RAILWAY ROUTES IN ALASKA*

By Alfred H. Brooks

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TRANSPORTATION is the first essential element to the industrial advancement of a new land. Therefore, though the subject of railway location may be of no great academic interest, there lies a justification for its discussion in the fact that it is of such vital importance to those who are developing the resources of Alaska. Moreover, the matter is timely because of its relation to a broad question of public policy, for many efforts have been made in recent years to obtain financial support from the federal government for Alaskan railway projects.

Popular interest in this subject appears to be only excelled by popular ignorance of it—an ignorance, too, which is constantly being augmented by misstatements in current literature. Some years ago the assertion was made in a magazine article that some parts of Alaska were being rapidly gridironed by railways. To those familiar with the primitive condition of transportation maintaining throughout the territory, such a statement can appear little short of ridiculous. This misleading article has, however, evidently been regarded as authoritative, for it has found place in a popular encyclopædia.

Though the aggregate mileage of railways in Alaska is less than 200, but little more than that of Porto Rico, this is divided among eight different lines. Of these, four are along the Pacific seaboard, three on the Seward Peninsula, and one in the Tanana Valley (see map, page 164). All of these railways have been built to supplement water transportation.

RAILWAY LOCATION

In the discussion to follow of the principles governing railway location, I will confine myself entirely to commercial lines, for obviously railways built for military or scenic purposes will follow routes determined by entirely different conditions.

The controlling factors of railway location fall into two important groups, here termed (1) commercial and (2) geographic, while in regions lying close to international boundaries a third, namely, political, becomes operative. Each of the first two groups resolves itself into several subordinate factors, one or more of which may dominate in any given province, to the practical exclusion of all the others. The following table is an attempt to present a terse analysis of the problem of railway location:

I. *Commercial control:*
  1. Developed resources (statistics of production and commerce).
  2. Undeveloped resources.
     Mineral (economic geology).
     Agricultural (climate, soils, and botany).
     Timber (distribution, quality, and quantity).
  3. Population.
  4. Competitive or supplementary lines of transportation (navigable waters and existing railways).

II. *Geographic control:*
  1. Position (terminals and connecting lines of transportation).
  2. Distances (comparison of distances of different routes).
  3. Relief (mountain ranges, passes, and valleys, as affecting gradients).
  4. Water-courses (depths and width of rivers, as affecting construction of bridges or ferries).
  5. Climate (precipitation, etc., as affecting cost of construction, operation, and maintenance).

III. *Political control:*
  1. Political boundaries.

Before analyzing this table I will forestall possible criticism by stating that certain elements which must of necessity

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have an important influence with a locating engineer are here entirely omitted because they do not appear to be germane to the subject. In this I refer more specially to the financial backing to any given project. Obviously the choice of a railway route may have to be governed by the low cost of first construction rather than by consideration of the ultimate economy in construction, operation, and maintenance. I believe, however, that the question of financing of a railway project should find no place in a scientific discussion of railway location. The available sources of material for construction have also not been included in this analysis, for this is, after all, a local problem and will not affect the general choice of routes.

COST PER MILE

Though it is not the purpose of this paper to discuss the more purely engineering aspect of my subject, yet it may be well to devote a few words to the question of the cost of construction because of the many current misconceptions regarding it. It will be pointed out below that the watersheds to be crossed by Alaskan railways (see profiles, page 179) vary from about 2,000 to 3,000 feet, which are low compared with the altitudes of 8,000 to 11,000 feet attained by many railways in the western states. It will also be shown that the routes of approach to the divides have as a rule low gradients, and that much of the region to be traversed by railways is one of only moderate relief. On the other hand, most of the proposed routes will demand bridging of many streams and rivers. This feature will possibly be the most difficult for the engineer to contend with, because of (1) the winter ice and (2) the spring floods.

The chief factor which will much enhance the expenditures for railway construction in Alaska is the distance of the coastal terminal to the centers of population, for this increases the cost of all labor and materials. Shortness of the summer season and adverse climatic conditions will also enhance the cost. It has been estimated by a competent engineer that the same class of construction will cost 75 to 100 per cent more in Alaska than in the western states. The same engineer has stated to the writer that in many parts of the interior, where valleys and rolling uplands are followed, the cost of a standard-gauge railway will probably not exceed $30,000 per mile, but through the coastal mountain ranges may be more than twice as great. Where detailed surveys and estimates are wanting, it will probably be safe to count on an average cost of at least $35,000 per mile for a standard-gauge railway from the Gulf of Alaska to the Yukon.

What I have termed commercial control is simply another name for tonnage, the great dominating element in railway location. This, in turn, is dependent in a large measure on resources, developed or undeveloped. In settled regions the distribution of population may wield a decided influence, but population again is often merely an evidence of developed resources. The amount of tonnage will also be affected by competitive and supplementary lines of transportation.

Five subdivisions are recognized under geographic control. The first is position, which pertains chiefly to location and character of terminals and their relation to other transportation systems. Under the second, distances, the different routes are compared in length. Under relief is included the influence of topography, while larger water-courses must be considered because they necessitate bridges or ferries. The influence of climate on cost of construction, operation, and maintenance is obvious. Heavy snowfalls, river floods, and the closing of waterways by winter ice are elements that deserve consideration. Political control obviously refers to international boundaries alone.

I have intentionally emphasized the commercial control of railway routes, for it is evident that without adequate tonnage railways cannot be built economically. On the other hand, given the resources to warrant the cost of construction and operation, and the modern engineer will build a railway almost anywhere. In this I do not intend to indorse the policy, too often followed, of railway location which is not preceded by comprehensive geographic investigation. Many railways have been based on routes chosen by the old adage: "The Indian followed the buffalo, the white man the Indian, and the locomotive the white man." As a consequence, nearly every transcontinental line has made or is contemplating changes of routes involving the expenditure of millions of dollars which might have been avoided by proper exploration and survey. The lesson has not yet been learned, however, for recently a corporation proposing to build a railway in Alaska, after spending several hundred thousand dollars in construction, abandoned the chosen route for another. In this case a tenth part of the money spent on what proved to be worthless construction would have more than paid for the necessary explorations and surveys.

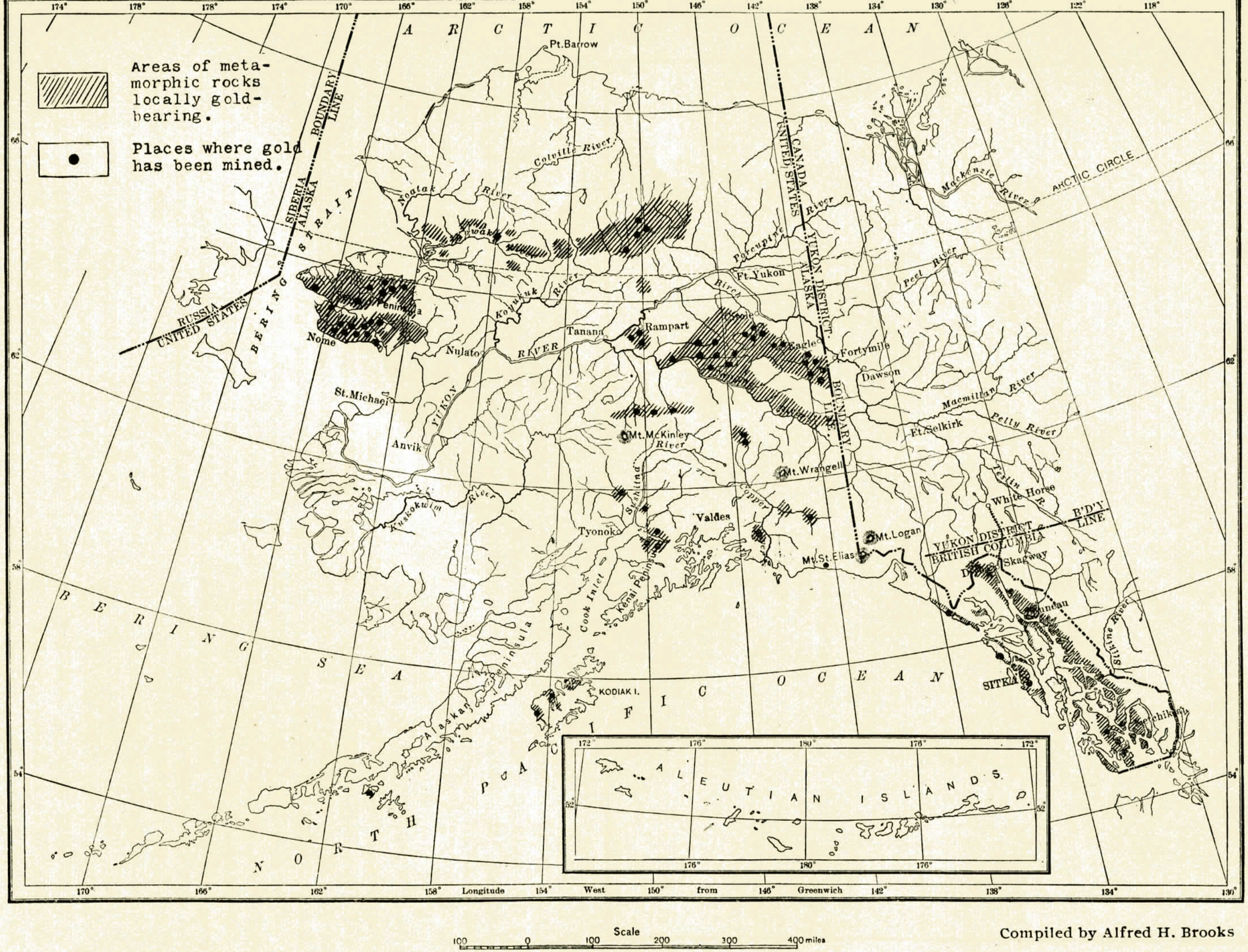
It follows from the above that while the demand for transportation between certain localities may be such that a railway will be built in spite of the physical obstacles, yet economic location demands the most careful adjustment to the topography.

RESOURCES TO BE DEVELOPED

It is evident that a discussion of railway routes must consider the resources of the territory as well as its physical features; that is, on one hand, the possibilities of traffic must be discussed; on the other, the routes of approach. The question of traffic again resolves itself into statistics of existing commerce and the foreshadowing of that to come from undeveloped resources.

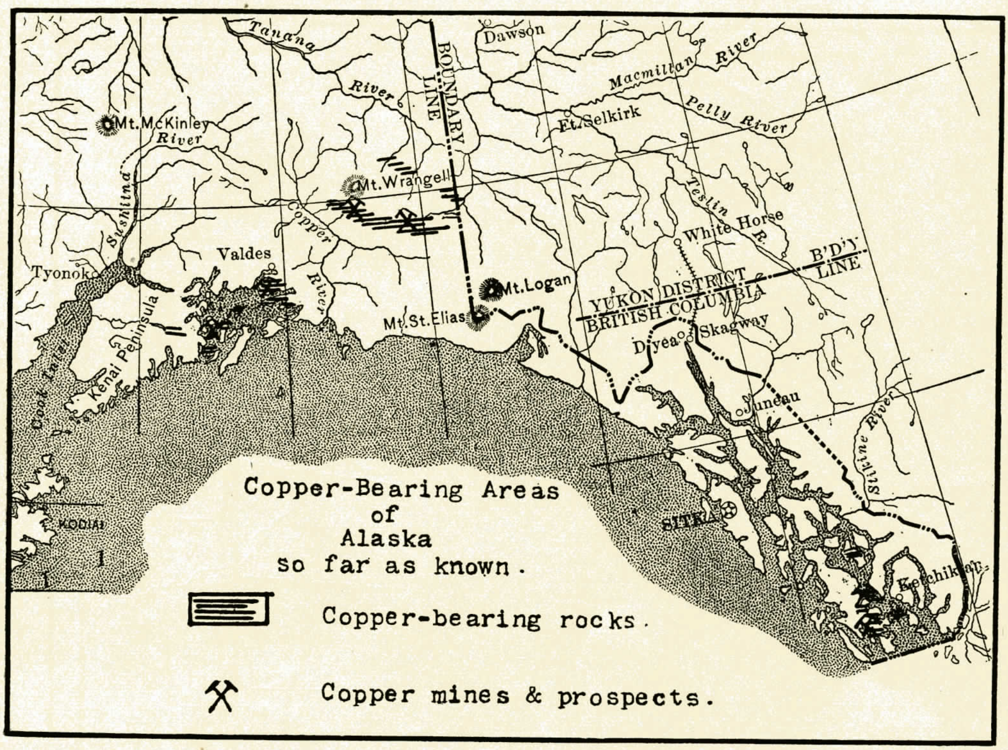
In Alaska the problem is simplified by the fact that the immediately available resources to be developed by railway construction are all of a mineral character. I do not by this mean to decry the agricultural possibilities of certain parts of the territory, but I do believe that these may be almost neglected in the present discussion, for the reason that these arable lands are too remote from centers of population to yet compete with the more accessible and fertile lands in the states. The capitalists will certainly look to the mines of precious metals and of coal to recoup themselves for outlays on railway construction. With the mining development some agricultural progress will unquestionably be made and eventually be a source of traffic for the road. There is no timber for export except along the Pacific seaboard (see page 183). In fact, much lumber is annually taken into the interior, and this consumption is likely to become greater, if the present ravages by forest fires in the Yukon Basin continue.

The discussion of resources to be developed by railways, therefore, resolves itself into a consideration of the mineral wealth and its distribution. In other words, it is a geologic problem. Though the basal facts are very incomplete, yet some salient features of the economic geology are known, and these bear directly on the problem of mineral resources. It is not my purpose to describe the geology of the territory, but I will call your attention to the distribution of certain terranes which carry minerals of economic value. The rocks grouped together as undifferentiated Paleozoic, including the gold-bearing horizons, occur in three belts, one running parallel to the Pacific seaboard, a second lying centrally in the Yukon Province, and a third forming the country rock of the major part of the Seward Peninsula (see map, page 168). Of the $100,000,000 which represents in round numbers the total mineral production of Alaska, over 98 per cent has been taken from areas underlain by these rocks. In southeastern Alaska there is a well-defined contact between a broad belt of intrusives and these metamorphic terranes, and this has been proved to be the general locus of auriferous lodes. It should be noted that the northern extension of this contact lies in



Compiled by Alfred H. Brooks

Map of Alaska, Showing, so Far as Known, the Distribution of Metamorphic Rocks, and the Localities where Gold Has Been Mined



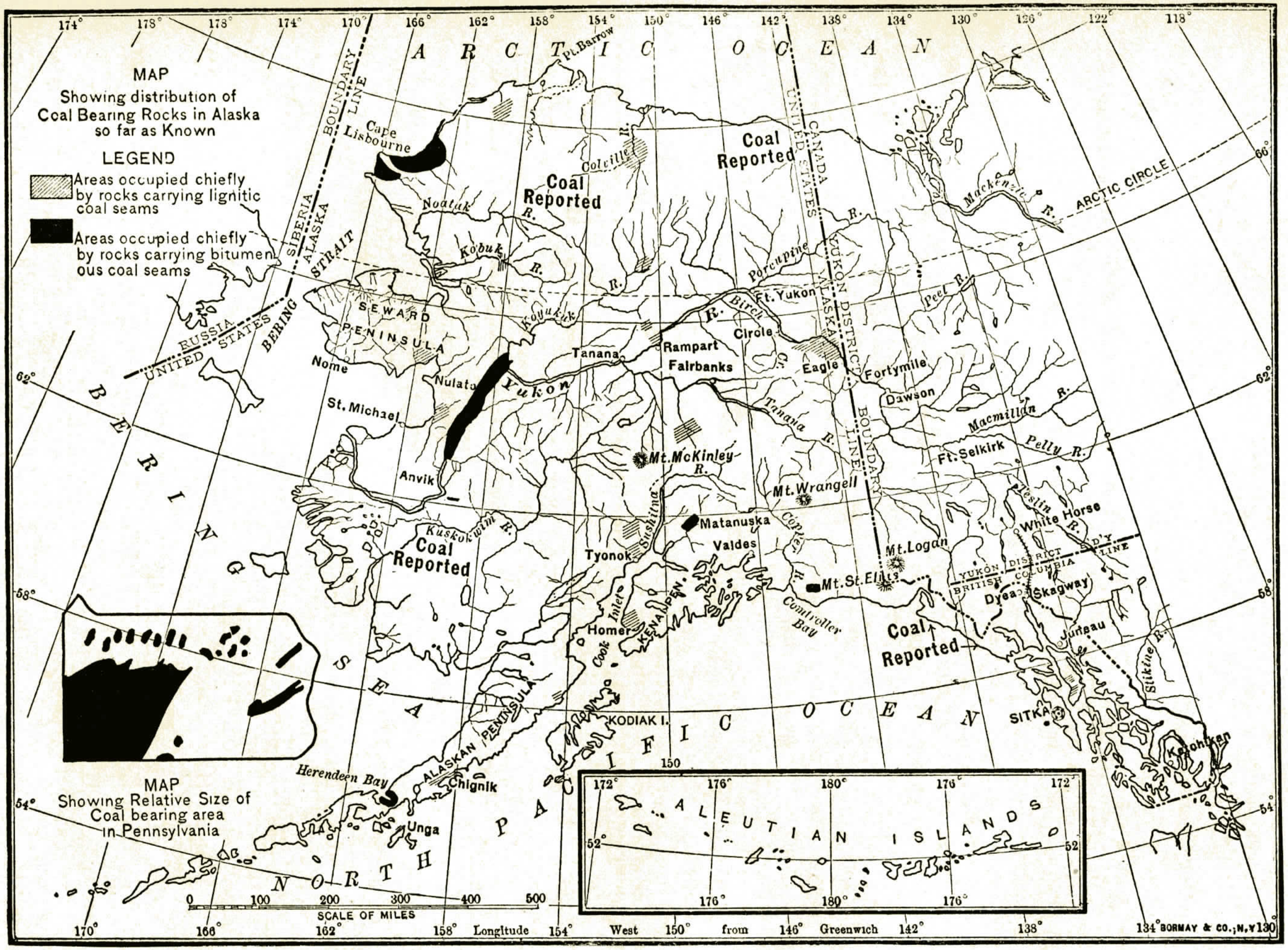
a little-known region, as will be shown later; it is close to one of the proposed railway routes into the interior. Another fact bearing on the mineral resources can be interpreted in terms of geology. On either side of the Wrangell Mountains is a belt of Devonian rocks which are copper-bearing (see map, page 169). These are, indeed, the outcrops of the same terrane along two areas of a syncline and form the objective points of several railway projects.

The map on page 168 shows the distribution of the auriferous terranes of the territory so far as determined. It emphasizes the fact that there is an extensive gold-bearing area lying well within the heart of the territory and 400 to 500 miles from tidewater.

COAL AND COPPER

The total area of the known coal-bearing rocks in Alaska is approximately 12,000 square miles (see map, page 170). Unfortunately, much of the coal in the northern province is of a lignitic character, and though it will eventually find local use, cannot now be regarded as an important source of tonnage for railways. There are two coal fields, however, the Controller Bay and Matanuska, aggregating at least 120 square miles, which carry high-grade bituminous and some semi-anthracite coal. This coal is superior to any mined on the Pacific seaboard of the continent and is suitable for metallurgical purposes. Both fields are objective points of railways now under construction and are expected to furnish local tonnage for these roads, to be eventually extended into the interior. Bituminous coals also occur on the Yukon and at Cape Lisburne, on the Arctic Ocean.

Only the copper deposits of the inland region are important to this discussion, and these include two different districts lying north and south of the Wrangell Mountains, on the two arms of a syncline



Compiled by Alfred H. Brooks

Map of Alaska Showing the Distribution of the Coal-bearing Rocks so Far as Known (see map, page 169). The southern belt, to which a railway is being built, has been sufficiently developed to indicate a large tonnage.

AGRICULTURAL POSSIBILITIES

I have shown that the resources which promise to yield a tonnage are gold, copper, and coal. The forests, except along the seaboard, have no value for export (see map, page 172). Inland the heavy timber, of which the largest trees are not over two feet in diameter, is closely limited to the river courses. Though there are sawmills in every placer camp of the Yukon, that these do not even supply the local demand is made evident by the fact that in 1905 upward of $30,000 worth of lumber was brought to the Yukon from Puget Sound. The timber map can also be used to indicate the general distribution of arable lands, for the areas marked as timber embrace practically all the lands which may possess future agricultural value. A region lying adjacent to and north of Cook Inlet appears to be best adapted for agriculture, but in the Copper and Tanana basins, too, there are considerable tracts of agricultural and grazing lands. It should be borne in mind that beyond the coastal barrier the subsoil usually remains perpetually frozen and the climate is semi-arid. These conditions, combined with the shortness of the growing season and the liability of frosts, do not invite agricultural pursuits. Nevertheless, the conditions are no more adverse than those existing in some European countries which support a thrifty agricultural peasantry and export agricultural products. The richness of the soil is attested by the many gardens found throughout the inland region. These are specially successful where hot springs have thawed the soil. One of these is shown in the illustration on page 183.

4 TONS OF COAL AND 30 TONS OF GOLD EXPORTED IN 1905

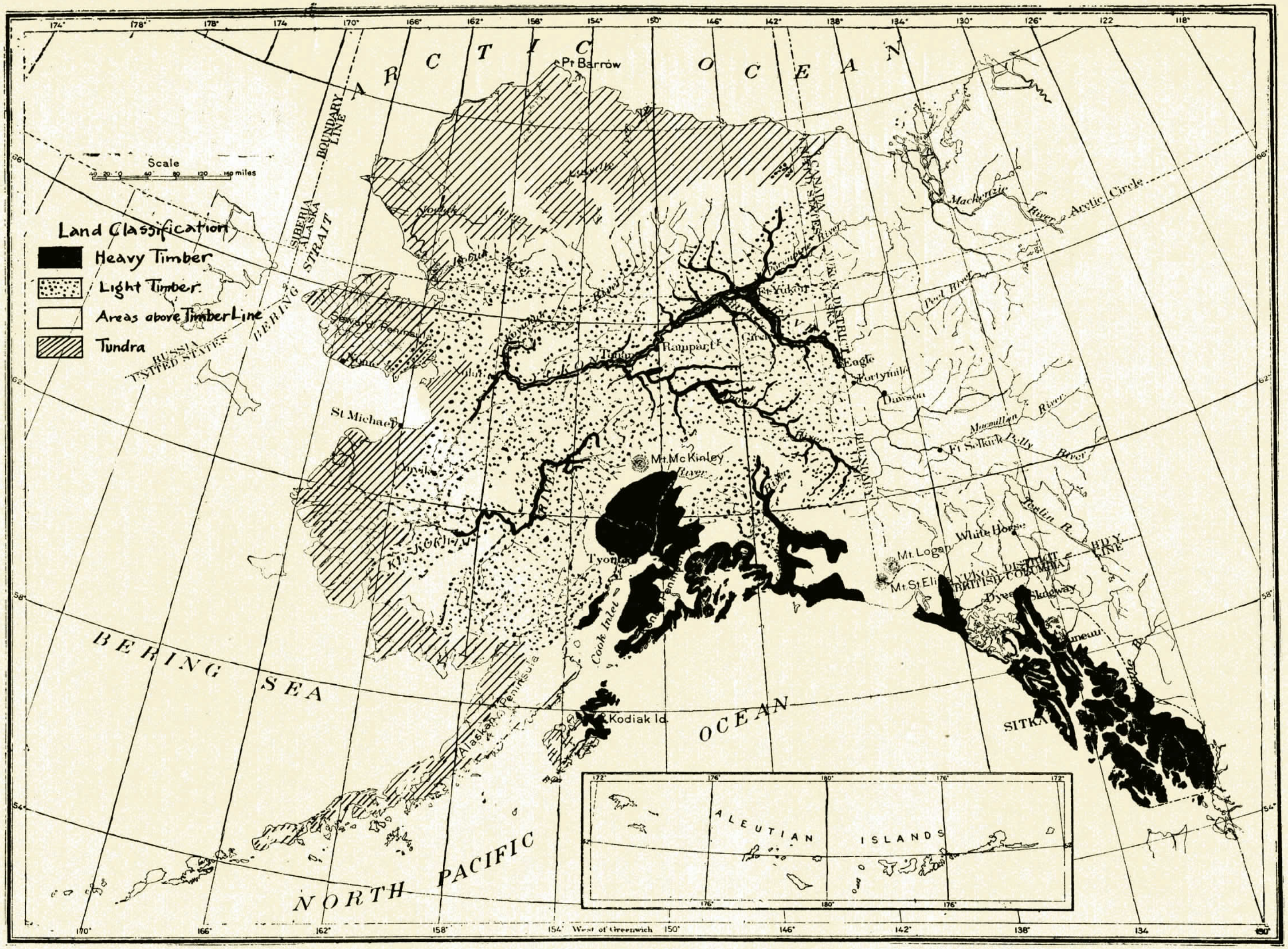
As regards the developed resources, little can be added to what has already been presented. The rapid increase in gold production is shown in the diagram on page 175. Including 1906, the total output of gold is about $100,000,000, only about one-quarter of which has come from the inland districts, as shown in the following table:

Gold Production of Alaska, with Approximate Distribution

Year.	Pacific coastal belt.	Copper River and Cook Inlet region.	Yukon Basin.	Seward Peninsula.	Total,
1880....	$20,000	....	....	....	$20,000
1881....	40,000	....	....	....	40,000
1882....	150,000	....	....	....	150,000
1883....	300,000	....	$1,000	....	301,000
1884....	200,000	....	1,000	....	201,000
1885....	275,000	....	25,000	....	300,000
1886....	416,000	....	30,000	....	446,000
1887....	645,000	....	30,000	....	675,000
1888....	815,000	....	35,000	....	850,000
1889....	860,000	....	40,000	....	900,000
1890....	712,000	....	50,000	....	762,000
1891....	800,000	....	100,000	....	900,000
1892....	970,000	....	110,000	....	1,080,000
1893....	838,000	....	200,000	....	1,038,000
1894....	882,000	....	400,000	....	1,282,000
1895....	1,569,500	$50,000	709,000	....	2,328,500
1896....	1,941,000	120,000	800,000	....	2,861,000
1897....	1,799,500	175,000	450,000	$15,000	2,439,500
1898 ...	1,892,000	150,000	400,000	75,000	2,517,000
1899....	2,152,000	150,000	500,000	2,800,000	5,602,000
1900....	2,606,000	160,000	650,000	4,750,000	8,166,000
1901....	2,072,000	180,000	550,000	4,130,700	6,932,700
1902 ...	2,546,600	375,000	800,000	4,561,800	8,283,400
1903....	2,843,000	375,000	1,000,000	4,465,600	8,683,600
1904....	3,195,800	500,000	1,300,000	4,164,600	9,160,400
1905....	3,430,000	500,000	6,900,000	4,800,000	15,630,000
1906....	3,500,000	400,000	10,000,000	7,300,000	*21,200,000
Total.	37,470,400	3,135.000	25,081,000	37,062,700	102,749,100

***Production for 1906 is estimated.**

The copper production, which in 1905 was valued at $750,000, has so far been only from the coastal zone, and therefore does not affect this discussion. In 1905 4 tons of coal were exported from Alaska, as compared with 30 tons of gold, which strikingly indicates that the coal fields have not yet been exploited. Several thousand tons are, however, mined annually for local use. It is worthy of note that both the Controller Bay and Matanuska coal fields (see map, page 170) carry some excellent coking coals, and, if made accessible by railways, the mining of this character of fuel for smelting of the copper ores is likely to become an important industry.



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Map of Alaska, Showing Distribution of Timber

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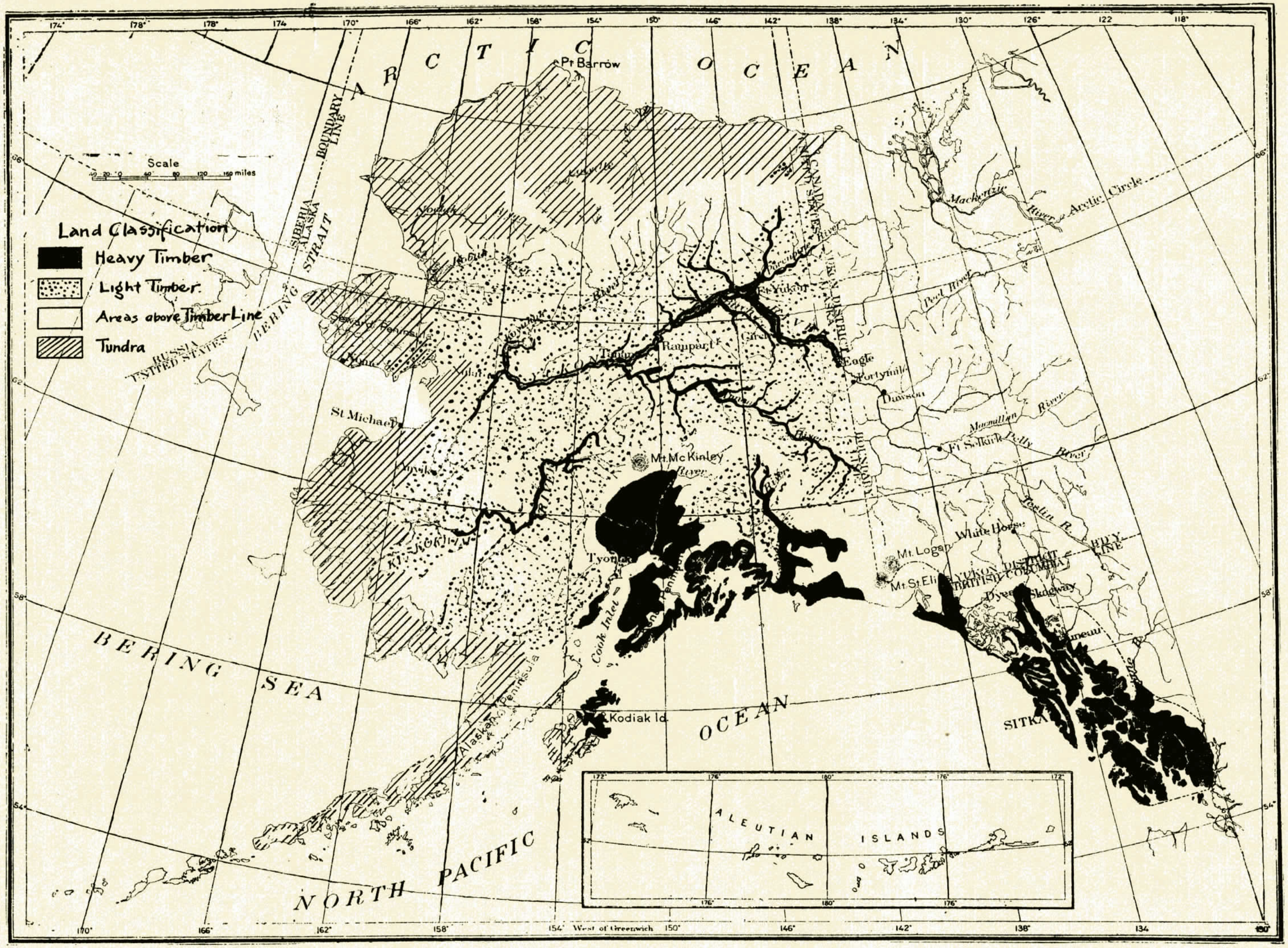


Compiled by Alfred H. Brooks

Map of Alaska, Showing Distribution of Timber

The custom-house statistics show that $3,272,411 worth of goods were carried to the Alaska Yukon from the United States in 1905, which probably represents between 15 and 20 thousand tons of freight. The cost of the freight on this tonnage amounted probably to over $1,200,000 to the consumer. This sum, allowing three-quarters for operating expenses, would pay probably 5 per cent interest on the cost of constructing 200 miles of railway, or half the distance from tide-water to the Yukon placer camps. I call attention to this to show that, even with the present condition of development, railway projects are not entirely visionary.

The important mineral-bearing area of Alaska falls into four provinces, most of which are undergoing rapid development (see map, page 181). These are (1) the Pacific littoral, (2) the Seward Peninsula, (3) the Sushitna-Copper River province, and (4) the Yukon-Tanana region. The Pacific littoral lies for the most part on tide-water (see map, page 164), open throughout the year, and needs no railway system to develop it, though there are many places where short lines will eventually be built. The Seward Peninsula, which in 1906 produced about $7,300,000 worth of gold, is accessible to ocean-going vessels for fully a third of the year. These, with the 100 miles of railway already in operation and other projected lines, afford means of communication which, while it leaves much to be desired, yet is sufficient to enable large mining operations to be carried on.

THE NEW YORK TO PARIS RAILWAY

Plans for the construction of the so-called New York to Paris Railway, across Alaska and Siberia, have found some earnest advocates during the past few years. Though this project rather falls outside of the present discussion, yet it deserves mention, if for no other reason than for the publicity it has received. Alaska can obviously not be connected with the United States by rail except by a line through Canadian territory (see map, page 176). When the new Canadian transcontinental railway, known as the Grand Trunk Pacific, which is to reach to the Pacific coast in latitude 54°, is completed, a branch could be extended northward, which could reach Fairbanks with 800 to 1,000 miles of track. While such a line would not encounter any serious obstacles, yet many watersheds would have to be crossed, and as it would run transverse to the larger drainage channels, there would be heavy expense for bridges. A railway from Fairbanks to Cape Prince of Wales would require at least 600 miles of track. It is proposed to tunnel Bering Strait, which is 54 miles from headland to headland, but is broken by the Diomede Islands, lying about half way between (see map, page 176). While tunnels of the length required are probably not an impossible engineering feat, they are so far beyond anything of the kind as yet attempted that it must be a bold group of capitalists who would undertake it. Ferriage across the strait, difficult in summer because of the strong northerly setting current, is impossible during seven or eight months in the year because of the ice floes. As the strait seldom freezes over, communication without a tunnel would be entirely interrupted.

This intercontinental railway project, divested of its glittering generalities, amounts to this: The first 1,000 miles of track would parallel the Pacific seaboard and reach a point less than 500 miles distant from tide-water by a more direct route. An additional 600 miles of track would be needed to reach Bering Strait, and this, too, would be in direct competition with deep-water navigation for at least a third of each year. Furthermore, to connect the two sides of the strait, as proposed, would require two tunnels more than twice as long as any hitherto constructed. The Siberian part of the route would appear to have even less justification, for here 1,500 to 2,000 miles of unsettled and unproductive territory would have to be traversed.

URGENT NEED OF RAILWAYS IN COPPER RIVER DISTRICT

Whatever the future may bring forth leading to a demand for railway connection with Seward Peninsula, it is certain that there is at the present moment an urgent need for railways between the Gulf of Alaska and the inland region lying to the north. Only by such railways can the copper and gold deposits of the Sushitna and Copper rivers and the placer fields of the Yukon reach their full development. Here is an area about 400 miles square, bounded on the east by the international boundary, on the north by the Arctic Circle, on the west by the 154th meridian, and on the south by the Pacific, which contains, as has been shown, valuable copper deposits, the best of the known Alaskan coal fields, as well as extensive areas of auriferous gravels. Good grass land is abundant and cattle-raising can probably be profitably carried on to supply the local market, which is sure to arise with mining developments. The agricultural values, though of interest to the economist, will probably be disregarded by the capitalist, who will look to the development of mines for returns on his venture. Certainly without the ore and coal deposits there would be no railways, and without these there will be no agriculture until more accessible regions are settled.

Though now the annual mineral output of this province is only about $10,000,000 in gold, there appear to be great possibilities in the way of mining developments, provided it can be made accessible to commerce.

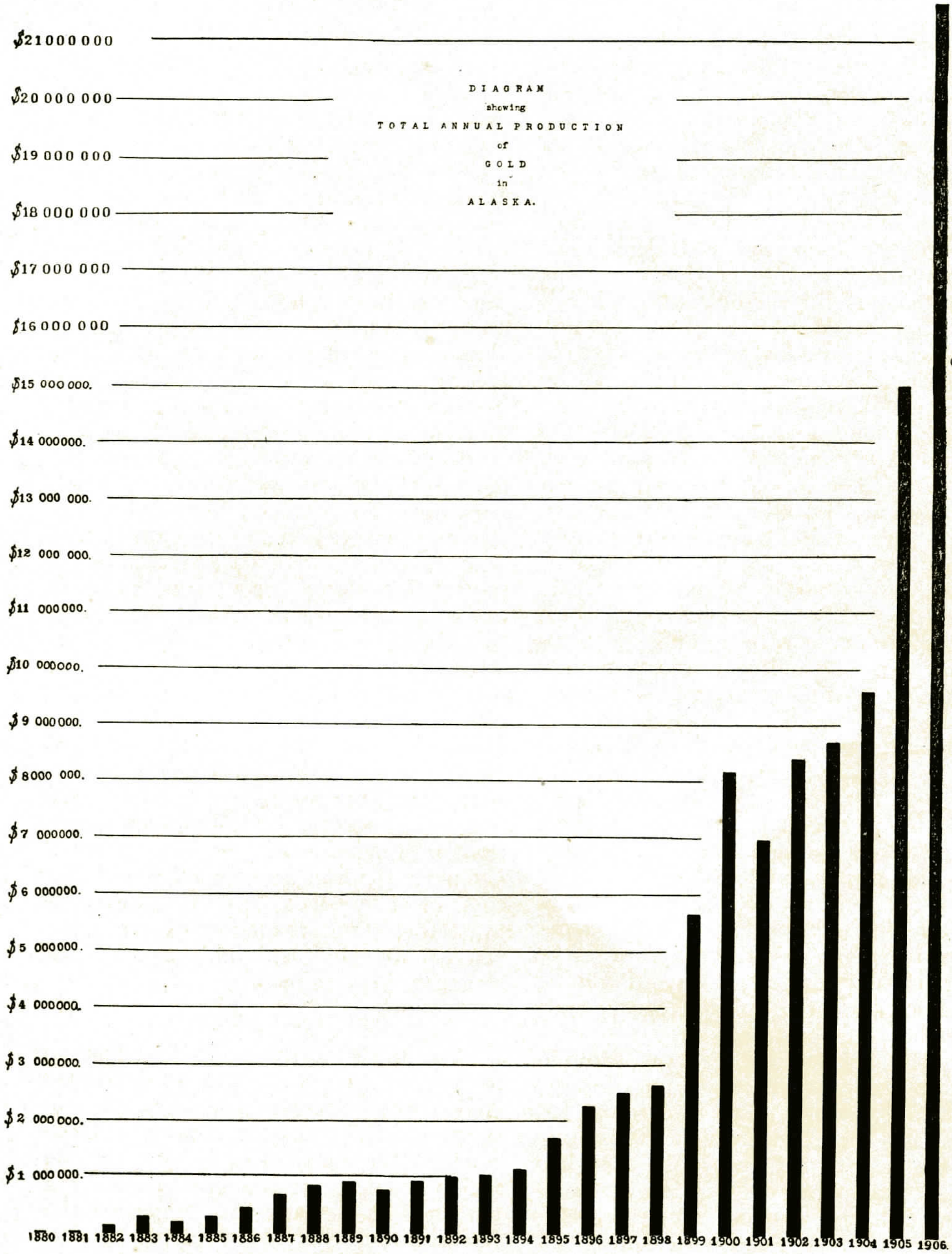
The mining districts of the Sushitna-Copper River province are only accessible by an overland journey of 100 to 300 miles, for the rivers which empty into the Pacific are for the most part torrential in character and but few are navigable. All the supplies for these districts have to be sledded in during the winter months, at a cost of 10 to 20 cents a pound. The charges for summer transportation by pack-horse are from 30 cents to a dollar a pound.

PRESENT LONG WATER-ROUTE TO FAIRBANKS DISTRICT

In the Yukon Basin conditions are somewhat more favorable, because of the extensive system of navigable waters (see map, page 164). Before the freight reaches the Yukon, however, it has to make a circuitous route to the mouth of the river, open to navigation only from the end of June to September. During summer months Yukon River steamers can deliver freight to points 20 to 100 miles distant from the placer districts. This freight must await the winter snow before it can be finally sledded to its destination, unless the summer charges of 20 to 25 cents a pound are to be paid. Under these conditions, freight which is moved by the cheapest form of transportation (by steamer in summer and sleds in winter) costs the miner from 5 to 10 cents a pound, delivered at his mine. Translated into terms more familiar to the average man, this means that the mine operator may have to pay a rate on all his heavy machinery equivalent to the charges for express between New York and San Francisco. In fact, I have known mining enterprises to be carried on in localities to which the transportation charges were greater than letter-rate postage. Under such conditions it is evident only deposits of extraordinary richness can be exploited, and that most extensive mining operations must await the reduction of costs that can be brought about only by the construction of a railway.

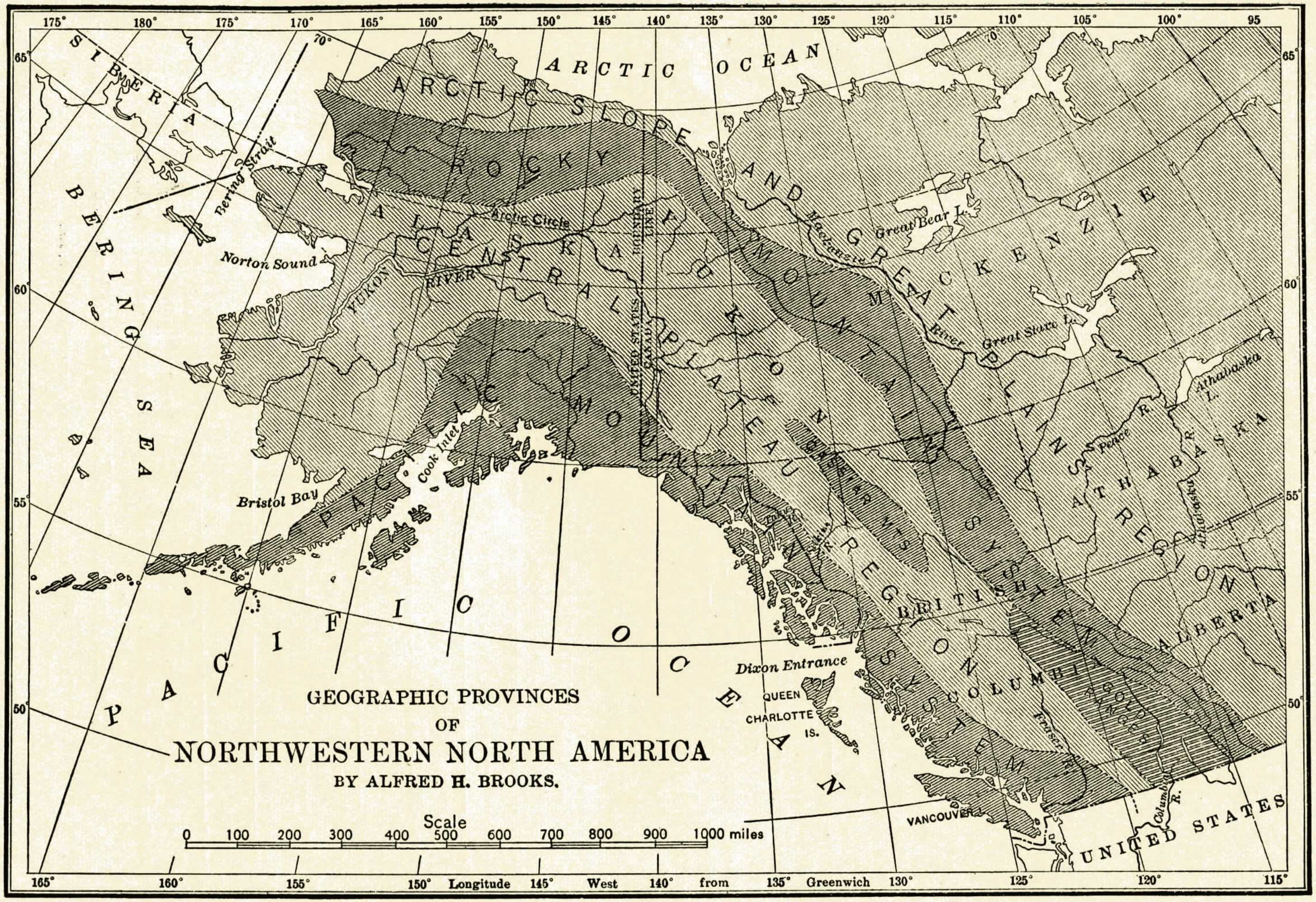
GEOGRAPHIC CONTROL

Having set forth the facts which go to indicate that the resources of central Alaska are sufficient to warrant the construction of a railway, it is in order to consider the question of geographic control of routes. It has been shown that the present demand for transportation facilities is in the province lying between the international boundary and the 154th meridian, and this district will here alone be considered. The rugged mountain mass skirting Alaska's southern border



Annual Production of Gold in Alaska Since 1880

The total amount is considerably over $100,000,000


ARCTIC OCEAN
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ALBERTA
UNITED STATES
Bering Strait
Norton Sound
Arctic Circle
Yukon River
Bristol Bay
Cook Inlet
Great Bear L.
Great Slave L.
Mackenzie River
Athabaska L.
Peace R.
Fraser R.
Columbia R.
Dixon Entrance
QUEEN CHARLOTTE IS.
VANCOUVER
UNITED STATES CANADA BOUNDARY LINE
GEOGRAPHIC PROVINCES OF NORTHWESTERN NORTH AMERICA BY ALFRED H. BROOKS.
Scale
0 100 200 300 400 500 600 700 800 900 1000 miles
Longitude West from Greenwich

presents a serious barrier to inland travel (see plate, page 184). This zone, including a number of parallel ranges forming the Pacific Mountain system of Alaska, but 50 miles in width at Lynn Canal, broadens out to the northwest, and at Cook Inlet attains a width of over 200 miles. Inland of this system lies another province of far less relief, which has been termed the Central Plateau region (see map, page 176). The drainage of this central region is carried, for the most part, to Bering Sea through the Yukon River, while the waters of the Pacific Mountain province flow southward and through the Chilkat, Copper, Susitna, and smaller rivers to the Pacific. One river alone, the Alsek, finds its source in the Central Plateau region, and traverses that entire Pacific Mountain system on its way to the sea. Obviously the valley of the Alsek is from a topographic standpoint the only logical railway route into the interior. It will be shown, however, that the commercial and political factors are so adverse in case of the Alsek Valley as to appear to rule it out.

Besides the valleys of the larger rivers, already mentioned as flowing into the Pacific, there are a number of low passes breaking through the mountain barriers. Among the most important for the present discussion are the White Pass (2,800 feet), a break in the Coast Range north of Lynn Canal, across which a railway has already been built. At the head of the Chilkat River, whose valley separates the Coast and Saint Elias ranges, there is an unnamed pass about 3,100 feet high (see profiles, page 179). West of Lynn Canal the coastal range represents an almost unbroken front, except for the Alsek and Copper River valleys. At the inland front of the Saint Elias Range the Alsek Valley has an altitude of about 2,000 feet, and is connected with the drainage basin of the White River to the west by a pass but 2,400 feet high.

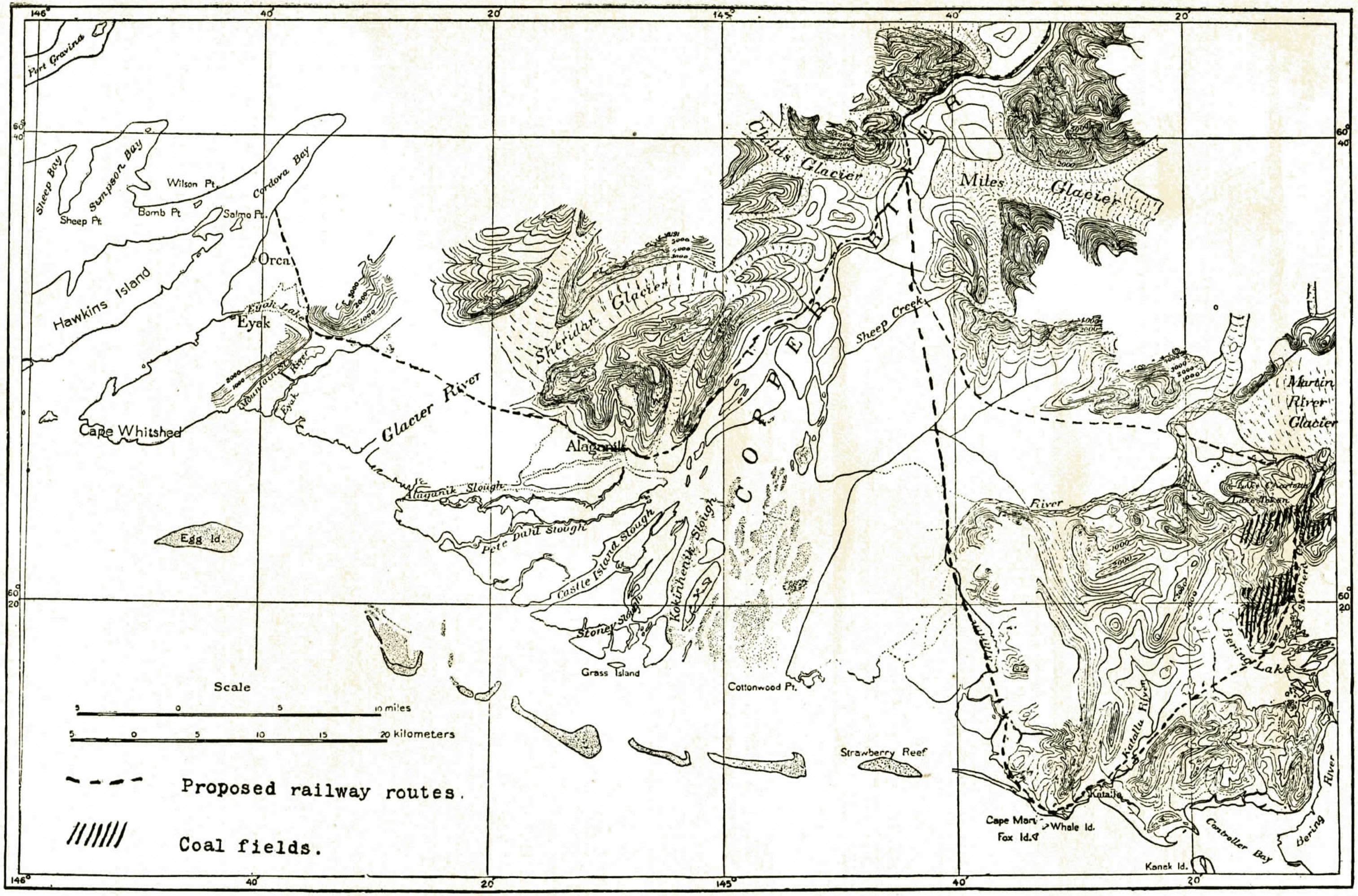
Low River, which empties into Valdez Inlet of Prince William Sound, is separated from the Copper River by Marshall Pass, about 1,900 feet high. At the head of the Copper there are several passes leading into the Tanana Valley, of which the lowest is called Mentasta (3,000 feet), and the next, which is unnamed, connects the Gulkana and Delta valleys. Both of these passes are through the eastern end of the Alaska Range, and one or the other will be used by any railway built from the Copper Basin into the Tanana Valley.

It will be evident from the matter presented that commercial control limits the choice of inland railway routes to the region lying between Lynn Canal on the east and Cook Inlet on the west (see map, page 181). Topographic control, furthermore, limits the choice to four general zones, which may be named after the chief rivers, whose valleys determine the location. These are named from south to north: (1) the Chilkat basin, (2) the Alsek basin, (3) the Copper basin, and (4) the Susitna basin.

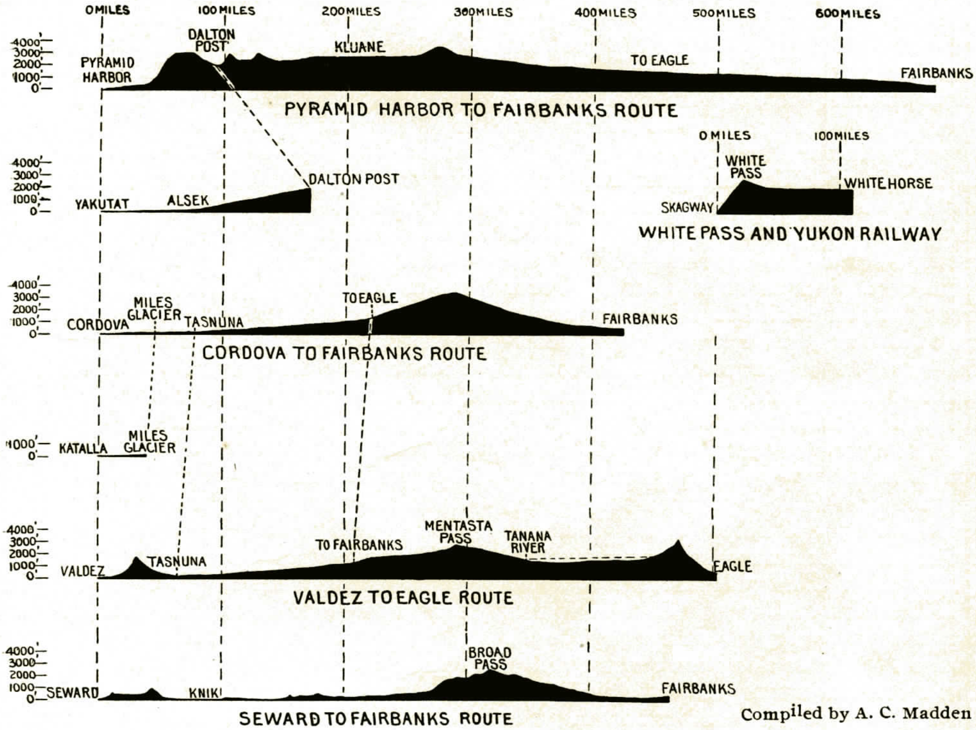
The first requisite for an inland railway from the Gulf of Alaska is an adequate coastal terminal. This means not only a deep-water harbor, but also opportunity for construction of wharfs, as well as a townsite near at hand. Other desirable, though not absolutely necessary, conditions are available timber, water power, and a favorable climate. If possible, the harbor should be accessible to sailing as well as steam vessels, and the routes of approach should be devoid of dangers to navigation; but, beside all these desirable attributes, the distance of the coastal terminal to the points of shipment on the west coast of the United States is of first importance.

HARBORS

The recent geological history of the Pacific shore-line of Alaska is favorable to the formation of harbors, for it is a glaciated region, and, as many have shown, glaciation produces fiorded coast lines. This is, however, only true where sedimentation subsequent to glaciation has not silted up and smoothed out the coast line. The first condition prevails



Topographic Reconnaisance Map from Controller Bay to Prince William Sound



Generalized Profiles of Proposed Railway Routes

in southeastern Alaska and on Prince William Sound, where the coast is characterized by deep fiords with many tributary embayments (see map, page 176). In the intervening region the retreat of the larger ice-sheet left many large glaciers on the coastal slope of the Saint Elias Range and in the Piedmont belt, and these, having access to bed rock along their margins, have contributed a large amount of sediment. This sediment has been deposited as extra-glacial material and has buried much of the fiorded coast line. Therefore the physiographic features make southeastern Alaska or Prince William Sound the most favored locality for coastal terminals.

Other factors have to be considered. Lynn Canal is a superb deep waterway, but its funnel shape causes it to be subject to severe wind-storms, and it is therefore not favorable for sailing vessels. The same holds true, in a less degree, of the upper part of Prince William Sound. Resurrection Bay, which penetrates the mainland to a much shorter distance, affords an almost ideal harbor. Though the shore-line between southeastern Alaska and Prince William Sound is not favorable for harbors, yet two indentations, Yakutat Bay and Controller Bay, furnish some protection for vessels (see map, page 178).

In the comparison of distances it will be convenient to use Puget Sound as a reference point (see map, page 176). Lynn Canal is less than 1,000 miles (statute) from Puget Sound, as compared with 1,150 for Yakutat Bay, 1,350 for Cordova Bay, 1,400 for Valdez Inlet and Resurrection Bay. The route to Lynn Canal is by an intricate and somewhat dangerous inland waterway, and the actual time consumed in the voyage is not very much greater to the western harbors than to Lynn Canal. As regards climate, there is little to choose between the various coastal terminals. Throughout the Pacific seaboard there is a heavy precipitation, varying from about 90 inches on Lynn Canal to about 125 inches in Prince William Sound. Heavy storms are usually from the southwest, and more commonly occur from October until May. As soon as the mountains are entered, very heavy snowfalls are to be expected. The coastal belt is usually heavily forested with timber which can be used in construction.

It remains to describe the individual routes and compare their respective advantages. For this purpose the general location of the different routes has been indicated on the map (see page 181), together with their relation to the mountain barriers and to the distribution of the known mineral resources. Profiles (page 179) have also been constructed of the more important projects, and these have been grouped together for purposes of comparison. It should be distinctly stated, that while in the construction of these profiles the best available data has been assembled, yet this is so incomplete that the results must be regarded as an approximation. Many of the distances and altitudes here presented will undoubtedly be found inaccurate when detailed surveys are made.

PYRAMID HARBOR, TANANA RIVER

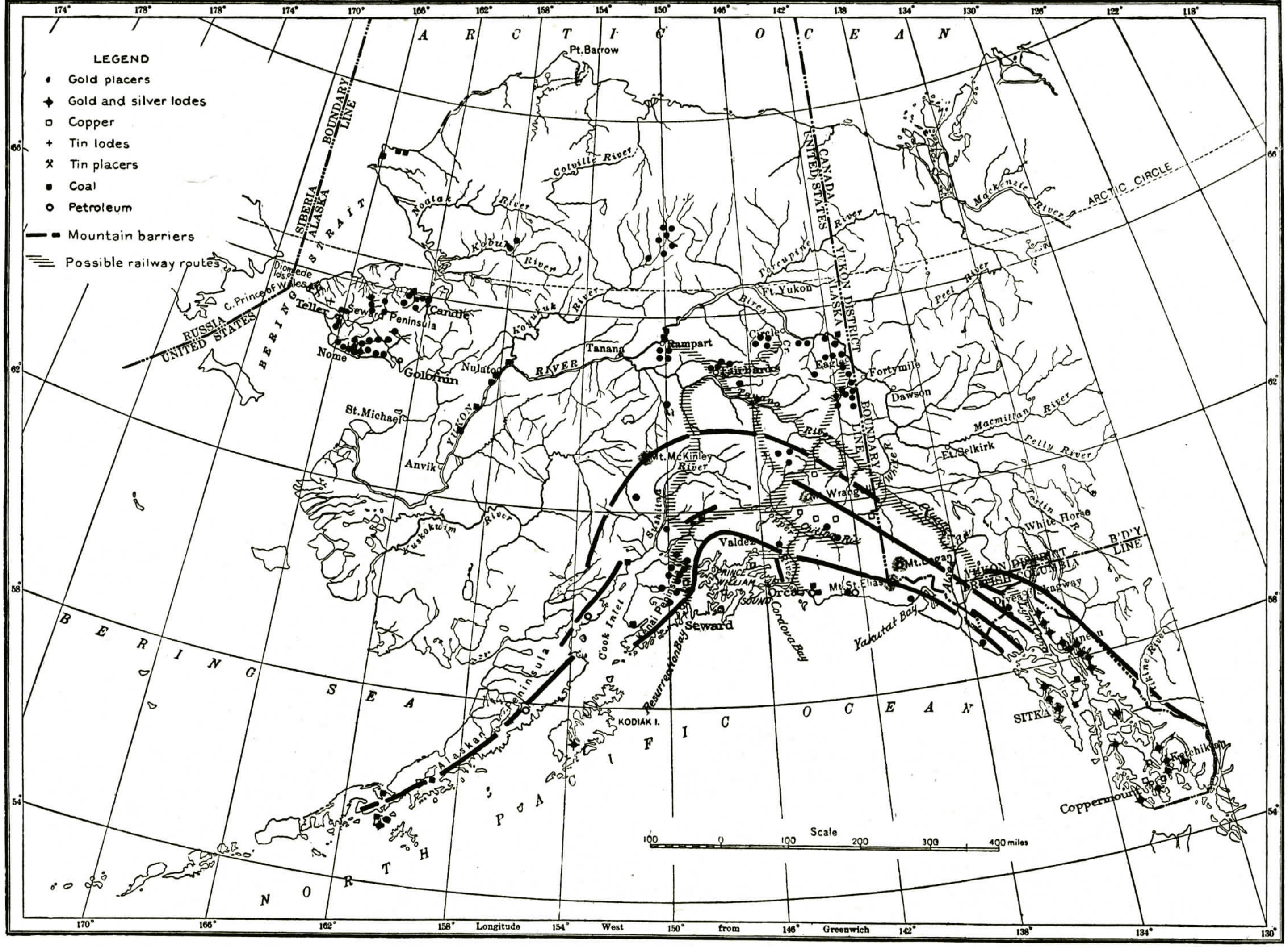
Chilkat River debouches into a western arm of Lynn Canal, called "Pyramid Harbor," and its valley separates the Saint Elias Range on the west from the Coast Range on the east. A broad pass about 3,000 feet high, 50 miles from the coast, separates its headwaters from inland-flowing streams. Beyond this pass the route would enter the Alsek basin and follow the inland front of the Saint Elias Range. Two forks of the Alsek will have to be crossed, but present no serious engineering difficulties. A series of depressions, part of a system of abandoned valleys, affords an ideal railway route beyond the west fork of the Alsek. The route would probably skirt the south shore of Lake Kluane 2,400 feet above sea-level and enter the White River Valley near the international boundary. After crossing White River at the canyon the line would be extended through a broad, flat depression to the Tanana Valley, which would be followed to Fairbanks. As indicated in the profile, there are no very heavy grades to be overcome in this route. Branch lines could be built to the copper deposits of the White River and to the Fortymile, Birch Creek, and Rampart placer districts.

Pyramid Harbor, which affords shelter for vessels and opportunities for wharf construction, can be reached by a 1,000-mile journey from Puget Sound, entirely within sheltered waterways. The Chilkat basin is well timbered (chiefly spruce and hemlock) (see map, page 172) and contains some auriferous gravels, though the producing district lies somewhat off the proposed railway route. The copper deposits of Rainy Hollow, which are undeveloped, lie about 20 miles off the main route. In the inland region there are no developed mineral resources except a small placer district. However, the meager knowledge of the geology indicates that there may be here a continuation of the mineralized belt of southeastern Alaska, and that workable ore deposits may yet be found.

There can be no doubt that this is a natural route into the interior, and it was long used by the natives in their intertribal intercourse. It has one grave disadvantage, namely, that for about 300 miles it traverses Canadian territory, and would therefore not afford an all-Alaskan route. Under the custom laws, international railways are always at a disadvantage. Moreover, it would not help to develop the resources of the Copper River and Sushitna River basins.

YAKUTAT BAY-ALSEK-TANANA RIVER ROUTE

The lower Alsek River valley, which is transversed to the Saint Elias range, affords a possible route into the interior.



Compiled by Alfred H. Brooks

Map of Alaska, Showing Railway Routes and Known Occurrences of Economically Important Minerals

The line would run southeastward from Yakutat Bay for about 50 miles, to the mouth of the Alsek. A narrow-gauge railway has already been built for about 10 miles of this distance, for the purpose of bringing fish to the salmon cannery at Yakutat. The Alsek Valley is almost unexplored, but no doubt a railway could be built through it. It would intersect the Pyramid Harbor-Tanana route about 200 miles from the coast, and would there attain an altitude of about 2,400 feet (see profile, page 179).

Yakutat Bay, which is about 1,150 statute miles (1,000 nautical miles) by sea from Puget Sound, is only a fair harbor, and, so far as known, the proposed railway would not tap any mineral deposits, though such may exist in the unexplored Saint Elias Mountains. At 170 miles from Yakutat it joins the Pyramid Harbor route, and is open to the same objection, inasmuch as it passes through Canadian territory.

CORDOVA BAY, OR CONTROLLER BAY, COPPER RIVER

Cordova Bay, an eastern arm of Prince William Sound, lies about 30 miles west of Copper River. A railway, now in construction, is to follow a route skirting the coastal margin of the mountains to the Copper River, and then, turning northward, to traverse the Chugach Mountains through the valley of that river. A distance of about 200 miles will bring it to the mouth of the Chitina, and with 100 miles more of track it will be able to tap the copper belt, which skirts the southern margin of the Wrangell Mountains. The route to the mouth of the Chitina follows the river grade, and there are no serious engineering difficulties, with the exception of the two bridges, 800 and 1,200 feet in length, which will have to be built across the Copper to avoid the Miles and Childs glaciers (see illustration, page 190).

A corollary to this plan is to construct a branch line about 35 miles in length from the Copper River to the Controller Bay coal field (see map, page 178).

A rival company has made a survey for a railway from near the mouth of Katalla River, 30 miles east of the Copper, which is to run northwestward to the head of the Copper River delta. A single bridge will be needed to avoid the glaciers, beyond which point the route will coincide with the one above described. This route has the advantage of the one above described, inasmuch as it is somewhat shorter and has to bridge the Copper but once. Katalla is only 1,200 miles distant from Puget Sound, as compared with 1,350 for Cordova Bay. On the other hand, at Cordova there is an excellent natural harbor, while at Katalla a breakwater will have to be constructed. On the other hand, again, a harbor at Katalla would serve the Controller Bay coal field. Whichever line is built, certain it is that there is not room for two railways along this Copper River route.

VALDEZ-COPPER RIVER ROUTE

An alternate plan for reaching the copper belt of the Chitina region is to build a railway from Valdez. Valdez Inlet, a northeastern arm of Prince William Sound, is 1,400 miles distant from Puget Sound. Surveys have been made and some construction work has already been done on two railway projects which are planned to cross Marshall Pass, about 1,900 feet high and 30 miles from Valdez, and thence down the Tasnuna River to the Copper (see profile, page 179). From the mouth of the Tasnuna the route would correspond with the route up the Copper River. The distance from Valdez to the mouth of the Chitina is about 20 miles less than from Cordova, but a pass 1,900 feet in height has to be crossed; on the other hand, two expensive bridges over the Copper would not be needed. This line would not reach the Controller Bay coal field.

Most of the railway projects into the Copper River have been planned with the ultimate object of extension into the Yukon basin. Some of these have chosen Eagle, other Fairbanks, as their ultimate objective point. Of the two, Eagle ap-

Photos by W. C. Mendenhall and L. M. Prindle

Camp on Bank of Copper River, Showing Character of Timber

Potato Patch at Baker Hot Springs, Tanana Valley

Photos by G. K. Gilbert and F. C. Schrader

Mt Perouse and Glacier

A typical view of the coastal barrier of Alaska

Mentasta Pass, on the Railway Route from Copper River to the Yukon pears to be the less logical, as a line built to it would pass through the eastern part of the auriferous district, while Fairbanks is much more central.

From the mouth of the Chitina a line to Eagle would follow the Copper River valley and cross to the Tanana through Mentasta Pass, 2,900 feet high (see illustration, page 184). Crossing the Tanana Valley, the line would enter an upland region not well known and would probably have to cross two passes, 3,000 feet high, before it descended to the Yukon.

A line to Fairbanks would be built up the Copper and Gakona River valleys across a pass 3,000 feet high, and down the Delta to the Tanana. Crossing that stream, it would continue down it to Fairbanks.

RESURRECTION BAY-SUSITNA VALLEY ROUTE

The upper waters of the Susitna River, which empty into Cook Inlet, are separated by a broad, low pass, about 2,400 feet high, from the Ninana, or Cantwell, River, which flows into the Tanana. This is one of the lowest depressions in the watershed between the Pacific and the Yukon.

Unfortunately the upper part of Cook Inlet is closed by the winter ice, so that a coastal terminal would have to be sought on the east side of the Kenai Peninsula, which separates Cook Inlet from the Pacific. Such a one has been found in Resurrection Bay, an excellent harbor, 1,400 miles distant from Puget Sound. Here the town of Seward was located two years ago and construction begun on the so-called Alaska Central Railway, of which about 50 miles has been completed and considerable work done on 20 miles more. This route stretches northward from Resurrection Bay and, crossing a pass, about 1,000 feet high, about 40 miles from the coast, descends again to tide-water at the head of Turnagain Arm. After swinging around Turnagain Arm, it bends northward, crossing the Matanuska near its mouth. Here a branch is to be built to Matanuska coal field, the immediate objective point of the railway (see map, page 170). It is proposed to extend the Yukon trunk line up the Susitna, across the depression above mentioned, down the Cantwell to a terminal which will be on the south side of the Tanana River, near Fairbanks. The total mileage from Resurrection Bay to Fairbanks is about 500. While this route is one of the shortest from the coast to Fairbanks and also has the best grades, it does not tap the copper deposits of the Copper River, and, with the exception of the Matanuska coal field and some placer districts, does not traverse an area now known to carry mineral in commercial quantities.

CONCLUSIONS

The matter presented shows that there is justification for a trunk line railway from the Pacific seaboard to inland points, for it is only by rendering accessible the vast mineral wealth of the interior that its full measure of development can be attained. It is evident that the value of such a trunk line would depend on the construction of many branches and feeders, which have not here been considered. Furthermore, these railways must be supplemented by many wagon roads.

The history of railway expansion in the United States has shown that the natural development is, first, railroads built supplementary to established lines of water transportation; second, the binding together of such auxiliary lines by a trunk system. In Alaska the same evolution is witnessed. The White Pass and Yukon Railway, traversing the coastal barrier, links tide-water with navigable waters of the Yukon system. The heavy traffic being all down stream, what should be a comparatively cheap form of transportation is established to Dawson, a distance of 700 miles. A placer field such as the Klondike yields practically no outgoing tonnage. When, however, lode or coal mines are developed, there is a return traffic which the upstream river steamers cannot handle economically. Moreover, freight shipped to Alaskan points on the Yukon must run the gamut of two custom-houses, with all the attending annoyances of delays and formalities. It should be remembered, too, that the route to Fairbanks *via* the White Pass Railway involves the transhipment of freight at White Horse to Canadian steamers, a journey of 500 miles to Dawson, then a transhipment to American boats and another journey of 800 miles, of which 200 miles is upstream. If good connections are made, some eight days are consumed in going from tide-water on Lynn Canal to Fairbanks, which by a direct line could be reached in 450 miles. As a rule, freight is at least a month in transit. The journey up the river, while it avoids one transhipment, involves changing from ocean vessels to river steamers at the mouth of the Yukon, and then a 1,200-mile upstream journey. Moreover, these routes are only open from the first of June to the middle of September. It would seem, therefore, that if the resources of the Yukon are sufficient to warrant the construction of a railway, such a railway should hold its own against the competition of water transportation. In any event, a railway into the Susitna-Copper River province would encounter no competition with steamboat transportation.

Considered geographically, the routes described fall into two classes, namely, the one comprising those parallel to the lines of height, and the other those transverse to the lines of height. In the first group belong the trans-Alaskan-Siberian line, the Lynn-Canal-Fairbanks line, together with its alternate, the Alsek-Fairbanks line.

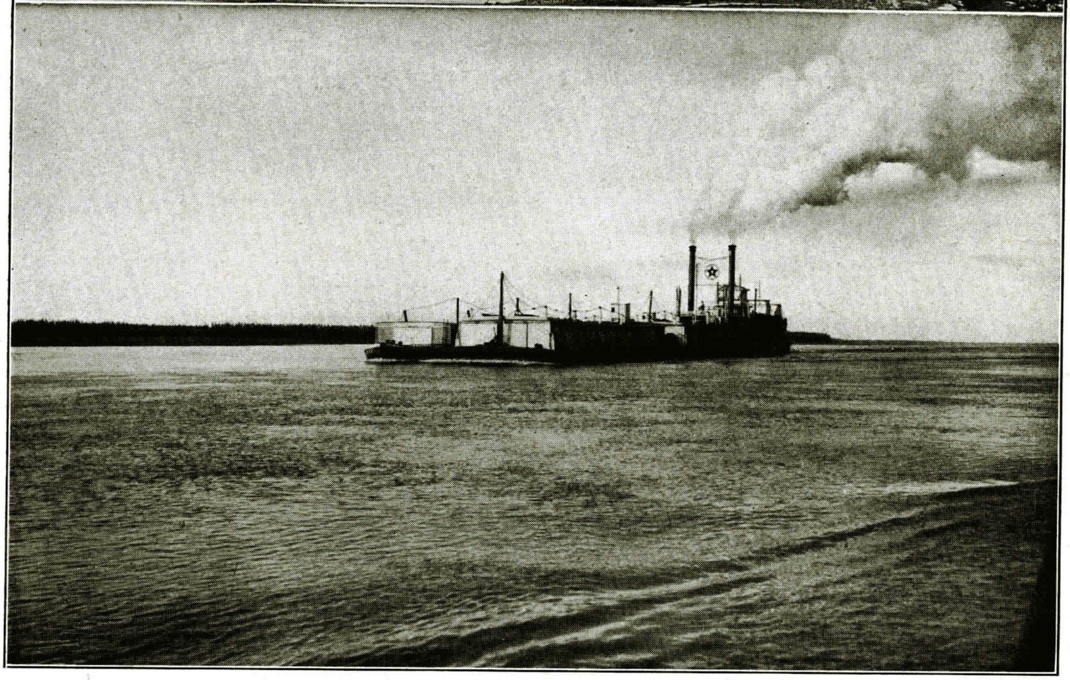
These routes, as has been shown, are parallel to the dominant axes of uplift, and therefore harmonious with the topography. As a matter of fact, however, pioneer railways are usually transverse to the watersheds, for the reason that they are located to supplement and not to supplant water transportation. The history of railway development in the United States shows that piedmont lines are the last to be built. A railway parallel to the inland front of the Saint Elias range would traverse a series of abandoned valleys such as are everywhere recognized as ideal topographic conditions.

Geographically, therefore, these routes would appear to have the advantage, and would, moreover, render accessible a large area in the interior of Alaska and northwest Canada not reached by any railways of the other group. When, however, the *developed* resources are considered, they are at a disadvantage, for while they would tap the upper copper-bearing region, they would reach neither the valuable southern copper belt nor the coal fields.

The transverse lines, including the Copper and Susitna routes, appear, as has been shown, to follow the laws which govern the location of pioneer railways; that is, they cross the watersheds and connect existing lines of water transportation.

In any event, it is clear that a properly located transverse line must follow one of the rivers which traverses the coast ranges. Two such railways, one up the Copper and one up the Susitna, are already under construction. The rival interests financing the two projects have been loud in claiming that each route was the best. In point of fact, the two supplement each other. It is certain that a railway by way of the Copper River follows the only feasible route to copper deposits of the Wrangell region. It is equally certain that as a route to the Yukon a railway up the Susitna River has the best of it. Again, neither of these lines bisect Alaska as would a railway extending from Lynn Canal to Fairbanks and to the Seward Peninsula.

The matter presented in the foregoing pages indicates that more facts are needed before scientific deductions can be drawn of the best route *for immediate construction*. Meanwhile, however, in view of the large amount of capital ready for investment in any promising enterprise, it is only too likely that the problem will be solved by experimentation alone, as has been done at great cost elsewhere; in other words, by the survival of the fittest.



Photos by W. C. Mendenhall and L. M. Prindle

Copper River Valley at Copper Center, on the Railway Route from Copper River to the Yukon

Freight Steamer and Barges on the Yukon River

Photo by W. C. Mendenhall

White Horse, Inland Terminal of the White Pass and Yukon Railway

This town is 6 years old. It is of about the same latitude as St Petersburg

The Interior Plateau Region of Alaska, Charlie River Basin

Photo by L. M. Prindle

Miles Glacier, Copper River

Photo by F. C. Schrader