IC bureau of mines information circular 8045

TRENDS IN ALASKA'S MINERAL INDUSTRY

By Alvin Kaufman

UNITED STATES DEPARTMENT OF THE INTERIOR

BUREAU OF MINES

1961

TRENDS IN ALASKA'S MINERAL INDUSTRY

By Alvin Kaufman

* * * * * * * * * * * * information circular 8045

UNITED STATES DEPARTMENT OF THE INTERIOR
Stewart L. Udall, Secretary

BUREAU OF MINES
Marling J. Ankeny, Director

This publication has been cataloged as follows:

Kaufman, Alvin

Trends in Alaska's mineral industry. [Washington] U.S. Dept. of the Interior, Bureau of Mines [1961]

ii, 43 p. illus., tables. 26 cm. (U.S. Bureau of Mines. Information circular 8045)

Bibliographical footnotes.

1. Mineral industries - Alaska. I. Title. (Series)

TN23.U71 no. 8045 622.06173

U.S. Dept. of the Int. Library.

CONTENTS

	Page
Introduction and summary	1
Acknowledgments	5
The country and its problems	5
The country	5
The problems	6
Comparison with other areas	10
The Alaskan economy and the mineral industry	14
The future economy and its mineral needs	14
Taxes and the mineral industry	21
Foreign imports, exports, and the mineral industry	30
The future mineral industry	31
Fuels	35
Metals	38
Nonmetals	41

ILLUSTRATIONS

Fig.		
1.	Value of Alaskan mineral production, 1906-60	2
2.	Alaska earnings in covered employment, 1958	16
3.	Cumulative employment by major industries covered by the Employment Security Act, 1950-58	18
4.	Population projection - Alaska, 1880-1980	19
5.	Value of construction and apparent consumption of cement and sand and gravel, 1950-59	21
6.	General areas of major mineral occurrences in Alaska	32

TABLES

1.	Alaska cost-of-living index	10
2.	Summary of manufactures - 1899-1954 (all industries)	17
3.	Consumption of major mineral industry products in Alaska, 1955-58 average and 1970 and 1980 estimates	20
4.	Value of construction, Alaska, 1955-59 average, and 1972 and 1982 estimates	22
5.	Estimated annual receipts and expenditures, 1960-66	23
6.	Alaska tax collections, by type, calendar years 1950-59	25
7.	Per capita general revenue for the Northwestern United States, by States, 1958	26
8.	Major taxes levied against the mining and petroleum industries by selected States	27
9.	Comparative taxes paid by mining or petroleum companies in selected States having a production valued (gross) at $1 million and a net income of $100,000 earned in the State	29

TABLES (cont.)

		Page
10.	Waterborne foreign mineral trade of Alaska, 1955-58.....	31
11.	Expenditures for exploration and prospecting by major companies in Alaska, 1955-59.....	35
12.	Comparative fuel costs, Anchorage, Alaska, 1960.....	37

TRENDS IN ALASKA'S MINERAL INDUSTRY[1]

by

Alvin Kaufman[2] [3]

INTRODUCTION AND SUMMARY

Following the gold discoveries of the late 1800's much was written regarding the vast mineral resources of Alaska, and much interest was aroused, and yet over the years little has been done to exploit those resources. Between 1906 and 1935 the Kennecott copper mines of the Copper River region were the keystone of the mineral economy (fig. 1). After the depletion of the Kennecott ore reserves and aided by the statutory rise in the price of gold, the yellow metal became the major mineral commodity. In recent years it has shared the honors with coal and sand and gravel. Although this trend should indicate the development of a stable, diversified mineral industry, yet the trend of production is downward.

This report results from a study by the Federal Bureau of Mines to delineate the problems and to forecast the growth of the mineral industries in Alaska. The need for such a blueprint for the future was enhanced by the population explosion in the United States and the consequent eventual need for additional living space, as well as the current interest in new areas, and the necessity to develop reserves of strategic minerals.

In arriving at the projections and hypotheses set out in the following pages the author made use of personal observations based on more than 4 years residence in Alaska, and of extensive published and unpublished data; these projections are subject to revision in the light of subsequent events.

The development of a mineral industry in Alaska is plagued by the usual problems of an undeveloped area, such as high costs, lack of transportation facilities, small population with a consequent lack of skilled labor, and limited local investment capital. These difficulties are increased by the climate, location, size, and rugged topography of this northern State. They are not, however, insurmountable problems. Areas with similar topography, climate, and location (such as Canada and Scandinavia) have been successful in developing a mineral industry.

---

[1] Work on manuscript completed November 1960.

[2] Project coordinator, Alaska Office of Mineral Resources, Juneau, Alaska.

[3] Statistical data used in this report were compiled by Ruth Robotham, Statistical clerk, Alaska Office of Mineral Resources, Juneau, Alaska.

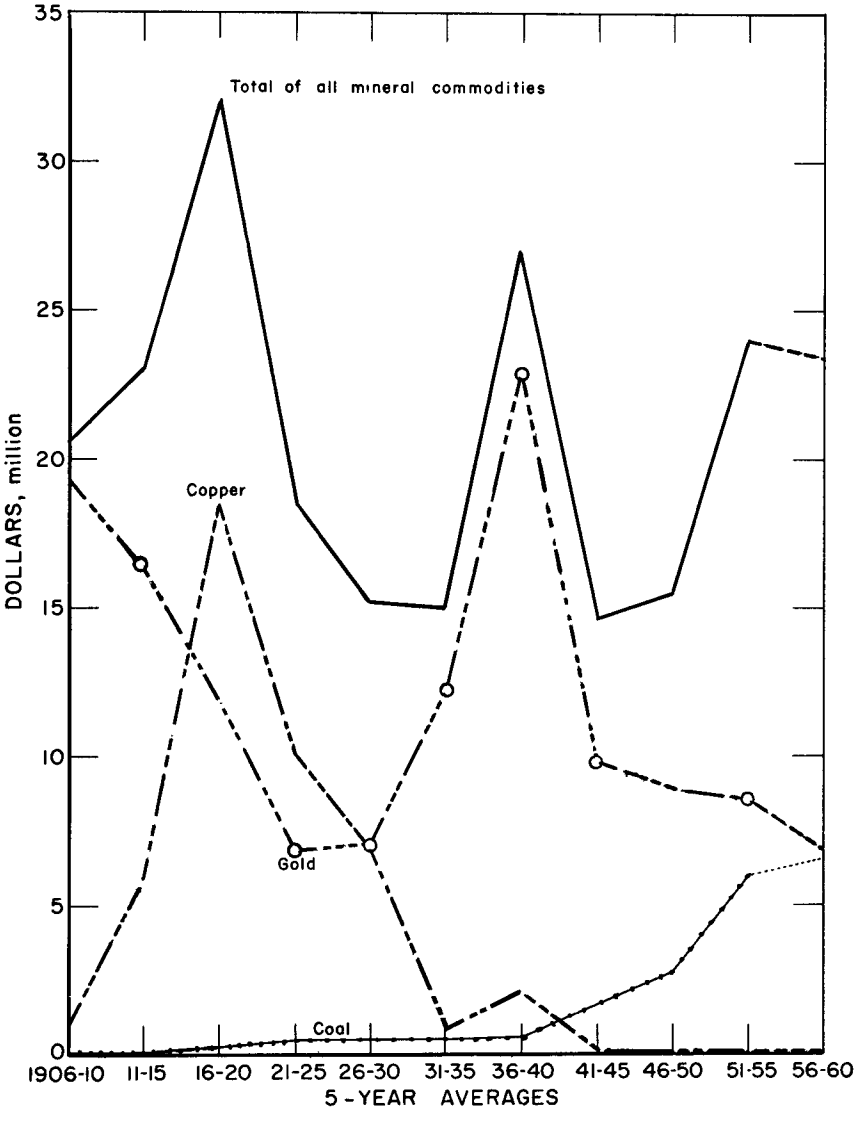

FIGURE 1. - Value of Alaskan Mineral Production, 1906-60.

In Canada considerable mineral development has taken place in the Arctic and subarctic areas; much of this development has resulted from a high worldwide demand for raw material and the increased availability of transportation facilities which opened new areas and permitted exploitation of previously marginal deposits. Some of the impetus for mineral exploration can also be traced to the Canadian tax laws which provide a subsidy for the miner. The State of Alaska has similar tax laws; however, it would appear that State taxes (at least in this instance) are a relatively minor expense compared to Federal taxes.

Scandinavia is a region remarkably similar to Alaska in topography, location, climate, and resources. Iron ore, coal, copper, and other commodities are presently being mined north of the Arctic Circle in these countries. Obviously climatic conditions are not an insurmountable handicap in the exploitation of mineral deposits. In each instance, however, the ores are of high grade with ample reserves. The Scandinavian nations seem to have reached their present high state of development because they are located in close proximity to a heavily populated region providing an excellent market for raw and finished materials, and because they have developed, to a considerable extent, the hydropower resources of their area.

The economy of Alaska is still evolving from its prewar frontier economy. Before the Second World War the economy of the then Territory of Alaska was based on construction activity, although the most important single employer was the Federal Government (exclusive of Federal-sponsored construction). The Alaskan economy is now in a period of instability changing from one stimulated by military activity to one based on resources; it is experiencing a period of

transition highlighted by the simultaneous decline of the military- and salmon-based economy and the expansion of the new resource economy based on forestry, petroleum and natural gas, and land.

One of the important factors in the future growth of the mineral industry is the growth of Alaska's population. Should this continue to follow its historic pattern, it would increase 60 percent by 1970, and almost triple by 1980. Although this growth is large percentagewise the base figure is small, and the extimated future populations are likewise small.

Population growth will affect most directly the consumption of fuels, building and monumental stone, and brick and tile. Heating oils, as well as coal, will also be affected by competition from natural gas or hydropower.

Consumption of concrete, sand and gravel, crushed stone, and iron and steel products will probably rise at the same rate as total construction; petroleum asphalt consumption should rise at the same rate as highway construction.

Sulfur consumption, primarily by the woodpulp industry, should increase more than five times by 1970, whereas fertilizer consumption should remain stable, compared with the 1955-58 base period.

As a result of the required expansion of local governmental services with statehood, Alaska faces a budget deficit of $35 million by 1966 unless new tax or other revenue is obtained.

State taxes probably can be increased without affecting development. As a result of heavy Federal subsidization the new State should be able to increase its tax load appreciably without burdening its people beyond the tax load carried by the populations (individual and corporate) of its sister States in the Northwest. Further, the new State permits the exemption of any new business or industry from all State and local taxes up to a period of 10 years based on the capital investment in the State.

Foreign imports of certain mineral commodities into Alaska should increase substantially over the next two decades. The Japanese should become greater suppliers of Alaskan mineral requirements in the years to come because of their regularly instituted ship service from Japan to their pulp mill at Sitka.

Of the known Alaska resources, petroleum probably will be the one immediately exportable commodity. In any consideration of export possibilities, however, it must be remembered that the nations of the Pacific Basin represent not only inviting potential mineral markets, but also competitive sources of those minerals.

Records indicate that the known mineral resources of Alaska are large and varied. Despite this apparent abundance of mineral wealth, the output from Alaska's mines is only $20 million per year. This lack of development results not only from the economic and other problems bearing on the mineral industries, but from the generally low grade of the various deposits. In those instances where grade is sufficient, reserves are generally inadequate. The future

promise of Alaska rests not so much with known mineral resources, but in the potential exhibited by geology. Large areas of the new State have not been prospected adequately; but it is apparent from the number of mineral occurrences that the 49th State is an area favorable to mineral deposition. This is borne out by steadily rising exploration expenditures.

Alaska, in 1961, has available proved reserves of coal, natural gas, and petroleum. A petroleum refinery will probably not be constructed in Alaska in the foreseeable future because refineries on the West Coast are available and the new State's producing fields are close to tidewater.

Initially, natural gas consumption is anticipated to exceed 2 billion cubic feet annually, and then rise to 7-1/2 billion by 1970; to a large extent natural gas will replace other fuels in residential heating. The current Anchorage gas rates are competitive in relation to other local fuel sources, but they are somewhat higher in relation to other areas. If a migration of industry to utilize the large-scale gas resources in the State is to take place, then the present rate structure must be modified downward for industrial consumers.

Of all the various metal-bearing materials found in Alaska only the iron-bearing and mercury materials appear significant at this time. The Kuskokwim River basin may develop into one of the largest potential mercury provinces in the world.

The iron-bearing materials of southeastern Alaska comprise a potential reserve exceeding several billion tons. There is a strong possibility that the magnetite-copper-sulfide properties on Prince of Wales Island will be the first to be developed. These are close to the Japanese-owned pulp mill at Sitka, and because of the low specific gravity of chemical pulp, heavy iron concentrates from these deposits could be used as ballast cargo for pulp-laden ships returning to Japan.

The nonmetallic resources, next to the fuels, have the greatest potential for early development. A relatively large potential market exists for locally produced brick, and consequently for local clays. This industry is destined to expand, and virtually all future consumption should be supplied from local brickyards.

The need for locally produced cement also should grow; the price of this product would probably equal the 1960 price for sacked cement. Suitable limestones close to transportation are available in the Railbelt. It is possible also that lightweight aggregate and mineral wool insulation industries could be developed. Deposits suitable for the manufacture of lightweight aggregates are known to exist, and if exploited could result in savings in building construction costs by reducing concrete deadweight. Insulation is required in Alaska because of the rigorous climate. Bureau of Mines tests indicate that Alaskan materials could yield an acceptable mineral wool. The availability of low-cost natural gas as a melting furnace fuel might provide the necessary impetus for the development of this industry.

ACKNOWLEDGMENTS

The author is indebted to a number of persons who contributed information and suggestions to this report. Special thanks is given to Charles E. Hinkson, Department of Commerce, James A. Williams, director, Division of Mines and Minerals, Department of Natural Resources, and Miss Helen Dirtadian, State Librarian, all of the State of Alaska; Miss Louise Shadduck of the Idaho Department of Commerce; Dean Ellis, tax commissioner, State of Oregon; and W. J. Winters, chairman, Montana Board of Equalization.

THE COUNTRY AND ITS PROBLEMS

The Country

Alaska sits astride the north Pacific Ocean, far from traditional trade routes, yet in a most strategic location for modern commerce. It lies roughly equidistant, because of its nearness to the North Pole, between the markets of Asia and Europe; the distances from Stockholm, Sweden, and Tokyo, Japan, to Anchorage are roughly equivalent. The distance from Yokohama, Japan, to Seward, Alaska, is approximately 1,200 miles less than the distance from Yokohama to San Francisco. The future importance of Alaska's location is best illustrated by the development of Anchorage into a hub of international air transport. In 1960, Scandinavian Airlines, Air France, Japan Airlines, and Northwest Orient Airlines all carried passengers and freight from Europe or the contiguous United States to the Orient by way of Anchorage.

Alaska adjoins Canada to the east; its mainland stretches westward to within 50 miles of Siberia. It extends from 130° W. to 173° E. longitude, stretching as far west of San Francisco as that city is west of New York; it lies between 51° and 72° N. latitude, roughly the same as the parallels at Liverpool, England and the northernmost point on the Scandinavian Peninsula.

A true conception of the size of Alaska can best be obtained by comparing it with more familiar objects. The State is one-fifth the size of the 48 contiguous States; its 586,000 square miles are the equivalent of 2 states the size of Texas with sufficient room to include Louisiana, Rhode Island, and Delaware.

This huge area is ringed along the southern coasts by a series of mountain peaks rising from the sea and extending for relatively short distances inland, then grading into valleys and rolling uplands that drain to the Bering Sea through the Yukon and Kuskokwim Rivers. This inland area is separated from the Arctic Slope by the Brooks Range, which stretches across northern Alaska.

The mountainous belt paralleling the seaboard, known as the Pacific Mountain System, is approximately 50 miles wide in Southeastern Alaska; as it trends to the northwest it reaches a width of 200 miles in the Prince William Sound area and then narrows down again in the Alaska Peninsula region. The mean altitude of the peaks in the Pacific Mountain System range from 5,000 to 10,000 feet with some peaks over 15,000 feet; Mt. McKinley is 20,320 feet in altitude. The principal mountain ranges making up the system are the Coast and St. Elias Ranges, the Chugach-Kenai and Wrangell Mountains, the Aleutian and Alaska Ranges, and the Talkeetna Mountains.

The broad, rolling upland North of the Pacific Mountain System is known as Interior and Western Alaska; it comprises extensive plains and broad flat valleys of grasslands, timbered gentle slopes, and flat-topped interstream areas that range from the Bering Sea on the west to elevations of 3,000 to 4,000 feet at the Canadian border. The northern boundary of this region is formed by the Brooks Range, a broad highland belt forming the watershed between the Arctic Ocean and the Yukon basin. These mountains begin in Alaska north of the Porcupine River, trend east and west and bend to the southwest, finally terminating near Kotzebue Sound. The major mountain systems making up the Brooks Range are the Endicott, Baird, and DeLong Mountains.

The Arctic slope region consists mainly of a plateau, actually a series of foothills, and a coastal plain north of the Brooks Range. This physiographic province starts at the International Boundary with the northern face of the Brooks Range rising almost directly from the sea, and with only a few miles of low coastal plain between the mountains and the Arctic Ocean. To the westward, the coastal belt widens to a distance of approximately 150 miles.

Alaska's climate[4] is as diverse as its topography; it ranges from a northern rain forest in the southeast to an Arctic desert in the north. The southern coastal areas generally have a very wet but temperate climate. Rainfall is heavy, averaging 92 inches total precipitation in the southeast and 90 inches on the south coast; snowfall at sea level is generally light (mean total snow and sleet at Annette Island is 53 inches) although considerably heavier (286 inches in 1958 at Annex Creek) in the mountains. The average temperature in the winter is approximately the same as that of Washington, D. C.; summers are similar to those experienced in Scotland. Mean annual temperature in the southeast is 42° F., and on the south coast 40° F.

The area between the Coast and Brooks Ranges has a subarctic climate. Rainfall is light (mean annual precipitation in the Interior basin is 13 inches), summers are generally hot; winters are extremely cold, with below zero temperatures a common occurrence.

The climate in the Arctic area generally is characterized by a long period of cold weather (annual average temperature is 15° F.), usually two-thirds of the year, and little precipitation (8 inches on an average; roughly about the same as that prevailing over the arid areas of Nevada and Utah). The Arctic summer days are long, with 24 hours of sunshine at the Arctic Circle (lat. 66-$\frac{1}{2}$° N.) on the longest day of the year. At lat. 70° N. there are more than 70 days of continuous daylight, unbroken except for clouds.

The Problems

The difficulties facing the Alaska mine operator were described by James A. Williams, director, Division of Mines and Minerals, State of Alaska, in a speech

---

[4] Climatic data are taken from Climatological Data, Alaska, Annual Summary 1958 and from Climatic Summary of Alaska 1960: Weather Bureau.

before the Third Annual Mining, Minerals, and Petroleum Conference at College, Alaska, in April 1958. Mr. Williams said:

> It seems to me that the extra expense, and most of the difficulties of doing business in Alaska go in the proverbial vicious circle. The high cost of doing anything in Alaska is caused mostly by high-priced labor. The high wages are caused by the high cost of living, this is due to the high cost of transportation, transportation is high mostly because of one-way freight and not enough of it to interest much competition. The small amount of freight is due to Alaska's small permanent population, which is due to the lack of basic industrial growth, which is due to the high cost of doing anything in Alaska.

These are problems that have plagued the development of every frontier area in the United States and elsewhere. They are not causes, but the result of the working of nature; the major causative factors are climate, location, size, and rugged topography.

Alaska's northern location results in a great variation in the length of summer and winter days plus abnormally short seasons between killing frosts. These factors plus climatic conditions (such as subzero temperatures) result in a strong characteristic of the Alaskan economy, and a primary determinant of the high cost of living and operating, known as seasonality or a short working season. Alaska's mines, principally placers, operated an average of only 160 days in 1958. This short working season means higher costs, because of the heavy capital investment that is tied up unproductively for a considerable part of the year. For those operations that are active throughout the year, the climate and location mean higher costs because of the need for stock-piling ample supplies before the winter season with its short days and consequent restricted flying time.

The location and climate also are reflected in higher costs through the necessity for the construction of housing and utility facilities for men and their families. One producer states that more than 38 percent of the capital outlay for plant and equipment for a 500-ton-per-day operation was required to build housing and utilities such as bunk houses, cafeterias, bachelor residences and family quarters, central heating plants, domestic water plants, and exterior pipelines.[5] This particular operation is active throughout the year, and construction had to include special insulated pipe boxes to contain water, steam, and other utility lines; placement of water and sewerage lines above the floors of buildings for warmth; and other precautionary features which tended to increase capital cost and consequently operating costs. The cost of heat alone was estimated at 75 cents per day per person or $1.14 per ton of ore.

The location, size, and topography of Alaska result in limited and expensive transportation routes. This is not necessarily a major obstacle to the development of mineral resources because as a general rule, transportation will follow a major discovery. The Kennecott mines of the Copper River Basin and the discovery of gold at Fairbanks, Nome, and Juneau are examples of what can happen. The discovery of the Kennecott deposits resulted in construction of a railroad from Cordova to the mines, the installation of harbor facilities, and the

[5] Taylor, C. D. N., Construction and Operation of Mining Camps in Northern Latitudes: Presented at Alaska Chapter of AIME Anchorage, April 1959.

development of towns in the wilderness. This same cycle has been repeated time and time again in Alaska, Labrador, Venezuela, and other parts of the world.

For the mine not quite up to bonanza standard, however, the cost of transportation resulting from limited facilities can be a crucial factor. The experiences of the United Keno Hill Mines, Ltd., and Cassiar Asbestos Corp., Ltd., operators of a silver-lead-zinc and an asbestos mine respectively, in the general area of the Canadian Yukon will serve as an illustration of the transportation difficulties facing a mine operator in the north.

> United Keno produces at present a combined tonnage of lead and zinc concentrates in the vicinity of 36,000 tons annually. The haulage distance by motor truck from mine to rail at Whitehorse is 287 miles over graveled highway. From here concentrates proceed 110 miles by the narrow-gauge railroad of the White Pass & Yukon Railway to Skagway (WP&YR), Alaska, and thence via a Canadian Coastal vessel, the MV C. J. Rogers, a unit of the WP&YR, to West Indies wharf in North Vancouver, B. C. At this point the concentrates are transshipped to the smelter of the Consolidated Mining and Smelting Co. of Canada, Ltd., at Trail, British Columbia. An annual in-bound freight tonnage from Vancouver of 3,000 tons is transported by the same routing and enroute between Whitehorse and the mine additional tonnage in coast and forest products is picked up to yield a total annual backhaul of 10,000 to 15,000 tons.[6]

Despite efficient loading and handling operations, as well as care in avoiding charges for excess cargo volume, the cost of transportation is estimated at 30 percent of gross ore value for United Keno and 33 percent for Cassiar; these properties have access to a highway. Most Alaskan mines would not be so fortunate. The State has a total of only 5,200 miles of connected road, which is approximately 9 miles of road per 1,000 square miles of area. Texas averages approximately 850 miles of highway for every 1,000 square miles of area. Therefore, in the majority of instances additional costs would have to be incurred for road construction or for the operation of tractor trains to a highway or rail connection.

The estimated cost of using tractors on a predominantly ice road during the winter is approximately 25 cents per ton-mile; in hilly foothill country this would increase to $1.00 per ton-mile. In those areas of Alaska where the country is timbered, and there are many stream crossings, tractor-freighting costs will vary from $1.00 to $1.50 per ton-mile exclusive of clearing costs which may average $300 per mile.[7]

Upon reaching the highway, costs would decline, but would still be relatively high. The U.S. Department of Commerce[8] reported that truck rates on the Alaska Highway ranged from 7 to 11 cents per ton-mile.

---

[6] Gritzuk, N., The Role of Transportation in the Development of the North: Western Miner and Oil Rev., April 1959, pp. 28-42.

[7] Mathews, Ted C., Alaskan Logistics: Presented before the Third Annual Mining, Minerals, and Petroleum Conference, College, Alaska, April 1958.

[8] Business and Defense Service Administration, Alaska, Its Economy and Market Potential: U.S. Department of Commerce, 1959, 61 pp.

Rail rates also are high. The Government-owned Alaska Railroad has an average ton-mile revenue of 5.7 cents compared with the United States railroad average of 1.4 cents. The high rate results primarily from one-way hauling; a special rate on southbound material probably could be negotiated. The WP&YR charges 1 cent and 1.8 cents per ton-mile, respectively, for carriage of concentrates and asbestos fiber from Whitehorse to Vancouver; this is a combined rail-water haul. The combined rail-water rate for ores and concentrates over a comparable distance (Wasilla to Seattle) in Alaska would cost $24.35 per short ton or 1.8 cents per ton-mile providing the value per ton did not exceed $60.00; $6.09 would be charged for each additional $60.00 valuation or fraction over that amount. The published rate for water carriage of southbound ores and concentrates from Seward to Seattle is $17.00 per ton or 1.4 cents per ton-mile, general cargo northbound would bear a much higher rate.

Total transportation cost in Alaska (north and south) would probably exceed the Cassiar rate by a wide margin because of the high wharfage, handling costs and the lack of southbound freight.[9] It has been estimated that 26 percent of total transportation costs from Seattle to Alaska are due to handling, loading, and unloading charges. Destination charges run 55 percent greater than Seattle primarily because of generally higher Alaskan wages and a lack of regulation and uniformity among dock companies.[10]

The failure of the Alaska hinterland to generate freight for southern points is symptomatic of the lack of industry, capital, and people. Alaska has a population density of 0.4 persons per square mile. The only other State having a density even remotely approaching this low figure is Wyoming with three persons per square mile. The lack of people is not in itself a problem to the mine operator; in fact, this probably is an advantage. The limited market potential far from distribution centers, however, results in a dearth of local investment capital. This condition is best illustrated by the fact that total aggregate capital, surplus, undivided profits, and reserves for all 18 Alaskan banks, were the smallest of any state in the nation; Nevada, the State with the next smallest population, had more than twice the amount, and the newest State, Hawaii, had four times the amount.

Population concentration is another problem; more than 60 percent of the people of Alaska reside in the Railbelt (the Anchorage-Fairbanks area). This concentration of people means additional expense for highway development since roads built from a market place into an undeveloped hinterland will not generate sufficient traffic to supplement State revenues through gas and business taxes for some years. This, coupled with the problem of permafrost (permanently frozen ground), muskeg, and rugged topography, means less road mileage per dollar expended. In addition, the concentration of people in one section of the State could result in the exercise of considerable pressure on State government officials for the expenditure of a disproportionate share of available funds on urban facilities (that is, wider and better paved roads, expressways, and other projects) rather than development highways and other long-range facilities.

Almost all of the foregoing difficulties, as previously stated, culminate in high costs. The most recent survey indicates that the cost of living will

---

[9] Except for salmon canning season northbound cargos make up 75 to 90 percent of total ocean revenue tonnage.

[10] Alaska Department of Natural Resources, Alaska Comparative Tariff Analysis: July 1959, p. 2.

vary from 20 percent above Seattle, Wash., at Ketchikan, to 50 percent more at Nome. A distribution by major items is shown in table 1. The higher cost of living is reflected in a shortage of skilled labor and in higher wage rates.

TABLE 1. - Alaska cost-of-living index[1], 1959 (100 = living costs in Seattle, Wash., 1959)

Item	Selected cities			
	Anchorage	Fairbanks	Juneau	Nome
Food	142.7	150.1	126.2	158.9
Housing	145.7	183.9	138.3	162.9
Apparel	114.9	112.6	119.0	109.4
Transportation	115.3	121.3	110.4	157.1
Medical care	122.3	114.4	101.3	109.3
Personal care	115.4	113.5	103.0	110.1
Reading and recreation	107.2	121.0	113.9	103.7
Other goods and services	102.6	111.5	106.0	123.2
Total (including sales tax where applicable)	130.0	147.5	121.8	148.3

[1] Ward index of consumer prices, prepared for Department of Natural Resources, State of Alaska.

In 1959 the metal mining average hourly wage for the contiguous States was $2.57; the coal mining average was $3.25. Alaskan coal mining wage rates range from $3.63 per hour for a laborer to $4.68 for a machine operator; metal mining rates range from 2.70 for a cook to $4.20 for a shovel-dragline operator. Many metal mining operations pay their men $3.00 per hour.

The major difficulties facing the mine operator in Alaska are generally the result of natural circumstances and should be alleviated as Alaska develops.

COMPARISON WITH OTHER AREAS

In attempting to determine the direction of growth of an area, it is often useful to study other regions with similar problems to determine the means and factors by which they have advanced their mineral economies. Scandinavia, northern Canada, and Siberia are three areas similar to Alaska in location, climate, topography, and so forth. Siberia would not be a suitable comparison because its development probably will not take into account the cost nor will investment in the area be dependent upon the profit motive.

Northern Canada is virtually as undeveloped as Alaska; a brief review of its mineral industry, however, will provide some useful information. In the main, Canada's mineral production is obtained from the southern third of the country; most of its mines are located within a few hundred miles of tidewater or a major transportation artery. The future situation in the north is described by the Gorden Commission[11] as follows:

> With Canada's economic frontiers moving both westward and northward, with new tools and techniques for the discovery of hidden ore

[11] Davis, John, Mining and Mineral Processing in Canada: Royal Commission on Canada's Econ. Prospects, October 1957, p. 27.

bodies difficult or impossible to find by older prospecting methods, and with geological conditions in the northern, less explored regions as favorable as those in which most presently producing mines are located, Canada's mineral potential and future status as a world producer and exporter can be viewed with optimism.

Considering that the value of Canadian mineral output has at least doubled in each decade since 1930, and that value of output in 1958 was approximately three times larger than that of 1950, the last section of the quotation appears to be somewhat of an understatement. The mineral industry of our northern neighbor has been burgeoning since World War II; there have been such notable landmarks in the growth of its Arctic and subarctic areas as development of large iron deposits in the Quebec-Labrador region, major uranium developments at Beaverlodge (northern Saskatchewan) and Great Bear Lake (Northwest Territories), a lead-zinc discovery at Pine Point, Great Slave Lake (Northwest Territories), copper-nickel deposits at Lynn Lake (Manitoba), asbestos at Cassiar (northern British Columbia) and Clinton Creek (Yukon Territory), as well as base and precious metals from the Yukon Territory. Petroleum has also been discovered in the Yukon, 550 miles north of Whitehorse.

Much of this development has resulted from high worldwide demand for raw material, and the increasing availability of transportation facilities has opened new areas and thus has permitted exploitation of previously marginal deposits. An example of the importance of transportation is the failure of Consolidated Mining and Smelting Co. of Canada to develop its Pine Point lead-zinc property after a decision by the Federal cabinet not to build a railroad to the mine. A more successful example is the Lynn Lake copper-nickel deposit; in this instance the Canadian National Railway extended its line from Sherridon to Lynn Lake, a distance of 167 miles, thereby permitting the Sherritt Gordon Co. to ship concentrate to a new refinery at Fort Saskatchewan, Alberta. The refinery was located at Fort Saskatchewan primarily because of the presence of large reserves of cheap natural gas (12 cents per thousand cubic feet under a 20-year contract); its location, distant from large-scale electric generating facilities, was made feasible by the development of a new ammonia pressure leach process. The refinery will produce 17 million pounds of nickel, 9 million pounds of copper, 300,000 pounds of cobalt, and 70,000 tons of ammonium sulphate annually when operating at full capacity.[12]

Some of the impetus for exploration can be traced to the Federal (Canadian) tax laws; these permit high rates of depreciation on mine buildings, equipment, and machinery, as well as 100-percent depreciation for underground facilities designed for continuing use (shafts, haulageways, and so forth), depletion allowances roughly equal to the United States rates, a tax-free allowance up to 20 percent of dividends received for Canadian Shareholders, a 3-year exemption from income taxes for new mines, writeoff of exploration and development expenses up to 25 percent of total preproduction costs per year, exemption from taxes for prospectors or grubstakers of the proceeds of a sale of a mining property discovered through the prospector's efforts, exemption from excise taxes for certain items used in mining. These laws, in effect, subsidize the mining

[12] deWet, J. P., Mineral Developments in Manitoba in 1953: Canadian Min. Jour., February 1954, vol. 75, No. 2, pp. 86-87.

industry and result primarily from government recognition of the role mining plays in opening up undeveloped territory. The adoption of such preferential legislation is possible in a relatively underveloped country such as Canada, but appears highly unlikely in a nation such as the United States. The State of Alaska, however, does have similar tax laws in that new mines are exempt from State mining license taxes (actually a profit tax) for 3-$\frac{1}{2}$ years after the start of mining; the law provides for depletion allowances and possible exemption from all State and local taxes for up to 10 years. Despite these relatively liberal tax provisions as well as the incentive provided by the necessity for a mining company to acquire mineral reserves sufficient for as much as 20 or 30 years ahead of requirements, there has been no rush to the north on the part of American mining interests. From the foregoing we can deduce that State taxes, at least in this instance, are a relatively minor expense compared to Federal taxes, and that Alaska's development (barring availability of low-cost power or inexpensive fuel) is largely dependent upon the eventual northward migration of people and industry and the development of technology, as well as upon a continued high rate of world mineral consumption.

Turning from North America to the Scandinavian countries, which for the purpose of this paper are defined as Norway, Sweden, and Finland, we find a region of remarkable similarity to Alaska insofar as topography, location, climate, and resources are concerned; these countries are equally remarkable in their dissimilarity to the new State in population and development.

The Scandinavian countries embrace an area of approximately 430,000 square miles compared with Alaska's 586,000 square miles. They lie between the same parallels as Alaska (lat. 55° to 72° N.). The population density per square mile ranges from 28 persons in Norway to a high of 42 in Sweden. Total population in Norway, which has the fewest people of the three countries, exceeds Alaska's population by more than 15 times. The gross value[13] of mine products, exclusive of other mineral industries, ranges from a low of $27 million in Finland to a high of $254 million in Sweden, as opposed to $21 million in Alaska. In addition, the Scandinavian countries have a large output from various other mineral industries, for instance, production of cement and aluminum, as well as the refining of metals such as copper and nickel.

To make a more thorough comparison with Alaska, the conditions in each of the Scandinavian countries are briefly outlined as follows:

The coast of Norway is heavily fiorded with many rocky islands. The warm Norwegian coast current washes the shore as far as the beginning of the Barents Sea, thus making possible year-round shipping; Norwegian harbors, even those far north of the Arctic Circle are ice free throughout the year. This is analogous to the Japanese current along the fiorded coast of southern and Southeastern Alaska. This analogy is further reinforced in that heavy precipitation and past glaciation result in a huge waterpower potential in Norway as in Southeastern Alaska. It is at this point that the similarities end; more than 24

[13] Virtually all statistics used in this section for the Scandinavian countries were obtained from the Statistical Yearbook, 1958. Statistical Office of the United Nations, New York, N.Y., 1958, 612 pp.

billion kilowatt-hours of electric energy are produced annually in Norway compared with 600 million kilowatt-hours in all of Alaska.[14] This huge, and inexpensive, power output has helped to attract various mineral industries to Norway. The production of mineral commodities requiring quantities of processing electricity, such as nickel, aluminum, ferroalloys, and chemical fertilizers are major industries. Norway has no bauxite (aluminum ore) mines, yet more than 134,000 short tons of aluminum, or 3 percent of world output was produced in 1958. The importance of the nation's hydropower resources is further indicated by the fact that Falconbridge Nickel Mines, Ltd., ships nickel matte from the Sudbury region of Canada to its electrolytic refinery at Kristiansand.

Finland is topographically and climatically similar to the Yukon Valley. Most of the country's present mineral output is yielded by copper mines at Outokumpu and Katalahati, both operated by Outokumpu, Oy. The huge nickel-copper deposits at Petsamo were ceded to Russia in 1944.

The cupriferous pyrite from the Outokumpu mine is concentrated, sintered in electric furnaces, and then shipped to Duisburg, West Germany, for recovery of the copper. The Kotalahati concentrates are smelted and refined at the company's own plant. Sulfur and sulfuric acid are recovered for use in wood and chemical pulp manufacture.

Sweden is the largest of the Scandinavian countries in area and population. It comprises approximately one-third the area of Alaska but supports a population more than 30 times greater than that of Alaska and larger than the combined populations of Finland and Norway. It is the richest of the Scandinavian countries in natural resources, primarily iron ore, timber, and waterpower. In 1958 more than 30 billion kilowatt-hours of electric energy were produced.

The size and importance of the mining industry can best be judged by the fact that close to 5 percent of the world's production of iron ore, and 2 percent of the lead and zinc ores, were yielded by Swedish mines in 1958.

Iron ore is by far the major mining product. Of the 18 million long tons produced in 1958, 17 million were exported, mainly to Germany (45 percent), United Kingdom (25 percent), and Belgium-Luxembourg (17 percent). Sweden is the major iron ore exporting country in the world; this is due largely to the inability of the Swedes to comsume their domestic production because of a limited local market, the lack of suitable coal deposits for processing, and the nearness of Sweden to ore-poor but highly industrialized nations.

The Swedes also produce close to 2 million tons of pig iron annually; almost all of this is consumed within the country for the manufacture of high-quality finished products. Most of the heavy steel products required by the nation are imported from other European nations.

One of the world's largest reserves (2 billion metric tons) of high-grade magnetite is located near the head of the Gulf of Bothnia near Kiruna (in-

[14] Estimate for Alaska supplied by Federal Bureau of Reclamation, Department of Interior.

cluding Malmberget). Production of iron ore from Kiruna began in 1903 by open-pit methods, following the completion of an electric railroad from the mines to tidewater. Present output is derived from both underground (60 percent) and open-pit operations.

In addition to the Kiruna deposits, high-grade ores (50 to 60 percent iron low phosphorus) occur in the Bergeslagen district in central Sweden. These are used mainly within the country to manufacture high-grade iron and steel products. These products, usually quality finished goods, are sold abroad to earn foreign exchange.

Climatic conditions such as those in the Scandinavian countries or Alaska apparently are not an insurmountable handicap to the exploitation of a mineral deposit. Iron ore, coal, copper, and other commodities are presently being mined north of the Arctic Circle. In each instance, however, the ores are of high grade with ample reserves and (of equal importance) have easy access to a large market. Ores and concentrates are generally heavy, bulky commodities of low value (iron ore f.o.b. port of shipment is $8 to $15 per ton), and are unable to absorb high freight rates. In most instances these materials require low-cost water transportation for a long haul.

The availability, however, of inexpensive electricity appears to act as a magnet to attract mineral industries that consider electricity a major cost item; these industries include the manufacture of aluminum, chemical fertilizers, and nickel. These products are generally of high value, such as ammonium nitrate fertilizer at $60 per ton, aluminum (26 cents per pound) and nickel (74 cents per pound) at $520 and $1,480 per short ton, respectively, and therefore are able to absorb a high freight bill.

Basically, the Scandinavian nations have reached their present state of development because they are located in close proximity to a heavily populated region which provides an excellent market for raw materials, they have large reserves of high-grade ore, and they have developed to a considerable extent the hydropower resources of their area. Possibly of greater importance, however, is the vigor and ingenuity of the Scandinavians, as the growth and power of a nation, or a state, depends in large measure upon the quality of its people.

The actual settlement of Alaska is only a few years old, and the ability of the Alaskan to develop his State is still a moot question. The earlier migrants were primarily interested in exploiting the fur and gold resources, and returning home; actual immigration to Alaska is only 15 years old at best.

THE ALASKAN ECONOMY AND THE MINERAL INDUSTRY

The Future Economy and Its Mineral Needs

Alaska is still evolving from its prewar frontier economy. With the exception of the construction of the Alaska Railroad (1918), and the settlement of the Matanuska colony (1935), the Alaskan economy before 1939 was based primarily on the production of fish, fur, gold, and copper. During the 1931-40

decade the Territory of Alaska had an annual average out-shipment of $59 million, composed of canned salmon ($33 million), gold and silver ($16 million), furs and skins ($3 million), and miscellaneous items $7 million. In-shipments approximated $28 million; of this amount, roughly $5 million was for tin cans and other supplies used in canning salmon, $3 million for petroleum products, $2 million for whiskey and other alcoholic beverages, and approximately $18 million for miscellaneous necessities. Alaska's economic revolution began in the 1941-50 decade. This occurred primarily because of Alaska's strategic location with respect to the Pacific and Arctic Oceans; this location caused Alaska to become one of the principal defense bastions of the air age. Military personnel in Alaska rose from 524 persons in 1939 to 152,000 in 1943, then to a postwar low of 18,000 in 194[illegible] and finally to an annual average of 47,000 in the post-Korean war period. The 1960 military population was estimated at 35,000.

The increases and decreases in military personnel were accompanied by a similar rise and fall in construction activity. This was primarily for defense including roads, airfields, and communication facilities. Employment in the construction industries comprised 1,255 persons in 1940; by 1941 more than 10 times that number were employed. The number of persons in contract construction then dropped to 1,650 in 1946 with a latter-day high in 1953 of 9,829. The current average is 7,000.[15]

The present ecomony is still heavily dependent upon construction activity. As shown by figure 2 (Alaska Employment Security Commission annual report), the most important single industry is the Federal Government, exclusive of government-sponsored construction. The substantial contribution of the Federal Government is obvious; 34 percent of total wages earned in Alaska, and 38 percent of total employment results from that organization. If military personnel were included these figures would exceed 60 percent of both total wages and employment.

The Alaskan economy, however, is changing from one stimulated by military activity to a resource-based economy. This is indicated somewhat by table 2 which shows that the value added by manufactures from 1954 to 1959 has increased more than 60 percent. This is substantiated by data presented by the Alaska State Planning Commission.

A report by the Commission[16] indicates that during the past decade, Alaska has experienced a period of transition with simultaneous decline of the military-and salmon-based economy and expansion of a new resource economy based on forestry and land. This simultaneous expansion and decline is similar to the problems encountered during the 1940's. The Commission predicted that in the 1960-70 decade the decline of the military economy would continue accompanied by expansion of the tourist and resource industries.

---

[15] Rogers, George, Analysis of the Alaskan Economy and Its Future Outlook; vol. II, Financing Alaska's Employment Security Program; Alaska Employment Security Commission., October 1958, 46 pp.

[16] Alaska State Planning Commission, State of Alaska, Capital Improvement Program, 1960-66; January 1960.

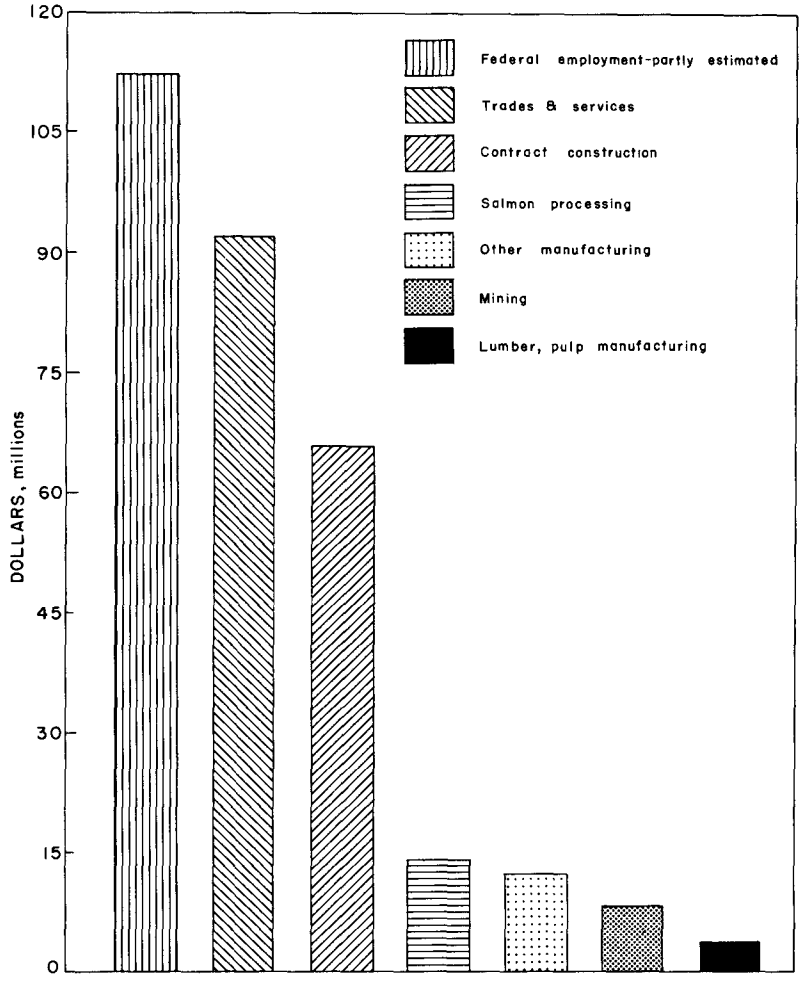

FIGURE 2. - Alaska Earnings in Covered Employment, 1958.

The general trend of the economy is shown by figure 3 which indicates the changes that occurred in employment covered under the Employment Security Act during the 1950-59 decade. By dissecting the broad groups shown on this graph, some unusual shifts in the economy are indicated. Salmon canning has declined from more than 15 percent of total wages in 1950 to less than 10 percent by 1958; lumber and pulp industries have increased from 2 to 5 percent; and service industries have increased from 30 percent to nearly 45 percent. Mining has remained relatively stable.

To project these shifts and to determine their effect on the mineral industry, it is necessary to consider several factors. Among these is population growth. Alaska's population should continue to grow according to its historic pattern if the national economy continues to expand, and the petroleum and wood pulp industries in Alaska fulfill their initial promise. The population (using 1960 as a base) will increase more than 60 percent by 1970, and almost triple in size by 1980 (figure 4). Although this growth is large percentagewise, the base figure (226,167 persons) is small, and the estimated populations by 1970 and 1980 are likewise small (1970, 365,000 persons; 1980, 655,000[17]). Consequently, although the increased population will create a need for more homes, schools, offices, buildings, sewers, roads, and so forth, with a consequent rise in the demand for mineral products such as sand and gravel, concrete, and other mineral products, the actual numerical increase will be small. The increased population and its increased needs could also cause a decline in development activity by boosting consumption requirements, thereby necessitating additional imports from outside the local economy with consequent decrease in available investment

[17] Estimates by the author. At the time this paper was prepared, the Bureau of the Census had not yet issued its 1970 and 1980 projections.

capital; outside industry, because of the relatively small size of the market, might be unwilling to invest in Alaska.

TABLE 2. - Summary of Manufactures, 1899-1954 (all industries)[1]

Census year	Number of establishments	Wages	Cost of materials, fuel, and electricity	Value of products	Value added by manufactures[2]
1899	48	$ 1,374,680	$ 1,762,583	$ 4,194,421	$ 2,431,838
1909	152	1,948,026	5,119,613	11,340,105	6,220,492
1919	147	8,839,452	19,482,485	41,495,243	22,012,758
[3] 1939	230	6,883,988	20,916,757	38,815,436	17,898,679
1954	219	16,546,000	([4])	([4])	40,235,000
[5] 1958	245	([6])	([6])	([6])	64,903,000

[1] Department of Commerce, statistical Abstract of the United States, 1960, pp. 921.
[2] Value of products less cost of materials, fuel, and purchased electric energy.
[3] For year ending September 30.
[4] Not shown because of excessive duplication.
[5] Preliminary.
[6] Not available.

Population growth will most directly affect the consumption of fuels, building and monumental stone, and brick and tile. Consumption of these except heating oils, as shown in table 3, is assumed to increase in direct proportion to population in that more people generally means more cars, more homes, and more buildings. Heating oils, as well as coal, will be affected by competition from natural gas; the effect of this has been taken into account in estimating future consumption of these two commodities.

Construction materials such as cement, sand, gravel, and crushed rock, and iron and steel products probably will increase at a considerably lower rate than the other products mentioned since these are more affected by other types of construction.

Figure 5 illustrates that the curve for sand, gravel, and crushed rock, as well as cement, follows very closely the value of construction by the U.S. Army Corps of Engineers. The trend of the latter is definitely downward, and the author believes that this will continue, exclusive of dam construction. The military construction boom, with its occasional ups and downs, resulted from the strategic military location of the new State in the air age. In a missile age, however, with the ability to destroy any point on the globe from any other point, location no longer appears to be of particular importance. Missile bases will probably be built within the contiguous states because of lower cost, accessibility, and other factors. Despite the decline in this major segment of the construction industry, overall construction as indicated in table 4, should increase. The increase will occur primarily because of higher public works expenditures for highways, institutions, and State office buildings, as

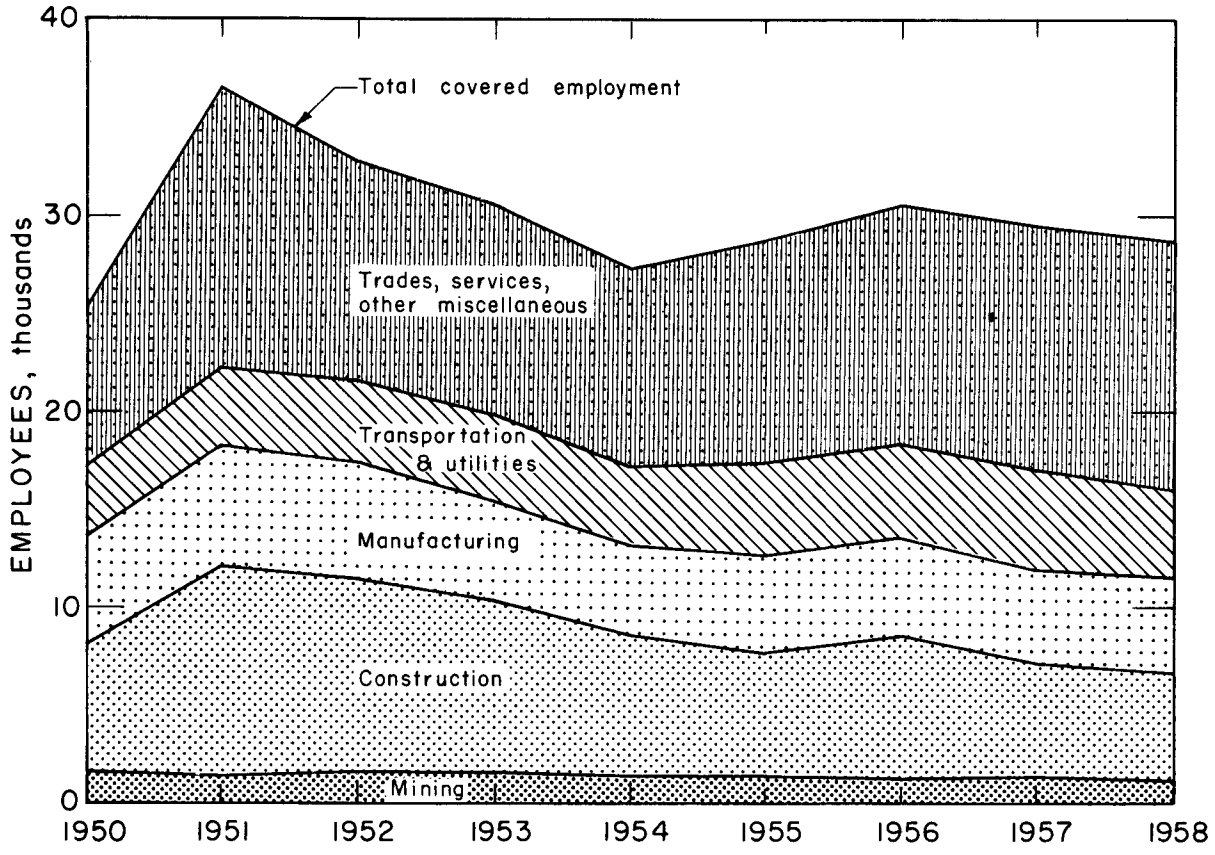

FIGURE 3. - Cummulative Employment by Major Industries Covered by the Employment Security Act, 1950-58.

well as for major construction items, such as pulp mills and hydroelectric projects. Inasmuch as these projects will use large quantities of cement, sand, gravel, crushed stone, and iron and steel, the consumption of these products should increase at the same rate as total construction.

Petroleum asphalt consumption, however, should rise at the same rate as highway construction. Assuming that the State will build or rebuild roads to the limit of the funds available to it under the various Federal highway acts, and that most roads will be paved (in order to reduce maintenance costs), asphalt consumption should double by 1970. A considerable part of the tonnage increase assigned to asphalt could be diverted to cement should the price of that commodity become competitive in the ensuing years.

Sulfur consumption, primarily for use in the woodpulp industry, should increase more than five times by 1970 compared with the 1955-58 period, and an additional 59 percent by 1980. The forest products industry (including pulp manufacture) is one of the fastest growing segments of the economy.

Forest products, as estimated by the United States Forest Service, were valued at an annual average rate of $4.4 million per year from 1950 to 1953.

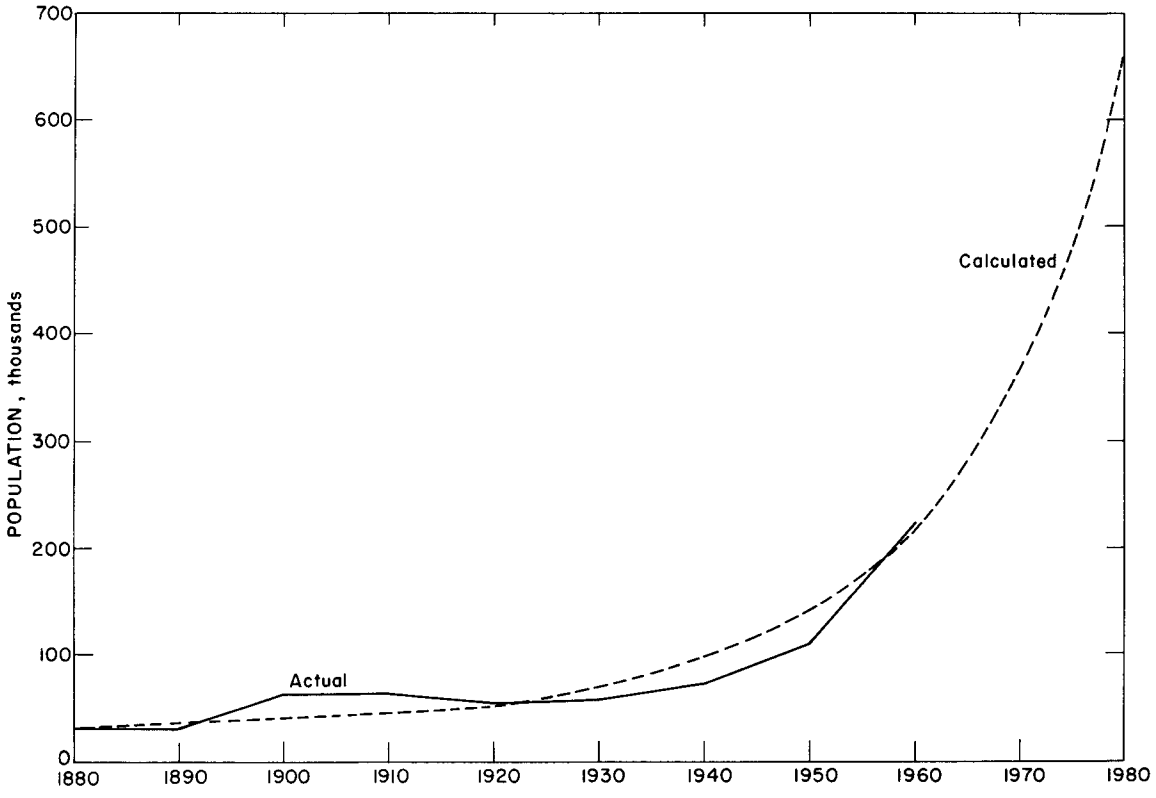

FIGURE 4. - Population Projection, Alaska, 1880 to 1980.

In June of 1954, Alaska's first pulp plant (300 tons per day initially, later expanded to 525 tons per day) was constructed at Ketchikan. The value of forest products in that year rose to $13 million; the 1955-59 average value was $31 1/2 million. In November 1959 a second pulp plant (300 tons per day) was put on stream at Sitka; this resulted in a rise to $52 million in 1960 with an estimated $58-million production in 1961.

Based on current plans, pulp capacity should exceed 580,000 tons per year by 1970, assuming completion of the Wrangell and Juneau mills; by 1980 plant capacity is estimated at 900,000 tons annually.

Information furnished by the two plants currently operating indicates that 0.03 short tons of sulfur are required annually per ton of pulp capacity to make up for process losses. In addition, approximately 2 tons of sulfur for each ton of daily capacity are required to start each new mill.

The only other Alaskan industry which would be likely to affect the future demand for mineral industry products (fertilizers) is agriculture. The total value of agricultural products has been increasing in a straight line since 1953; the number of acres of land harvested has doubled in the same period. Further analysis, however, indicates that crop acreage has tended to stabilize

in the past few years, and the continued rise in value of farm products is more the result of increased efficiency than additional acreage. In addition, the growth sectors of the industry are dairying, poultry, and livestock. These require little, if any, mineral products (other than mineral feed). Crop acreage under cultivation, and consequently fertilizers required, should not substantially increase over the next 2 decades. This is not surprising considering crop limitations (lettuce, cabbage, carrots, radishes, potatoes, and celery) imposed by a cold, damp climate as well as the cost of clearing land, low soil fertility, short growing season, and other factors. The local market for agricultural products is and should remain relatively small even with increased population. It is unlikely that Alaskan crops would be shipped outside the State in view of transportation and production costs.

TABLE 3. - Consumption of major mineral industry products in Alaska, 1955-58 average [1] [2], 1970, 1980 estimates [3]
(Short tons unless otherwise stated)

Commodity	Average, 1955-58	Estimated	
		1970	1980
Motor fuel and gasoline thousand barrels	1,886	3,000	6,000
Gas, oil, distillate, residual fuel and kerosine thousand barrels	3,845	3,100	3,400
Petroleum asphalt	18,622	35,000	44,000
Cement (376 pound barrels)	360,866	420,000	500,000
Coal (all ranks), briquetts, coke thousand short tons	742	550	100
Building, monument, and other stone manufacturers	1,946	3,100	6,000
Brick and tile	1,284	2,000	4,000
Sulphur	3,342	17,000	27,000
Sand and gravel, crushed rock thousand short tons	6,926	8,100	9,000
Iron and steel products	8,127	9,500	11,000
Fertilizer materials	3,419	3,500	3,500

[1] As measured by coastwise receipts, foreign imports, and where applicable, by local production.

[2] Data adapted from Waterborne Commerce of the United States, part 4, U.S. Army Corps of Engineers, and from Minerals Yearbook, Bureau of Mines.

[3] Average annual consumption, 1968-72; 1978-82.

The U.S. Coast Guard regulations restrict the movement of material classified as explosives over docks located in or immediately adjacent to towns. Because of this regulation, a considerable but undetermined percentage of the nitrogenous fertilizers are brought into Alaska for use as explosives. There is also a substantial differential in freight rates (Seattle to Seward: Fertilizers $1.24 per 100 pounds, compared to explosives $3.92 for 100 pounds).

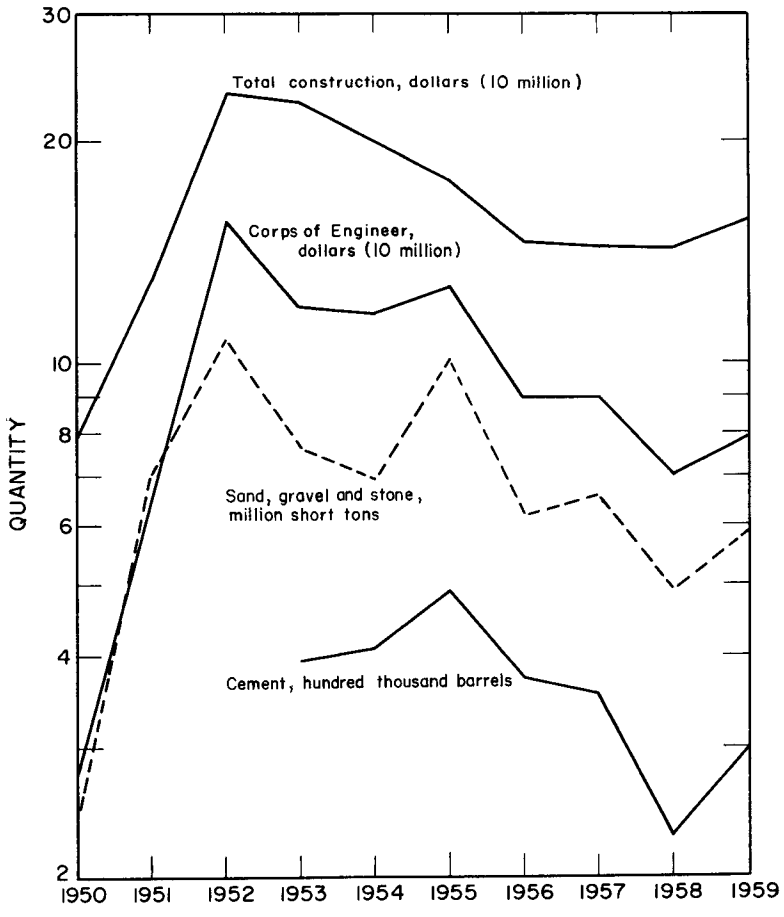

FIGURE 5.- Value of Construction and Apparent Consumption of Cement and Sand and Gravel, 1950-59.

Taxes and the Mineral Industry

During the battle for statehood one of the primary arguments put forward by opponents was that Alaska would not be able to pay the bills that would accure as a result of statehood. This argument was discounted by those in favor of statehood on the theory that the territory was already doing everything that a state should be doing. These arguments were based primarily upon the feelings of the person advancing them. Shortly after Alaska's accession to statehood, however, it became imperative to determine the State's needs and resources. Consequently, a State Planning Commission was appointed by the Governor to determine the capital improvements necessary for the proper conduct and operation of State affairs and the revenues accruing to the new State.

In January 1960, the commission submitted its report,[18] which indicated that by 1966 the State would have a $29 million operating deficit and a total deficit, including capital expenditures, in excess of $70 million. These figures assumed that there would be no increase in costs, taxes, or license fees, above the 1960 level, and that the State would accept Federal matching-fund grants in the full amount (although the State need not and may not accept the full amount with a corresponding decrease in matching-fund requirements). The commission further assumed that there would be no expansion in operating programs above the current level. Its operating expenditures were increased only by the estimated cost of maintaining highways and airfields. Before statehood, and for a 3-year transitional period afterward, state highway maintenance costs may be financed from Federal highway funds. Also included in the commission's calcu-

[18] Work cited in footnote 16, p. 15.

lations were the special Federal grants given to the State during a 5-year transitional period. These ranged from a high of approximately $10 million for fiscal year 1960 to a low of $3 million for fiscal year 1964. The projected receipts and expenditures are shown in table 5 substantially as calculated by the State Planning Commission; changes (as noted on the table) have been made to reflect new mineral lease charges,[19] increased State revenue from mineral severance taxes and royalties resulting from new developments. and changes in Federal highway matching-fund requirements.[20]

TABLE 4. - Value of construction, Alaska, 1955-59 average, and 1972, 1982 estimates, in thousands of dollars

	1955-59 average	1972 estimate[1]	1982 estimate[1]
Corps of engineers (military and civilian).....	[2] $ 91,460	$50,000	$40,000
Construction permits.....	[3] 11,240	20,000	30,000
Public works (including highways and airports)..	[4] 30,540	65,000	70,000
Pulp mills and other major construction.....	13,430	30,000	50,000
Other.....	7,000	15,000	10,000
Total.....	153,670	180,000	200,000

[1] Bureau of Mines estimate.
[2] U.S. Army Engineer District, Alaska, Corps of Engineers.
[3] Alaska Department of Commerce, Division of Tourism and Economic Development.
[4] Figures derived from Report of the Governor of Alaska, U.S. Department of Interior, 1955-57; Report of the Secretary of Interior, U.S. Department of Interior 1958-59; and Bureau of Public Roads, U.S. Department of Commerce.

Mineral lease revenue, according to the commission, would have amounted to $13.2 million by 1964 and $14 million by 1966; consideration of the increased rentals indicates that State revenue (90 percent of Federal charges) will exceed $14 million by 1964 and $21 million by 1966. At the time of the Commission's report mineral severance and mining license taxes accounted for $36,000 per year. Consequently very little weight was given to these taxes as revenue producers. With the recent discovery, however, of the Soldatna Creek unit and the subsequent completion of a pipeline from the Kenai oilfields to Nikishka Inlet, oil production has increased substantially. Based on 1960 pipeline capacity, oil production by 1966 should be at an annual rate of at least 5,000,000 barrels. Sometime during 1961, the completion of the pipeline from the recently discovered Kenai gasfield to Anchorage, will result in additional State severance tax revenue. Based on current mineral taxes and the State's share (90 percent) of the 12 1/2-percent royalty levied by the Federal Government on Federal land, it is estimated that mineral taxes and royalties will reach at least $1 million by 1966. The future importance of the mineral

[19] Fifty cents per acre per year minimum, compared with former rental of 50 cents per acre the first year, nothing the second and third years, 25 cents the fourth and fifth years, 50 cents per acre per year for the next 5 years.
[20] Federal Aid Highway Act of 1960 reduced Alaska's maximum matching-fund requirements from $5.9 million annually to $1.96 million.

TABLE 5. - Estimated annual receipts and expenditures, 1960-66[1], in thousands of dollars

	Fiscal year ending June 30						
	1960	1961	1962	1963	1964	1965	1966
Nonmineral receipts:							
State taxes, licenses[2]	$27,200	$28,300	$ 29,500	$ 30,200	$ 29,400	$ 31,000	$ 32,000
Federal transitional grants	9,900	6,000	6,000	3,000	3,000	------	------
Other Federal grants	17,700	51,400	59,400	50,300	48,800	49,300	48,000
Total	54,800	85,700	94,900	83,500	81,200	80,300	80,000
Mineral receipts:							
State land revenue	5,100	2,800	3,300	3,400	3,500	4,800	4,000
Federal mineral leases[3]	6,000	3,100	4,000	9,400	14,400	19,400	21,000
Severance and other mineral taxes[3]	------	------	300	600	800	900	1,000
Total	11,100	5,900	7,600	13,400	18,700	25,100	26,000
Total receipts	65,900	91,600	102,500	96,900	99,900	105,400	106,000
Expenditures:							
Operating expenses	43,600	54,000	56,600	57,200	57,800	58,400	59,000
Capital improvements							
Federal funds	8,600	41,800	42,700	41,100	39,500	39,900	40,000
State and miscellaneous[4]	4,200	4,000	11,300	12,200	11,100	11,900	8,000
Total	12,800	45,800	54,000	53,300	50,600	51,800	48,000
Total expenditures	56,400	99,800	110,600	110,500	108,400	110,200	107,000
Annual surplus or deficit	+9,500	-8,200	-8,100	-13,600	-8,500	-4,800	-1,000
Cumulative surplus or deficit	+9,500	+1,300	-6,800	-20,400	-28,900	-33,700	-34,700

[1] Adapted from State of Alaska Capital Improvement Program 1960-66, Alaska State Planning Commission, January 1960, and Budget Document, 1960-61, except as noted.

[2] Adjusted to reflect increased highway taxes.

[3] Bureau of Mines estimate includes increased lease rentals, revenue from recent discoveries, and the States' share of production royalties collected by the Federal Government.

[4] Adjusted to reflect changes in matching fund requirements under the Federal Aid Highway Act of 1960.

industry, particularly the petroleum and natural gas segment, is quite evident. In fiscal year 1960 total mineral receipts accounted for 7 percent of total State revenue; by 1966 these may contribute 25 percent. State land revenue is considered as part of mineral receipts, because for the present and the forseeable future most of the land revenue will accrue from bonus bids for oil exploration or lease rentals on State-owned oil lands.

Considering these additional sources of revenue the aggregate deficit which the State faces by 1966 will be roughly half of the State Planning Commission figure, albeit considerable. Should a substantial bonding program be approved by the electorate and implemented shortly thereafter resulting in a distribution of capital expenses over a 20- or 30-year period, the State will still face a considerable aggregate operating deficit. Immediate savings accruing from such a capital proration would probably be used to provide additional State services and cover the expenses of an expanding government.

In view of this situation, it appears obvious that taxes in Alaska will be increased by fiscal year 1962 or 1963 at the latest. This is particularly certain in view of the current State administration's pledge to maintain a balanced budget.

Table 6 indicates the source of State tax revenue in the past 10 years. In 1950, 32 percent of the State's tax collection was obtained from sales and gross receipts taxes, 13 percent from licenses and fees, 22 percent from the net income tax on individuals and corporations, and 15 percent from the net income tax on individuals and corporations, and 15 percent from severance taxes (primarily on fish); by 1955 the net income tax was yielding 43 percent of collections, sales and gross receipts taxes accounted for 38 percent, licenses and fees 12 percent, and severance taxes had dropped to 5 percent (primarily because of the declining salmon fishery).

If taxation follows its present trend then the net income tax (either corporate or individual rates or both) will be increased, or possibly new or additional sales or gross receipts taxes will be levied. The effect of increased taxes on the mineral industry can be judged only by comparing Alaska with other States. Table 7 shows the per capita general revenue accruing to the Pacific Northwestern States. General revenue is defined as total revenue except for income from Government-owned utilities, liquor stores, and insurance trusts. Although the per capita revenue collected in Alaska since statehood is considerably higher than any other northwestern state, or for any other state, per capita revenue from State taxes, charges, and miscellaneous receipts, is much lower. If total State expenditures and Alaska's revenue derived from Federal sources (grants and mineral leases) followed the pattern shown in table 5 (estimated receipts and expenditures), and assuming an increase in taxes resulting in a balanced budget, total per capita State revenue in 1966 would increase to $460. Of this amount $296 would be derived from the Federal Government thus leaving $164 per capita revenue to be raised from State sources. The $164 would be 16 percent below the 1958 figure for Idaho, lowest of the Northwestern States in per capita revenue from State sources. It would appear, therefore, that as a result of heavy Federal subsidization, the new State will be able to increase its total taxes appreciably without burdening its people beyond the tax load carried by the population (both individual and corporate) of other States in the Northwest.

TABLE 6. - Alaska tax collections, by type, calendar years 1950-59[1], thousand dollars

Tax	1950	1951	1952	1953	1954	1955	1956	1957	1958[2]	1959[2]
Sales and gross receipts:										
Business and mining licenses	$ 328	$ 972	$ 1,431	$ 1,541	$ 1,505	$ 1,441	$ 1,513	$ 1,725	$ 1,748	$ 1,843
Alcoholic beverages, and tobacco products	1,811	2,293	2,436	2,420	2,353	2,473	2,629	3,107	3,089	3,149
Motor fuels	916	1,124	1,282	1,274	1,322	2,051	3,584	3,508	3,535	3,513
Other	11	16	1	5	3	1	1	1	712	750
Total sales and gross receipts	3,066	4,405	5,150	5,240	5,183	5,966	7,727	8,341	9,084	9,255
License and fees:										
Motor vehicle registration	280	372	587	647	718	726	762	819	1,410	1,571
Liquor licenses	-----	-----	-----	-----	-----	-----	-----	457	663	613
Other	1,005	1,391	635	844	664	860	1,063	747	1,058	729
Total licenses and fees	1,285	1,763	1,222	1,491	1,382	1,586	1,825	2,023	3,131	2,913
Net income tax	3,302	5,197	6,330	6,414	6,057	6,391	8,629	9,487	9,826	10,507
Severance tax:										
Fisheries	1,467	1,535	2,032	2,098	1,605	1,911	1,687	2,228	1,866	1,195
Oil and gas	-----	-----	-----	-----	-----	-----	-----	-----	1	1
Total severance tax	1,467	1,535	2,032	2,098	1,605	1,911	1,687	2,228	1,867	1,196
Property, death, poll taxes	429	537	492	387	365	355	486	606	734	705
Grand total, taxes and licenses	9,549	13,437	15,226	15,630	14,592	16,209	20,354	22,685	24,642	24,576

[1] Annual statement of licenses and taxes collected, Department of Taxation, State (Territory) of Alaska, 1950-59.

[2] Estimated from fiscal year data.

TABLE 7. - Per capita general revenue for the northwestern United States, by states, 1958[1]

State	Total	From Federal Government	Total from State sources	State Taxes	Charges and Miscellaneous
Alaska (1958)[2].....	$255	$126	$129	$113	$16
Alaska (1961)[3].....	409	269	140	113	27
Idaho.....	234	39	195	161	34
Montana.....	286	48	238	195	43
Oregon.....	288	43	245	201	44
Washington.....	284	41	243	196	47
Wyoming.....	404	123	281	209	72
U. S. Average.....	238	28	210	175	35

[1] From Statistical Abstract of the United States, 1960, page 410, except Alaska; excludes income from Government-owned utilities, liquor stores, and insurance trusts.
[2] Calculated from available data for 1958.
[3] 1961 figure given to show impact of statehood.

The problem of taxation also may be viewed from a different angle. Table 8 shows the major taxes levied against mining and petroleum industries by those Northwestern States with tax systems similar to Alaska. The corporate income tax rate in Alaska (effective rate estimated at 9 percent for corporations) would be quite high compared with the other states. Idaho's rate (9.5 percent) also appears high; however, Idaho permits the deduction of Federal income taxes from net income, thereby giving an effective corporate rate of approximately 3 percent. Taxes levied specifically against the mining and petroleum industries by the State of Alaska, appear much lower as they are either on net income rather than gross value, or are at a lower percentage. Table 9 indicates the estimated taxes that would be paid by mining and petroleum companies in each state. Data in this table are only a very rough indication of taxes payable, as actual taxes would be dependent upon an individual company's particular business expenses. Allowable deductible items will also vary from state to state, as would the consequent method of arriving at net income.

All the States studied also levy an unemployment compensation tax varying from 1.3 percent of gross payroll in Montana to 2.7 percent in Idaho; the Alaska rate varies from 1.5 to 4 percent, the applicable rate being determined by quarterly payroll decline. The taxable salary limit per person per year ranged from a low of $3,000 in Montana and Idaho to $7,200 in Alaska. The unemployment compensation tax is not included in table 9 because of the many variable factors involved. Various taxes levied by counties also are not included.

TABLE 8. - Major taxes levied against the mining and petroleum industries by selected States

State	Corporate net income tax	Mining severance taxes	Petroleum severance taxes
Alaska	18 percent of computed Federal income tax on Alaska income	License tax: Net income under $40,000 - no tax $40,000 to $50,000, 3 percent 50,000 to 100,000, $1,500 + 5 percent of excess over $50,000 over $100,000, $4,000 + 7 percent of excess over $100,000	License tax: 1 percent of gross value of production Conservation tax: 5 mills per barrel of petroleum 5 mills per 50,000 cubic feet of natural gas marketed
Idaho	9.5 percent of net income earned in State; Federal income taxes are deductible	3 percent of net value	- - - - - - - - - - - - - - - - - -
Montana	3 percent of net income earned in State	License tax: - $1 plus 0.50 percent of gross value in excess of $100,000 .75 percent of gross value in excess of 250,000 1.00 percent of gross value in excess of 400,000 1.25 percent of gross value in excess of 500,000	Production Tax: 2.5 mills per barrel on leases producing less than 25 barrels per quarter 5 mills per barrel on all other leases $0.01 per 100,000 cubic $0.01 per 100,000 cubic feet of natural gas License Tax: First 450 barrels per lease or unit per calendar quarter - 2 percent of an amount Calculated by multiplying gross value by number of producing wells. All in excess of 450 barrels - 2.50 percent of gross value (production used by operator not included). Net proceeds tax - rate fixed by county Board of Equalization.

TABLE 8. - Major taxes levied against the mining and petroleum industries by selected States (Con.)

State	Corporate net income tax	Mining severance taxes	Petroleum severance taxes
Oregon	6 percent of net income earned in State	([1])	([1])

[1] No severance taxes on petroleum or minerals; mineral content of land is subject to additional valuation under property tax appraisal procedures.

TABLE 9. - Comparative state taxes paid by mining or petroleum companies having a production valued (gross) at $1,000,000, and a net income of $100,000 earned in the State

	Alaska	Idaho	Montana	Oregon
Mining companies:				
Net income tax	$ 9,000	$3,000	$ 3,000	$6,000
Mining and severance taxes	4,000	3,000	12,500	(1)
Total	13,000	6,000	15,500	[2] 6,000
Petroleum companies:				
Net income tax	9,000	3,000	3,000	6,000
Severance taxes (500,000 barrels)	12,500	-----	[3] 27,500	(1)
Total	21,500	3,000	[2] 30,000	[2] 6,000

[1] Taxed under Property Tax Appraisal Procedures, rates are variable.
[2] Incomplete total.
[3] Exclusive of net proceeds tax; rates are set by counties and are therefore variable.

Based on the foregoing rough calculations, it appears that Alaska taxes applicable to the mineral industry are somewhat higher than those levied by other Northwestern States exclusive of county taxes. This apparently was recognized by the Alaska legislature, and curative measures were provided. Mining companies entering business in Alaska pay no mining license tax (actually a net profit tax) during the first 3-1/2 years of operation; the mining license tax supersedes the business license tax which is in effect a gross receipts tax; in the case of the petroleum industry the 1-percent gross value tax is in lieu of all state, city, town, or school district ad valorem taxes on leases, production, or value of machinery. The State can also exempt any new business or industry from all State and local taxes up to a period of 10 years based on the capital investment within the State. The exemption ranges from a 5-year period for a $1 million investment or less, up to a 10-year exemption for capital investments in excess of $10 million. In addition, the royalty rate for oil production on State land is similar to that of the Federal Government in that 12-1/2 percent of output is paid the State except on the discovery lease which is levied at the rate of 5 percent. None of the other States has any particular industry incentives with the exception of Oregon which does not tax certain types of new construction for 2 years. Virtually all the States under comparison permit depletion allowances similar to Federal depletion allowances in their calculations of net income.

Weighing all of the factors involved, particularly the exemptions listed, it does not seem that an increase in State taxes would appreciably affect the development of the mineral industry.

Foreigh Imports, Exports, and the Mineral Industry

The effect of imports and exports on the mineral industry in Alaska is difficult to assess because of lack of detailed data. Based on the limited information available, however, the dollar value of imports for consumption, as well as exports, (which were, with the exception of fish and pulp products, primarily reexported items) doubled in the second half of the 1950 decade as compared to the first half. Mineral imports of items such as cement, sulfur, and iron and steel products, in the decades ahead should continue to grow because of generally lower prices for equal quality as well as the strategic location of Alaska in relation to Asia, resulting in relatively low-cost water transportation. In the last few years the importation of mineral commodities, particularly from Japan, has increased tenfold (table 10). The Japanese should become even greater suppliers of Alaskan mineral requirements in the years to come because of their recently instituted regular ship service from Japan to their pulp mill at Sitka with a consequent desire to carry cargo to Alaska as well as pulp on the return. Overland shipments from Canada are not included in the data in table 10. The sole source of detailed data on total imports and exports is a special compilation prepared by the Department of Commerce[21] in 1957 and the first half of 1958. This survey indicated that major mineral imports into Alaska during the 18-month period consisted primarily of gasoline from Canada; other major items were petroleum products from Saudi Arabia and fertilizer materials from Canada. Major exports consisted of steel scrap to Japan and fuel oil to Canada.

Increased importation of mineral commodities might prevent the establishment of some local mineral industries such as cement, sulfur, and fertilizer manufactures, but generally should result in an increase in total local industry by tending to reduce the cost of living in Alaska and by exerting leverage on United States producers to reduce the cost of their Alaska-delivered products. The precise effect of foreign imports on the mineral industry can not be determined at this time because substantial Alaska international trade is too new.

Of the known Alaska resources awaiting development, petroleum will probably be the one immediately exportable commodity. In the 1957-58 Department of Commerce survey, over $3 million in petroleum products were reexported to Canada. In the future, however, Alaska producers and refiners will probably have to compete with refineries constructed in the Yukon Territory, Canada, to process locally produced crude oil. Japan, however, might be a prime market as over 95 percent of its crude oil supply is obtained from abroad and about 20 million barrels of refined products annually. Sales of the latter exceeds 160 million barrels per year; refining capacity is in excess of 640,000 barrels per day. This market could increase substantially in view of the postwar rise in the Japanese standard of living and the consequent use of automobiles and modern household equipment.

In any consideration of export possibilities, however, it must be remembered that the nations of the Pacific Basin represent not only inviting potential mineral markets, but also competitive sources of those minerals. Most of

[21] Foreign Trade Division, Bureau of Census, Seattle Field Office Release, December 9, 1958.

the countries have available the same mineral commodities as those known to occur in the 49th State; these are generally of higher grade and production costs are lower because of relatively inexpensive indigenous labor. Alaskan mineral products probably will not be able to compete in the market places of the Pacific Basin until the standard of living in those countries has risen sufficiently to erase present labor cost advantages, and until Alaska has developed sufficiently for its labor costs to decline as the cost of living drops.

TABLE 10. - Waterborne foreign mineral trade of Alaska, 1955-58[1]

Commodity	Country of origin or destination	Quantity (short tons unless otherwise specified)			
		1955	1956	1957	1958
Imports:					
Coal	Canada	370	260	----	140
Cement (376 pound barrels)	Japan	----	----	----	1,477
Sufur	Canada	----	----	8,133	5,233
Iron and steel product	Japan	----	----	----	1,497
Fertilizers	Canada	617	590	391	1,598
Exports:					
Iron and steel scrap	Japan	----	13,876	12,907	9,525

[1] Adapted from Waterborne Commerce of the United States, Part 4, Pacific Coast, Alaska, and Pacific Islands, calendar years, 1955-58: U.S. Army Corps of Engineers.

It might be possible eventually to ship Alaska crude or refined petroleum to the Scandinavian countries by nuclear-powered submarine tanker across the top of the world. The feasibility of the route has been proven by various U.S. Navy submarines; a tentative rough sketch of the tanker[22] has been propounded by the former captain of the Nautilus, first submarine to make the journey. Swedish imports of fuel approximated $350 million[23] in 1959, indicating a substantial market throughout Scandinavia.

THE FUTURE MINERAL INDUSTRY

The future mineral industry of Alaska will depend on the mineral resources of the State. These, based on present knowledge, are indicated to be large and varied (figure 6). In the past, gold has provided the major part of revenue obtained from mining. Placer mining has been widespread throughout Alaska; lode gold mining has been restricted primarily to the Southeastern Alaska region, particularly in the areas around Juneau, Douglas Island, and

[22] Anderson, William R., Comdr., USN: Nat. Geo. Mag., January 1959, vol. CXV, No. 1, pp. 21-24.

[23] Bureau of Foreign Commerce World Trade Information Service: Economic Reports, Part 1, Department of Commerce No. 60-31, 1960, p. 9.

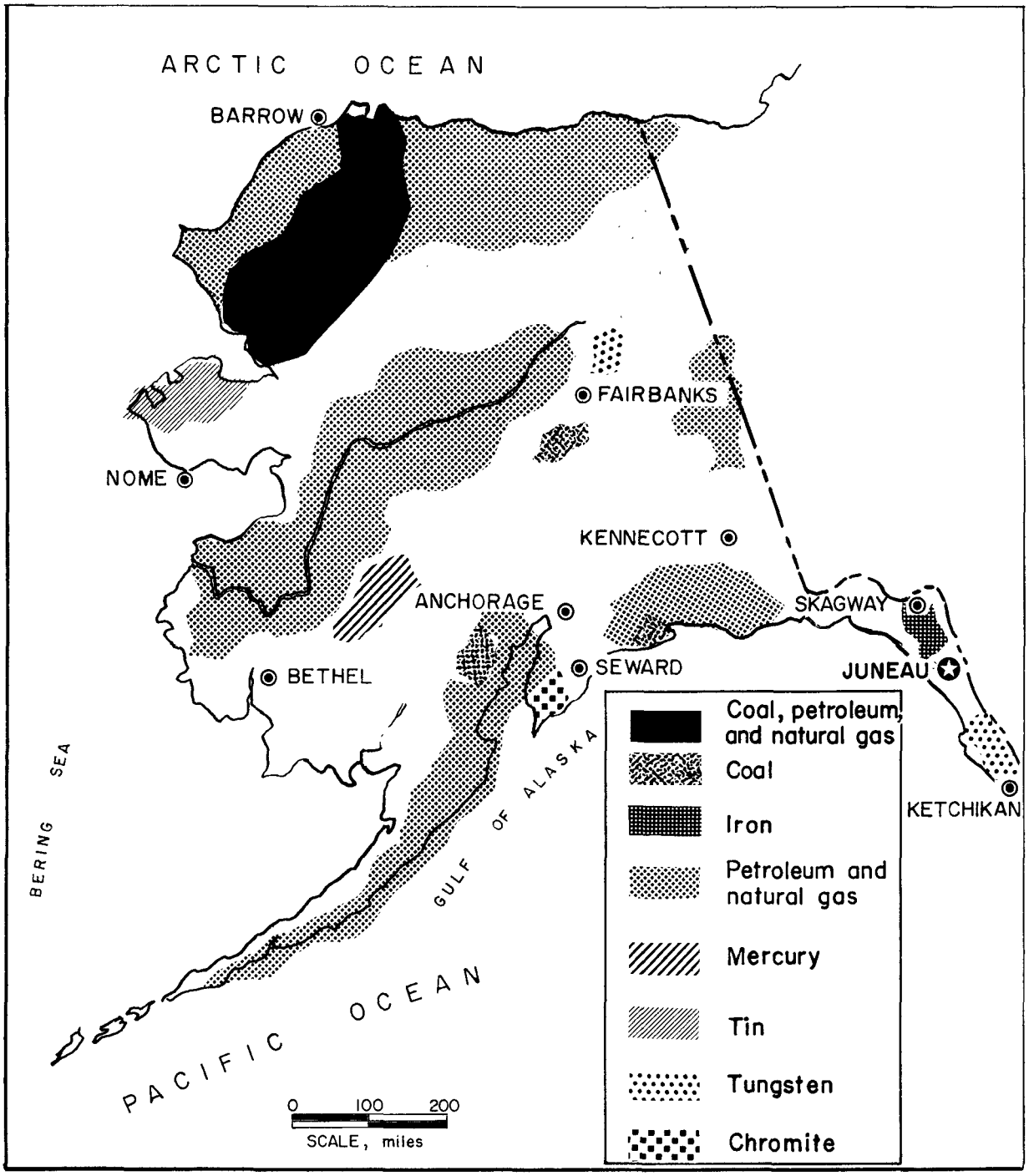

FIGURE 6. - General Areas of Major Mineral Occurrences in Alaska.

Chichagof Island. Copper has been yielded by mines on Prince of Wales Island, from the Kennecott mines in the Copper River Valley, and from the Prince William Sound area. Lead has been obtained in the past as a concentrate from the Alaska Juneau gold mine near Juneau, although there are a number of known deposits, mainly in Southeastern Alaska. Zinc has been noted near Mt. McKinley,

in Southeastern Alaska, and on some islands in Southwestern Alaska. Iron-bearing materials are known to exist in Southeastern Alaska particularly at Klukwan, near Haines on Snettisham and Cleveland Peninsulas; and on Prince of Wales Island. There are other occurrences of this type of material.

Coal is being mined in the Matanuska coalfield near Anchorage and in the Nenana coalfield near Fairbanks. These are both along the Alaska Railroad. This commodity is also abundant in the Beluga and Bering River fields, on the Kenai Peninsula, and in the Arctic. The latter area appears to have the most extensive reserves in the State; these are estimated to be 85 percent of the total solid fuel resources. The best available estimate[24] [25] indicates that there are at least 71 billion tons of subbituminous and lignitic coals, 21 billions tons of bituminous coal, and 2 billion tons of anthracite available in the State. The estimated 94 billion tons of all grades of coal represent a reserve equal to the original reserves of the Commonwealth of Pennsylvania.

Petroleum and natural gas also have been reported in various sections of the State. The Swanson River and Soldatna Units (Kenai Peninsula) of the Standard Oil Co., and Richfield Oil Co. are presently producing appreciable quantities of oil. Additional oil reserves have been discovered in northern Alaska through exploration of the Umiat field in Naval Petroleum Reserve No. 4.[26]

Natural gas has been discovered on the Kenai Peninsula by the Union Oil Co. and Standard Oil Co. and in the Gubic and South Barrow fields by the Federal Government. The South Barrow field supplies gas for use at Government installations near Barrow. A gas pipeline is currently under construction from Kenai to Anchorage.

Potential petroleum and natural gas areas aside from those already mentioned are the Cook Inlet area, the Copper River and Yukon River basins, Yakataga and Yakutat areas, Bristol Bay region, and the Alaska Peninsula.

Other resources include a variety of metals and nonmetals. Within the borders of the State is one of the largest mercury mines in the United States. This is in the Kuskokwim River Basin, and it is probable that other commercial ore bodies exist in that area. Tin has been mined on the Seward Peninsula and there are several lode and placer deposits which appear suitable for exploitation. Placer tin has been noted at many placer gold mines, particularly in the Yukon Basin. Antimony occurs near Stampede, and one mine has operated in that area. In addition, antimony in workable quantities has been reported in the Hyder district in Southeastern Alaska, near Sleetmute in the Kuskokwim Valley where it occurs with mercury, and in many other areas of the new State.

In the past, tungsten ore has been mined in the Fairbanks and Hyder districts; principal mining has occurred on Gilmore Dome along Cleary Creek in

---

[24] Gates, George O., Coal Fields of Alaska, Analyses of Alaska Coals: Bureau of Mines Tech. Paper 682, 1946, pp. 1-9.

[25] Barnes, Farrell F., Coal Fields of Alaska: Geol. Survey Open File Rpt. 492, 1959, 5 p. 1 map.

[26] Bureau of Mines, Recoverable Petroleum Reserves in the Umiat Structure, Naval Petroleum Reserve No. 4, Alaska: Open File Rept.

the Fairbanks district. In Southeastern Alaska (Hyder district) scheelite has been mined at the Riverside, Mountain View, and Monarch properties. Molybdenite has been reported in the Virginia Lake district, and on the Ohung River 30 miles east of Aniak. It has also been found on St. Lawrence, Baker, Kosciusko Islands, and near Hayes Glacier.

A considerable amount of development work has been done on various chromite deposits in Alaska. Several mines on Red Mountain (Kenai Peninsula) have produced chromite; there are other deposits in the area. Nickel has been reported from a number of locations in Alaska in the area between Juneau and Sitka, and on some of the islands in that region, including Admiralty, Yakobi, Chichagof, and Baranof. Reports show that it also occurs on Spirit Mountain and at other localities in the Copper River Valley. Platinum is being produced from placer deposits at Goodnews Bay, on the west coast of the State, below the mouth of the Kuskokwim River. In the past, some of the copper properties on Kasaan Peninsula, and Prince of Wales Island, have yielded platinum-group metals and these metals also were reported on the Seward Peninsula (Koyuk River, Quartz Creek, and in the Fairhaven district).

Alaska is wealthy in nonmetallic minerals also, including clays, stone, and sand and gravel, which are present throughout the State. Among the other nonmetallics, asbestos has been reported from excavations on ancient village sites between Shungnak and Kiana on the Kobuk River. Asbestos was found on Dahl Creek, and near Kotzebue, as well as in other areas of the Northwestern region. The Northwestern region is famous too for its jade, which occurs as the nephrite variety, and is suitable for various gem uses. Gypsum has been produced in Alaska from the Southeastern Alaska region; this material may be found in other areas. Volcanic deposits appear at Makushin Volcano, and near Stepovak Bay, as well as on Akun Island. There may be other deposits in the vicinity of volcanoes.

Despite this apparent abundance of mineral wealth, output from Alaska's mines is only $20 million per year, less than half of that from New Jersey which is only 1 percent as large in area. This lack of development results not only from the problems outlined in an earlier section, but from the generally low grade of the various known deposits. In those instances where grade is sufficient, reserves are generally inadequate. Alaska's promising future rests not so much with what is currently known of her mineral resources, but in the potential exhibited by her geology. Large areas of the new State have not been adequately prospected, although it is apparent from the foregoing recitation of occurrences that the 49th State is an area favorable to mineral deposition.

As exploration techniques improve, and as mining companies, driven by the necessity to uncover additional reserves before the exhaustion of current operations, move northward, additional deposits should be discovered, perhaps as rich as the Kennecott mines.

Exploration in the new State is already on the upswing (table 11). Aside from the small but steady increase in metal exploration expenditures, petroleum

exploration has increased significantly and should continue to rise. In a recent speech[27] an official of a major company estimated that more than $40 million would be spent in the search for oil and gas in 1961. He also stated that unless additional significant discoveries were made within the next few years, expenditures would decline.

TABLE 11. - Expenditures for exploration and prospecting by major companies in Alaska, 1955-59[1]

Year	Expenditures	
	Metals	Petroleum & Nat. Gas
1955	$ 505,000	$ 2,865,000
1956	996,000	2,980,000
1957	1,140,000	10,500,000
1958	1,180,000	5,900,000
1959	1,285,000	30,798,000

[1] Compiled by Division of Mines and Minerals, Department of Natural Resources, State of Alaska.

The author strongly believes that additional discoveries of both metals and petroleum are a certainty. The discussion that follows, however, is based on known available resources.

Fuels

Alaska by 1961 will have available usable reserves of coal, natural gas, and petroleum. The availability of the latter is important because it will contribute substantially toward the solution of the State's financial problems through the generation of tax and lease revenue as well as some additional employment. It is not envisioned that a petroleum refinery will be constructed in Alaska in the foreseeable future because refineries on the West Coast are available, and producing fields are close to tidewater. Futher, the local petroleum market does not appear large enough to attract the capital necessary to build a refinery.

A major petroleum discovery could change the situation dramatically not only by providing an ample supply of crude oil, but by the growth engendered by such a discovery. An example is the city of Williston, N. D. In a 7-year period from 1950 (before the completion of the Williston Basin discovery well) to 1956 population increased 70 percent, value of building permits rose 74 percent, bank deposits increased 53 percent, and retail sales doubled.[28]

During the current search for petroleum in Alaska, substantial reserves of natural gas were discovered; the Kenai unit near Kaliforsky Beach is

[27] Gester, P. T., district superintendent of exploration, Standard Oil Co. of California, Speech before the Anchorage Chamber of Commerce, October 25, 1960.

[28] Dalton, J. W., Survey of the Future Growth of the Petroleum Industry in Alaska and Its Impact On Anchorage: Greater Anchorage Chamber of Commerce, August 1958, pp. 99-100.

reported capable of yielding 60 million cubic feet per day from three wells, and the nearby Halbouty-King-Alaska Oil No. 1 was reported at 80 million cubic feet daily, open flow. In view of these discoveries and the anticipated completion of the natural gas pipeline in 1961, this commodity will assume great importance in Alaska's mineral future. It is estimated that initial consumption will exceed 2 billion cubic feet annually, rise to 7-1/2 billion by 1970, and jump to at least 16 billion cubic feet by 1980. These figures are conservative as they assume that the military will not convert to natural gas, and that the gasline will not reach Fairbanks until 1970. The latter conclusion is based not only on the fact that a rival organization owns a 20-year franchise for gas service in Fairbanks, but on difficulties in construction (particularly in the landslide area north of McKinley Park), and in obtaining capital to finance a 400-mile pipeline through sparsely settled country to a limited marketing area. Nevertheless, it is anticipated that the gasline eventually will be extended north from Anchorage rather than a new line being built south from the Gubic field. The distance from the Kenai gasfield to Fairbanks is roughly equivalent to the Gubic-field-Fairbanks mileage; however, the Kenai line would be able to follow the railroad right-of-way from Anchorage thereby saving clearing and other costs. Consumption would also be higher because the two major population centers would be served as well as the various small settlements along the railroad. A pipeline from Gubic to Fairbanks would traverse 450 miles of barren, rugged, frozen ground before serving its first customer.

Shipment of liquefied gas from the Kenai area to Japan and other countries also is a possibility. This is now under study by the Union Oil Co.; no conclusions have, as yet, been announced. Such a venture would require a considerable investment not only in liquefying equipment but in special ships as well as terminal facilities abroad.

Natural gas will, to a large extent, replace the other fuels in residential heating; not only is it convenient, but the comparative cost based on rates approved by the Anchorage City Council[29] is lower. (See table 12.) Insofar as the larger coal users are concerned there probably will be no appreciable shift to gas unless the rates are lowered. Any fuel savings that might accrue from such a changeover (including savings from coal handling and storage costs not included in table 12 calculations) would be required to amortize the costs of conversion.

Although the current Anchorage gas rates are competitive in relation to other fuels they are somewhat higher in relation to other cities. At the average heating price, 100 therms cost $17.20 in Anchorage as compared to $6.69 in Los Angeles, Calif., $11.68 in Portland, Ore., and $5.73 in San Francisco, Calif.[30] This is not too serious considering the generally higher cost of doing business in Alaska; however, there can be no migration of industry to utilize the large-scale gas resources of the State under the

---

[29] Residential - $5. for the first M cu. ft., 20 cents per hundred for the next 3.1 M cu. ft., 12 cents per hundred cu. ft. thereafter; Commercial and industrial - $200 for the first 200 M cu. ft., 90 cents per M cu. ft. for the next 300 M cu. ft.; 80 cents per M cu. ft. thereafter.

[30] Department of Commerce, Statistical Abstract of the United States: 1960, p. 343

present rate structure. The lowest rate for consumers (80 cents per M cv.ft.) is double the average value for industrial users in the other Northwestern States and more than triple the national average (23.6 cents). It is lower, however, than the average value for commercial users in the Northwest. The actual average value of commercial-industrial gas in Alaska will be somewhat higher than the 80 cents figure because of the graduated-rate scale based on consumption. If the gas resources of Alaska are to be fully used, and contribute their full share in the development of the State, a new and lower industrial rate will have to be established.

TABLE 12. - Comparative fuel costs, Anchorage, Alaska, 1960

Fuel	Average heat value B.t.u.	Average delivered price	Assumed overall efficiency of fuel[1],	Comparative cost, mills per therm
Small users:				
(Homes and so forth)..				
Coal.....	11,000/lb.	$22.75/ton	55	18.8
Oil:				
Furnace oil.....	138,000/gal.	[2] 0.273/gal.	80	24.7
Stove oil.....	136,000/gal.	[2] 0.215/gal.	70	22.6
Natural gas.....	1,000/cu.ft.	1.20/M cu.ft.	80	15.0
Large users:				
Coal:				
Military.....	11,000/lb.	13.78/ton	65	9.6
Other.....	11,000/lb.	14.40/ton	65	10.0
Oil.....	152,000/gal.	[3] 0.128/gal.	80	11.3
Natural gas.....	1,000/cu.ft.	0.80/M cu.ft.	80	10.0

[1] University of Illinois Fuels and Burners: Bull., vol. 50, No. 64, May 1953.

[2] Delivered in lots of 400 gallons or more.

[3] Calculated at $5.17 per 42-gallon barrel plus delivery charge.

It is not anticipated that natural gas will seriously affect the coal market. At least 80 percent of the coal produced in Alaska is used primarily for electric power generation (with heat as a byproduct); at current gas rates it is doubtful that these plants will convert. Data computed by the Bureau of Reclamation, U.S. Department of Interior, show a power shortage by 1964 in the Railbelt area (Anchorage-Fairbanks-Kenai). Current (1961) firm nonmilitary generating capacity equals 91,000 kilowatts (45,000 kilowatts, hydropower; 33,000 kilowatts, steam; 13,000 kilowatts, diesel); by 1964 power requirements are estimated at 91,000 kilowatts, and by 1970 at 170,000 kilowatts. It is obvious that additional capacity will have to be built. The Federal Bureau of Reclamation has proposed construction of hydropower facilities along the Susitna River (Devils Canyon project); this project will have an initial installed capacity of 217,600 kilowatts and a total capacity of 580,000 kilowatts. Firm power cost is estimated at 6 mills per kilowatt-hour at the bus bar; dump power would be considerably cheaper. Such relatively inexpensive

electric power would tend to replace electricity from the older steam plants. The cost of electricity from coal-fired nonmilitary generating facilities is estimated at 20 mills per kilowatt-hour at peak capacity and at 24 to 30 mills per kilowatt-hour for diesel plants.

The military establishment maintains its own electric generating plants. The cost of electric power from these is estimated at 6.5 mills when heat and electricity requirements are in balance in relation to plant design; costs will be much higher during the summer months when little steam for heat is required. It is assumed, therefore, that coal consumption will gradually decline as power requirements are met by less expensive hydroelectric generating facilities. In the event the Devils Canyon project is not underway by 1964 additional thermal power facilities will be required. These will probably be built at either the mine mouth or wellhead depending on the comparative cost of coal and natural gas at the time.

The foregoing indicates a grim future for the coal industry. However, before this situation becomes critical it is possible that new processes (carbonization, hydrogenation, and soforth) and new markets will develop. In addition, exploration in the Arctic, an area not well known may uncover substantial reserves of coal suitable for export. The very large coal resources of Alaska certainly should not be left in the ground.

Another factor in the Alaska fuel picture is nuclear power. In a paper presented before the Third Annual Minerals and Petroleum Conference at College, Alaska in 1958, Colonel W. C. Gribble, Jr. (former district engineer, Alaska District, Corps of Engineers) stated that operating costs of nuclear power plants are equal or less than those of conventional plants, that nuclear fuel costs are equivalent to those of petroleum fuels at 6 cents per gallon, but that capital costs are quite high. The cost of the Ft. Belvoir, Va. nuclear-powered generating facilities was $1,350 per kilowatt; the Ft. Greely, Alaska, plant was estimated at $1,150 per kilowatt. The Federal Power Commission in 1955 reported that conventional thermal plants were being built at a cost of $222 per kilowatt in New York and $114 per kilowatt in Pennsylvania. It would appear therefore, that nuclear power will not affect the Alaska fuel situation for some time except perhaps in very high-cost areas such as Nome and various isolated Distant Early Warning sites. It is significant that when the Corps of Engineers recently issued contracts for the Ballistic Missile Warning site at Clear, Alaska, a 22,000 kilowatt coal-fired generating facility was specified.

Metals

Of all the various metallic ores found in Alaska only the iron-bearing and mercury materials appear significant in 1960. The Kuskokwim River basin has the potential to become one of the largest mercury provinces in the world. Many cinnabar occurrences are known; several mines have operated for short periods. It is probable that over the next 20 years three or four mercury mines may be in operation.

The Federal Geological Survey, in August 1957, estimated that measured and indicated ore reserves minable at $250 per flask were equal to 30,000 flasks; inferred ore was estimated at 10,000 flasks. Potential reserves are probably much larger in that the ore included in the above classes of reserves averaged 30 pounds of mercury per ton in Alaska as compared to the 8-pound average for the other States. As Alaska costs decline the tenor of ore capable of being mined at $250 per flask or lower should also drift downward toward the 8-pound average. Since the majority of the known ores also contain antimony this might become a major byproduct.

One of the most promising metalliferous resources is the iron-bearing materials of Southeastern Alaska. These materials are estimated at 5 million long tons classified as direct shipping ore and concentrates with a total iron content ranging from 45 to 52 percent,[31] plus a potential ore reserve estimated in the billions of tons. The iron-bearing materials of Alaska vary from magnetite in association with copper sulfides to titaniferous magnetites. Examples of the latter occur at Klukwan, Snettisham, and Cleveland Peninsula. The magnetite-copper sulfide material is typified by the deposits at Mt. Andrew, Poorman, Tolstoi Mountain, and Jumbo Basin, all on Prince of Wales Island. The Mt. Andrew-Mamie-Poorman areas contain the highest grade deposits in Alaska. Should the development program of the Mt. Andrew Mining Co., and Prince of Wales Mining Co. prove successful there is a strong possibility that these properties might become active within a few years. They are close to the Japanese-owned pulp mill at Sitka, and because of the low specific gravity of chemical pulp, heavy iron concentrates from these deposits could be used as ballast cargo for pulp-laden ships returning to Japan.

The iron-bearing materials of Alaska will probably not be shipped to the contiguous United States for at least 10 years because of ample reserves of generally higher grade ores already existing in the West. The western region of the United States is estimated to have 490 million long tons of direct shipping ore and concentrates containing 50 percent iron, plus a conservatively estimated 500 million long tons of potential ore of which 290 million tons contain 40 percent iron, the remainder 50 percent.[32] At the present annual rate of production (6 million long tons) reserves of direct shipping ore and concentrates alone would be ample for more than 80 years; however, 63 percent of this reserve is inferred (quantititive estimate based on broad knowledge of the geologic character and relations of the deposit with few, if any, samples or measurements); actual mining may prove considerably smaller (or larger) reserves. However, the western area is a growing section and as population continues to move westward the steel producers will follow. In the 5-year period from 1954-58 consumption of metalliferous materials by blast furnaces declined 9 percent for the United States (primarily as a result of the 1957-58 recession and steel strike) as a whole; consumption in California, Colorado, and Utah rose at least 1 percent.[33] Pig iron consumption dropped 2 percent for the United States in the same period, but increased 15 percent in the

---

[31] Carr, M. S., and Dutton, C. E., Iron Ore Resources of the United States including Alaska and Puerto Rico 1955: Geol. Survey Bull. 1082C, 1959, p. 102.

[32] Work cited in footnote 31, p. 87.

[33] 1954 figure includes Texas; actual increase for the three Western States would be greater than 1 percent.

Pacific and Mountain States. In the 1953-57 period pig iron consumption rose 2 percent and 17 percent respectively in the United States and in the West. As this trend continues, additional iron resources will be required and the producers may turn northward to Alaska. Should this happen the huge titaniferous magnetite deposits will be of primary interest. These deposits, with reserves measured in billions of tons, are comparatively low grade (10 to 20 percent Fe) and not usable under present blast furnace practice. The lode deposits probably could be mined by surface methods and the large alluvial deposit at Klukwan by dredging; the known deposits are close to ice-free, deep-water ports.

Bureau of Mines beneficiation tests at Juneau, Alaska[34] [35] indicated that the Klukwan and Snettisham iron-bearing materials are amenable to standard ore-dressing techniques.

Six samples from the Klukwan lode and alluvial fan were concentrated by wet magnetic separation of minus 20-mesh ore followed by grinding (minus 65-mesh) and re-treatment of the rougher concentrate. This process produced a concentrate averaging 63 percent iron, 2.7 percent titania, 0.3 percent vanadium, 0.3 percent sulfur, and less than 0.02 percent phosphorus. Iron recovery ranged from 45 to 97 percent depending on the initial grade of the sample with an average recovery of 71 percent. Titania content of concentrates from lower grade material averaged 2.2 percent; higher grade ores resulted in a titania content as high as 4.2 percent. The Snettisham ores were treated by wet-magnetic separation of a minus 150-mesh sample or by staged wet-magnetic separation of 35-mesh ore with the resulting concentrate ground to minus 150-mesh and re-treated. These processes resulted in the recovery of 61 to 64 percent of the total iron in a concentrate assaying 64 percent iron, 3.5 percent titania, 0.3 percent vanadium, 0.4 percent sulfur, and less than 0.01 percent phosphorus.

The titania in both the Klukwan and Snettisham material generally is considered too high to meet blast furnace specifications and too low for economic recovery. Bureau of Mines tests conducted at Albany, Ore., and as yet unpublished, indicate that these ores can be electrosmelted to yield pig iron of various grades with no adverse affects from the high titania content. This process requires huge quantities of electric power; a pig iron plant with a daily capacity of 100 tons would require an estimated 300,000 kilowatt-hours of electricity daily. Although a large-scale hydropower potential exists nearby (Taiya project estimated at 22 billion kilowatt-hours annually) development of this power does not appear possible in the foreseeable future because of international considerations. The project requires the diversion of some of the headwaters of the Yukon River in Canada. However, Alaskan pig iron landed in the large markets of the Western United States would probably be unable to compete in price with imported and local products. Iron smelting technology, however, is changing and it may not be too many years before research

[34] Thorne, R. L., and Wells, R. R., Studies of the Snettisham Magnetite Deposit, Southeastern Alaska: Bureau of Mines Rept. of Investigations 51,95, 41 pp.

[35] Wells, R. R., and Thorne, R. L., Concentration of Klukwan, Alaska, Magnetite Ore: Bureau of Mines Rept. of Investigations 4984, 1953, 15 pp.

evolves a suitable procedure such as a sponge-iron or direct-iron process. Most of these newer processes also require considerable electric power.

Barring some major breakthrough such as steel directly from low-grade ore, the author does not believe that Alaska's major iron resources will be tapped before 1970 and most likely not until after 1980.

Nonmetals

Alaska's nonmetallic resources, next to the fuels, have the greatest potential for early development. These are generally bulky, low-value materials and local processing might in many instances make for a lower delivered cost considering transportation charges from the contiguous States.

There is latent in Alaska a great potential for the growth of various building product industries; at present there are several cement block manufacturers, concrete plants, and a brick kiln active in the new State. These industries seem destined to expand because of the population growth potential. The total population of Alaska, although equal only to that of a medium sized city such as Worchester, Mass., rose 77 percent in the 1940-50 period, 74 percent in the decade just ended, and it is estimated that the population will increase an additional 60 percent in the decade ahead.

A relatively large potential market for locally produced brick, and consequently for local clays, seems to exist. Considering the climate in most of the State, a brick house or office building should be a popular type of construction. This opinion seems to be supported by the fact that more than 1,000 tons of brick is shipped into the State annually, and a locally produced product is sold despite a price of 15 cents per brick. Recently a modern downdraft kiln was set up in Anchorage by a new group of operators. This, together with the availability of natural gas, should result in lower costs through better control of kiln temperatures with consequent lower brick loss during a burn. This industry seems destined to expand, and virtually all of future consumption will be supplied from local brick yards.

As Alaska grows, the need for locally produced cement also will grow. At present, cement consumption, as measured by waterborne shipments, is at an approximate rate of 360 thousand barrels (376 pounds) per year. This is somewhat below the usual plant capacity deemed economic; however, consumption as shown in table 3, should increase as the result of normal growth. The location of a plant in Alaska might also serve to stimulate additional use through conversion from competitive materials such as asphalt paving, and other materials. Suitable limestones close to transportation are available. Promising deposits are located on Kings River near Castle Mountain and near Foggy Pass on the West Fork of Windy Creek. The latter is located close to the Healy River coalfield, and is approximately midway between Anchorage and Fairbanks on the Alaska Railroad.

The Castle Mountain deposit is near the Matanuska coalfield and within range of the Kenai gasline; it is also quite close to the major market at

Anchorage. Costs at either site, because of comparable or compensating conditions, probably would be equal and no higher than the 1960 price of $7.45 per barrel sacked. The Anchorage delivered price for cement in bulk is $6.95 per barrel. The cost of producing cement in Alaska may be lower than estimated because of reduced fuel costs and lower transportation charges.

Development of lightweight aggregate and mineral wool insulation industries also is possible. The use of lightweight aggregates in the preparation of concrete would result in substantially reduced construction costs through reduction in concrete dead weight (concrete with sand and gravel weighs 145-159 pounds per cubic foot; concrete with lightweight aggregate weighs 35-115 pounds per cubic foot) with consequently lower costs for trusses, columns, footings. Use of this material also permits an increase in building height and in the size of floor panels. Considering that several million tons of sand and gravel are now used in concrete a potential market for 2 to 3 million tons of lightweight aggregate is possible by 1970. Deposits suitable for the manufacture of haydite (expanded shale) are known to exist in the Railbelt and an abundance of pumice is available near tidewater on the Alaska Peninsula.[36]

Mineral wool or some type of insulation is required in Alaska because of the rigorous climate. Data regarding the size of this industry in the 49th State are not available; however, considering the apparent industry growth trend in the contiguous States as well as the number of new buildings that will be required in Alaska, future demand should be sufficient to warrant development of a local industry. Low-bulk density and ease of crushing generally place this commodity in the high-cost transportation class. Freight savings resulting from local manufacture should more than compensate for Alaska's higher cost of operating. Suitable material is available in the Anchorage, Cantwell-Windy, and Homer-Seldovia areas, as well as the West Fork of the Chulitna River.[37]

These materials were tested[38] and found to produce an acceptable wool. The availability of relatively low-cost natural gas as a melting furnace fuel might provide the necessary impetus for the development of the mineral wool industry. Gas has been used in reverberatory furnaces in several places instead of the usual coke-fired cupola furnace. An electric furnace of the induction type might also be used if sufficient quantities of inexpensive electricity were available.

An earlier part of this report discussed the substantial increase anticipated in sulfur consumption. In all probability this need will be met by continued imports over the short term. In the long term, however, sulfur requirements might be met from byproduct treatment of natural gas or possibly through

---

[36] Rutledge, F. A., Thorne, R. L., Kerns, W. H., and Mulligan, J. J., Preliminary Report: Nonmetallic Deposits Accessible to the Alaska Railroad as Possible Sources of Raw Materials for the Construction Industry: Bureau of Mines Rept. of Investigations 4932, 1953, pp. 47-50.

[37] Work cited in footnote 36, pp. 85-87.

[38] Kenowrthy, H., and Moreland, M. L., Laboratory Results on Testing Mineral Wool Raw Materials: Bureau of Mines Rept. of Investigations 5203, 1956, pp. 9-10.

exploitation of sulfur deposits in the volcanic areas of the Alaska Peninsula and the Aleutian Islands.

Aside from industrial minerals, Alaska is justly famous for its jade. There is, at present, a small but thriving jade carving industry (gem stones, and bookends) in the State. This should expand as the local craftsmen, with the help and guidance of the Federal Indian Arts and Crafts Board, develop greater skill in working this material.

☆ U. S. GOVERNMENT PRINTING OFFICE : 1961 O - 622412