of strength characteristics of the coal, the poor infrastructure of the region, and insufficient equity assistance. The recent decline in oil prices and the discovery of substantial petroleum deposits off the California coast were also important considerations.

Figure 10. Blue Pit bulk-coal sampling site, Beluga field, southern Susitna Lowland (July 1983).

Beluga Coal also studied the feasibility of reopening the Evan Jones Mine on the east side of Wishbone Hill in the Matanuska coal field. The area contains some of the best steam coal in Alaska, with a general run-of-mine heating value of 12,000 Btu. If reopened, the mine would be an underground operation and would produce about 500,000 tons of coal per year. The coal would be transported via the existent rail spur to the Alaska Railroad and then to Seward.

6. Resource Associates of Alaska (division of NERCO, Inc.) conducted a coal exploration program with some drilling in the Chignik area on the Alaska Peninsula in 1981.

7. Canadian Superior, Inc. (now McIntyre Mines) drilled the Little Tonzona River coal deposits on the north flank of the Alaska Range in 1980.

8. Delta Coal, based in Fairbanks, received a mine permit from the U.S. Bureau of Land Management. The company conducted exploration drilling and feasibility studies on their lease tract in the Jarvis Creek coal field. Although the company was inactive in 1983, they plan further exploration drilling this year. Their mine plan calls for a production of 500 short tons of coal per day (seasonally) to be used for local power generation and for agricultural grain-drying facilities in the Delta Junction area.

9 Arctic Slope Technical Services, Inc., completed geologic, exploration drilling, and engineering investigations to determine the feasibility of mining coal reserves near Wainwright on the North Slope coastal plain as an energy source for the village.

10. Usibelli Coal Mine has practiced a successful program of coal-mine land reclamation since about 1970. The company's contract with Suneel Shipping Company, Ltd., Suneel Alaska Corporation, and Korea Power Corporation (KEPCO) calls for the eventual transport of 880,000 short tons of coal per year to a KEPCO power plant. Coal export shipments from the mine to Korea have been delayed until harbor facilities are completed at Seward, now expected by late 1984. Usibelli currently employs about 100 workers, recently completed a new headquarters complex, and purchased new trucks and other equipment. Overburden at the mine is removed by the 33-yd^3 'Ace-in-the-Hole' dragline (fig. 8).

11. The Alaska Division of Geological and Geophysical Surveys (DGGS), through various contractors, completed a geologic field investigation and exploration drilling program in northwest Alaska. Geologic mapping and shallow augering failed to delineate potentially minable coal resources on St. Lawrence Island. A significant deposit of lignite was defined by over 3,000 ft of drilling at Chicago Creek on the Seward Peninsula (fig. 11). A second site on the peninsula near Grouse Creek (Death Valley), which may hold high potential for future development, was also investigated. Over 5,000 ft of exploration drilling was completed at Cape Feaufort and has defined a major coal deposit (fig. 12). Other DGGS coal-exploration programs were completed at

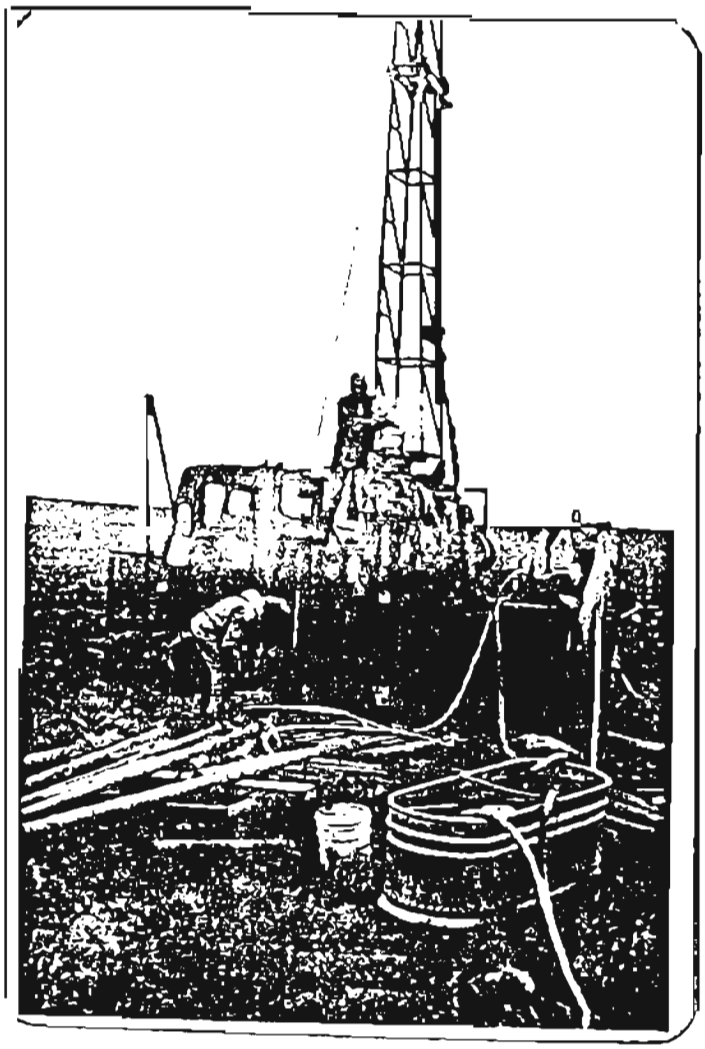

Figure 11. Contractor drill-rig setup on DGGS coal exploration site at Chicago Creek, Seward Peninsula. Photograph by J.G. Clough (July 1983).

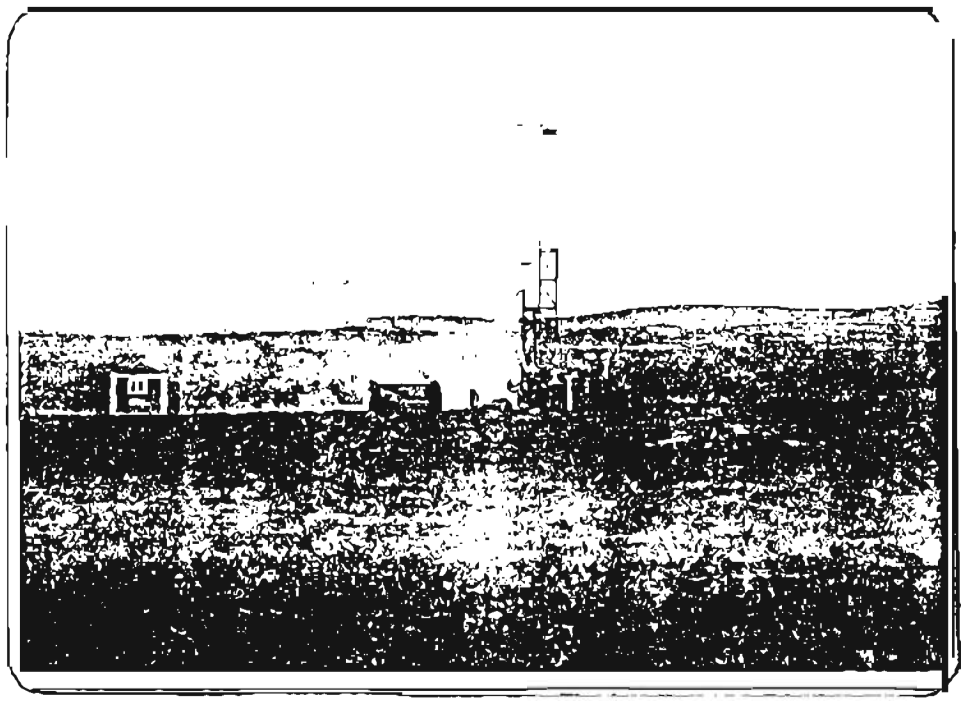

Figure 12. DGGS exploration drilling site in the Cape Beaufort region, northern Alaska coal field. Photograph by A. Benet (July 1982).

Koyuk and Unalakleet. Tn addition, DGGS is preparing a series of coal atlases that will detail the major coal fields of the state.

12. The Alaska Division of Minerals and Energy Management received primacy from the Federal Office of Surface Mining on May 2, 1.983 for the implementation of the Alaska Surface Coal Mining Control and Reclamation Act (ASCMCRA; Alaska Statute 41.45). The state law is as stringent as the federal law, but performance standards have been modified to be more applicable to the unique mining conditions in Alaska. This would include, for example, the mining of coals in areas of the state underlain by permafrost. The agency (now the Division of Mining) is also processing new coal-prospecting permits after a 7-year 'freeze' while the state decided on the bonus issue. A competitive state coal Leasing schedule has also been reinstituted after an 1 l-year hiatus. A coal-mined land inventory recently completed by the division located over 200 former coal-mine sites in the state. An abandoned mined-land reclamation plan was drawn up to facilitate site-specific reclamation activities at potential problem areas. The first site selected for work is at Houston in the Little Susitna field of south-central Alaska.

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SELECTED COAL REFERENCES

American Society for Testing and Materials (ASTM), 1981, Classification of coal by rank (ASTM designation D 388-77): 1981 Annual book of ASTM standards, pt. 26, p. 212-215.

Arctic Environmental Information and Data Center (AEIDC), 1982, Mineral terranes of Alaska: including coal: Anchorage, University of Alaska, scale 1:1,000,000, 6 sheets.

Averitt, Paul, 1973, Coal, in Brobst, D.A., and Pratt, W.P., eds., United States mineral resources: U.S. Geological Survey Professional Paper 820, p. 133-142.

Barker, J.C., 1981, Coal and uranium investigation of the Yukon Flats Cenozoic basin: U.S. Bureau of Mines Open-file Report 140-81, p. 24-39.

Barnes, F.F., 1951, A review of the geology and coal resources of the Bering River coal field, Alaska: U.S. Geological Survey Circular 146, 11 p.

_____, 1966, Geology and coal resources of the Beluga-Yentna region, Alaska : U.S. Geological Survey Bulletin 1202-C, 54 p., scales 1:250,000 and 1:63,360, 7 sheets.

_____, 1967, Coal resources of Alaska: U.S. Geological Survey Bulletin 1242-B, 36 p., scale 1:2,500,000, 1 sheet.

Barnes, F.F., and Cobb, E.H., 1959, Geology and coal resources of the Homer district, Kenai coal field, Alaska: U.S. Geological Survey Bulletin 1058-F, p. 217-260, scale 1:63,360, 12 sheets.

Barnes, F.F., and Payne, T.G., 1956, The Wishbone Hill district, Matanuska coal field, Alaska: U.S. Geological Survey Bulletin 1016, 88 p., various scales, 20 sheets.

Barnes, F.F., and Sokol, Daniel, 1959, Geology and coal resources of the Little Susitna district, Matanuska coal field, Alaska: U.S. Geological Survey Bulletin 1058-D, p. 121-138, scale 1:63,360, 5 sheets.

Barnes, F.F., Wahrhaftig, Clyde, Hickcox, C.A., Freedman, Jacob, and Hopkins, D.M., 1951, Coal investigations in south-central Alaska, 1944-46: U.S. Geological Survey Bulletin 963-E, p. 137-213, various scales, 14 sheets.

Callahan, J.E., 1971, Geology and coal resources of T. 6 S., R. 51 W., unsurveyed, Umiat principal meridian, in the Cape Beaufort coal field, northwestern Alaska: U.S. Geological Survey Open-file Report 496, 18 p.

_____, 1976, Coal investigations in western arctic Alaska, in Rao, P.D., and Wolff, E.N., eds., Focus on Alaska's coal '75, Conference, University of Alaska, Fairbanks, October 15-17, 1975, Proceedings: Fairbanks, University of Alaska Mineral Industry Research Laboratory Report 37, p. 48-53.

Callahan, J.E., and Martin, G.C., 1981, Coal occurrences of the Nanushuk Group, western arctic Alaska---an update, in Rao, P.D., and Wolff, E.N., eds., Focus on Alaska's coal '80, Conference, Second, University of Alaska, Fairbanks, October 21-23, 1980, Proceedings: Fairbanks, University of Alaska Mineral Industry Research Laboratory Report 50, p. 32-60.

Capps, S.R., 1913, The Yentna district, Alaska: U.S. Geological Survey Bulletin 534, 75 p.

Chapman, R.M., 1963, Coal deposits along the Yukon River between Ruby and Anvik, Alaska, in Contributions to economic geology of Alaska: U.S. Geological Survey Bulletin 1155, p. 18-29.

Chapman, R.M., and Sable, E.G., 1960, Geology of the Utukok-Corwin region, northwestern Alaska; exploration of Naval Petroleum Reserve No. 4 and adjacent areas, northern Alaska, 1944-53, pt. 3, areal geology: U.S. Geological Survey Professional Paper 303-C, p. 7-20, 47-167, various scales, 14 sheets.

Collier, A.J., 1903, The coal resources of the Yukon, Alaska, in Emmons, S.F., and Hayes, C.W., Contributions to economic geology, 1902: U.S. Geological Survey Bulletin 218, p. 276-283.

Committee on Alaskan Coal Mining and Reclamation (COACMAR), 1980, Surface coal mining in Alaska; an investigation of the Surface Mining Control and Reclamation Act of 1977 in relation to Alaska: Washington, D.C., National Academy Press, 328 p.

Conwell, C.N., 1977, Energy resource map of Alaska: Alaska Division of Geological and Geophysical Surveys map, scale 1:2,500,000, 1 sheet.

Conwell, C.N., and Triplehorn, D.M., 1978, Herendeen Bay-Chignik coals, southern Alaska Peninsula: Alaska Division of Geological and Geophysical Surveys Special Report 8, 15 p., scale 1:125,000, 2 sheets.

Conwell, C.N., Triplehorn, D.M., and Ferrell, V.M., 1982, Coals of the Anchorage Quadrangle, Alaska: Alaska Division of Geological and Geophysical Surveys Special Report 17, 8 p., scale 1:250,000, 4 sheets.

Denton, S.W., 1981, Geology and coal resources of the lower Lignite Creek area, in Rao, P.D., and Wolff, E.N., eds., Focus on Alaska's coal '80, Conference, Second, University of Alaska, Fairbanks, October 21-23, 1980, Proceedings: Fairbanks, University of Alaska Mineral Industry Research Laboratory Report 50, p. 138-143.

Eakins, G.R., Bundtzen, T.K., Robinson, M.S., Clough, J.G., Green, C.B., Clautice, K.H., and Albanese, M.A., 1983, Alaska's mineral industry---1982: Alaska Office of Mineral Development and Division of Geological and Geophysical Surveys Special Report 31, p. 9, 12, 13, 24.

Ferrians, O.J., Jr., 1965, Permafrost map of Alaska: U.S. Geological Survey Miscellaneous Geologic Investigations Map I-445, scale 1:2,500,000, 1 sheet.

Harker, D.F., Jr., 1983, Alaska coal mined land inventory: Frankfort, Kentucky, Plangraphics, Inc., for the Alaska Department of Natural Resources, Division of Minerals and Energy Management, Anchorage, 268 p.

Holloway, C.D., 1977, Map showing coal fields and distribution of coal-bearing rocks in the western part of southern Alaska: U.S. Geological Survey Open-file Report 77-169-D, scale 1:1,000,000, 1 sheet.

Hopkins, D.M., 1951, Lignite deposits near Broad Pass Station, Alaska, in Barnes, F.F., and others, eds., Coal investigations in south-central Alaska, 1944-1946: U.S. Geological Survey Bulletin 963-B, p. 187-191, scale 1:10,000, 1 sheet.

Knutson, H.A., 1981, Geologic and economic evaluation of bituminous coal, Kukpowruk River region, Northern coal field, Alaska, in Rao, P.D., and Wolff, E.N., eds., Focus on Alaska's coal '80, Conference, Second, University of Alaska, Fairbanks, October 21-23, 1980, Proceedings: Fairbanks, University of Alaska Mineral Industry Research Laboratory Report 50, p. 62-78.

Magoon, L.B., Adkison, W.L., and Egbert, R.M., 1976, Map showing geology, wildcat wells, Tertiary plant fossil locations, K-Ar age dates, and petroleum operations, Cook Inlet area, Alaska: U.S. Geological Survey Miscellaneous Investigations Map I-1019, scale 1:250,000, 3 sheets.

Martin, G.C., 1915, The western part of the Kenai Peninsula, in Martin, G.C., Johnson, B.L., and Grant, U.S., eds., Geology and mineral resources of Kenai Peninsula, Alaska: U.S. Geological Survey Bulletin 587, p. 41-112.

Martin, G.C., and Callahan, J.E., 1978, Preliminary report on the coal resources of the National Petroleum Reserve in Alaska: U.S. Geological Survey Open-file Report 78-1033, 23 p., 2 plates, scale 1:500,000.

May, R.R., and Warfield, R.S., 1957, Investigations of subbituminous coal beds near Houston, westward extremity of Matanuska coal field, Alaska: U.S. Bureau of Mines Report of Investigations 5350, 20 p.

McConkey, W., Lane, D., Quinlan, C., Rahm, M., and Rutledge, G., 1977, Alaska's energy resources; final report, phase 1, volume 2, Inventory of oil, gas, coal, hydroelectric, and uranium resources: Anchorage, Alaska Division of Energy and Power Development, p. 133-216.

McGee, D.L., 1972, Coal reserve study, Chuitna-Beluga-Capps area, Alaska: Alaska Division of Geological and Geophysical Surveys Open-file Report 30, 7 p., scale 1:15,840, 1 sheet,

McGee, D.L., and Emmel, K.S., 1979, Alaska coal resources: Alaska Division of Geological and Geophysical Surveys unpublished internal report, 16 p.

McGee, D.L., and O'Connor, K.M., 1975, Mineral resources of Alaska, and the impact of Federal land policies on their availability---coal: Alaska Division of Geological and Geophysical Surveys Open-file Report 51, 29 p.

_____, 1975, Cook Inlet basin subsurface coal reserve study: Alaska Division of Geological and Geophysical Surveys Open-file Report 74, 24 p., scale 1:500,000, 3 sheets.

Merritt, R.D., Eakins, G.R., and Clough, J.G., 1982, Coal investigation of the Susitna Lowland, Alaska: Alaska Division of Geological and Geophysical Surveys Open-file Report 142, 42 p., 2 apps., scale 1:250,000, 4 sheets.

Mertie, J.B., Jr., 1937, The Yukon-Tanana region, Alaska: U.S. Geological Survey Bulletin 872, p. 261-264.

NASA/UK Technology Applications Program, 1983, Information on Alaska coal; computer printout: National Aeronautics and Space Administration, v. 1, 2.

Naske, C.M., and Triplehorn, D.M., 1980, The federal government and Alaska's coal: The Northern Engineer, v. 12, no. 3, p. 11-23.

Patsch, B.J.G., 1976, Exploration and development of the Beluga coal field, in Rao, P.D., and Wolff, E.N., eds., Focus on Alaska's coal '75, Conference, University of Alaska, Fairbanks, October 15-17, 1975, Proceedings: Fairbanks, University of Alaska Mineral Industry Research Laboratory Report 37, p. 72-83.

_____, 1981, Remaining coal resources of the Matanuska field, in Rao, P.D., and Wolff, E.N., Focus on Alaska's coal '80, Conference, Second, University of Alaska, Fairbanks, October 21-23, 1980, Proceedings: Fairbanks, University of Alaska Mineral Industry Research Laboratory Report 50, p. 144-153.

Plafker, George, 1967, Geologic map of the Gulf of Alaska Tertiary province, Alaska: U.S. Geological Survey Map I-484, scale 1:500,000, 1 sheet.

Player, Gary, 1976, The Little Tonzona coal bed near Farewell, Alaska; an important extension of the coal field north of the Alaska Range: Anchorage, Gary Player Ventures consultant report, 10 p.

Plangraphics, Inc., 1983, Alaska abandoned mined land reclamation plan: Frankfort, Kentucky, prepared for the Alaska Department of Natural Resources Division of Minerals and Energy Management, 147 p., 9 apps., scale 1:2,500,000, 2 sheets.

Ramsey, J.P., 1981, Geology, coal resources, and mining plan for the Chuitna River field, Alaska, in Rao, P.D., and Wolff, E.N., eds., Focus on Alaska's coal '80, Conference, Second, University of Alaska, Fairbanks, October 21-23, 1980, Proceedings: Fairbanks, University of Alaska Mineral Industry Research Laboratory Report 50, p. 111-121.

Rao, P.D., 1976, Characterization of Alaska's coals, in Rao, P.D., and Wolff, E.N., Focus on Alaska's coal '75, Conference, University of Alaska, Fairbanks, October 15-17, 1975, Proceedings: Fairbanks, University of Alaska Mineral Industry Research Laboratory Report 37, p. 150-157.

Rao, P.D., and Wolff, E.N., 1981, Petrographic, mineralogical, and chemical characterization of certain Alaskan coals and washability products, in Rao, P.D., and Wolff, E.N., eds., Focus on Alaska's coal '80, Conference, Second, University of Alaska, Fairbanks, October 21-23, 1980, Proceedings: Fairbanks, University of Alaska Mineral Industry Research Laboratory Report 50, p. 194-235.

Richards, R.W., and Waring, G.A., 1933, Progress of surveys in the Anthracite Ridge district: U.S. Geological Survey Bulletin 849-A, p. 5-27, scale 1:31,250, 2 sheets.

Rutledge, F.A., 1948, Investigations of the W.E. Dunkle coal mine, Costello Creek, Chulitna district, Alaska: U.S. Bureau of Mines Report of Investigations 4360, 9 p.

Sanders, R.B., 1976a, Geology and coal resources of the Bering River field, in Rao, P.D., and Wolff, E.N., eds., Focus on Alaska's coal '75, Conference, University of Alaska, Fairbanks, October 15-17, 1975, Proceedings: Fairbanks, University of Alaska Mineral Industry Research Laboratory Report 37, p. 54-58.

_____, 1976b, Coal resources of Alaska, in Rao, P.D., and Wolff, E.N., eds., Focus on Alaska's coal '75, Conference, University of Alaska, Fairbanks, October 15-17, 1975, Proceedings: Fairbanks, University of Alaska Mineral Industry Research Laboratory Report 37, p. 21-32.

_____. 1981. Coal resources of Alaska. in Rao, P.D., and Wolff, E.N., eds., Focus on Alaska's coal '80, Conference, Second, University of Alaska, Fairbanks, October 21-23, 1980. Proceedings: Fairbanks, University of Alaska Mineral Industry Research Laboratory Report 50, p. 11-31.

_____, 1982. Coal resources of Alaska. in Henning, R.A., ed., Alaska's oil/gas and minerals industry: Alaska Geographic Quarterly, v. 9, no. 4, p. 146-165.

Schaff, R.G., 1980, Geologic characteristics of Alaskan coal deposits, in Surface coal mining in Alaska, by the Committee on Alaskan Coal Mining and Reclamation (COACMAR): Washington, D.C., National Academy Press, p. 12-13.

Schaff, R.G., and Merritt, R.D., 1983, Alaska's coal provinces and resources, in International Conference on Coal, Minerals, and Petroleum, Anchorage, February 16-17, 1983. Proceedings: Anchorage, Resource Development Council for Alaska, Inc., p. 157-161.

Sloan, E.G., Shearer, G.B., Eason, J.E., and Almquist, C.L., 1981, Reconnaissance survey for coal near Farewell, Alaska, in Rao, P.D., and Wolff, E.N., eds., Focus on Alaska's coal '80, Conference, Second, University of Alaska, Fairbanks, October 21-23, 1980, Proceedings: Fairbanks, University of Alaska Mineral Industry Research Laboratory Report 50, p. 152-170.

Swift, W.H., Scott, M.J., and Haskins, J.P., 1981, Beluga coal export market study, in Rao, P.D., and Wolff, F.N., eds., Focus on Alaska's coal '80, Conference, Second, University of Alaska, Fairbanks, October 21-23, 1980, Proceedings: Fairbanks, University of Alaska Mineral Industry Research Laboratory Report 50, p. 358-373.

Triplehorn, J.H., 1982, Alaska coal---a bibliography: Fairbanks, University of Alaska Mineral Industry Research Laboratory Report 51, 293 p.

U.S. Bureau of Mines, 1983, Coal locations and coal bibliography of Alaska: Juneau, U.S. Bureau of Mines computer printout.

U.S. Geological Survey, 1976, Coal resource classification system of the U.S. Bureau of Mines and U.S. Geological Survey: U.S. Geological Survey Bulletin 1050-B, p. 1-7.

Wahrhaftig, Clyde, 1973, Coal reserves of the Healy Creek and Lignite Creek coal basins, Nenana coal field, Alaska: U.S. Geological Survey Open-file Report 368, geologic and resource maps, various scales, 24 sheets.

Wahrhaftig, Clyde, and Hickcox, C.A., 1955, Geology and coal deposits, Jarvis Creek coal field, Alaska: U.S. Geological Survey Bulletin 989-G, p. 353-367.

Wahrhaftig, Clyde, Wolfe, J.A., Leopold, E.B., and Lanphere, M.A., 1969, The coal-bearing group in the Nenana coal field, Alaska: U.S. Geological Survey Bulletin 1274-D, 30 p.

Warfield, R.S., 1967, Resume of information on Alaskan bituminous coals with particular emphasis on coking characteristics: U.S. Rureau of Mines Open-file Report 11-67, 20 p.

Waring, G.A., 1936, Geology of the Anthracite Ridge coal district, Alaska: U.S. Geological Survey Bulletin 861, 57 p., scale 1:62,500, 14 sheets.

Wilson, C.L., 1980, Coal; bridge to the future; report of the world coal study (WOCOL): Cambridge, Massachusetts, Ballinger Publishing, p. 157-168.

APPENDIX A.

GLOSSARY OF COAL CLASSIFICATION TERMS.[1]

Demonstrated[2] ---A collective term for the sum of coal in both measured and indicated resources and reserves.

Hypothetical resources---Undiscovered coal resources in beds that may reasonably be expected to exist in known mining districts under known geologic conditions. Generally, hypothetical resources are in broad areas of coal fields where points of observation are absent and evidence is from distant outcrops, drill holes, or wells. Exploration that confirms their existence and reveals quantity and quality will permit their classification as reserves or identified subeconomic resources.

Identified resources---Specific bodies of coal whose location, rank, quality, and quantity are known from geologic evidence supported by engineering measurements.

Identified subeconomic resources---The part of coal resources that occurs in demonstrated and inferred resources that is not now minable economically.

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[1] Modified from McGee and Emmel (1979).
[2] Definitions applicable to both the reserve and the identified subeconomic resource components.

Indicated[1] ---Coal from which estimates of the rank, quality, and quantity have been computed partly from sample analyses and measurements and partly from reasonable geologic projections.

Inferred*---Coal in unexplored extensions of demonstrated resources for which estimates of the quality and size are based on geologic evidence and projection.

Measured*---Coal for which estimates of the rank, quality, and quantity have been computed, within a margin of error of less than 20 percent, from sample analyses and measurements of closely spaced and geologically well-known sample sites.

Quality (or grade)[1]---Refers to individual measurements such as heating value, fixed carbon, moisture, and ash; sulfur, phosphorous, and other major, minor, and trace elements; coking properties; petrologic properties; and particular organic constituents. The individual quality elements may be aggregated in various ways to classify coal for such special purposes as metallurgical, gas, petrochemical, and blending usages.

Rank[2]---The classification of coals relative to other coals, according to their degree of metamorphism, or progressive alteration, in the natural series from lignite to anthracite (ASTM, 1981).

Recovery factor---The percentage of total tons of coal estimated to be recoverable from a given area in relation to the total tonnage estimated to be in the reserve base in the ground.

Reserve---That portion of the identified coal resource that can be economically mined at the time of determination. The reserve is derived by applying a recovery factor to that component of the identified coal resource designated as the reserve base.

Reserve base---That portion of the identified coal resource from which reserves are calculated.

Resources---Concentrations of coal in such forms that economic extraction is now or may become feasible.

Speculative resources---Undiscovered coal beds that may occur either in known types of deposits in a favorable geologic setting where no discoveries have been made, or in deposits that remain to be recognized. Exploration that confirms their existence and reveals quantity and quality will permit their classification as reserves or identified subeconomic resources.

Undiscovered resource---Unspecified bodies of coal surmised to exist on the basis of broad geologic knowledge and theory.

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*Definitions applicable to both the reserve and identified subeconomic resource components.