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A HISTORY OF THE KENNECOTT MINES KENNECOTT, ALASKA

BY WILLIAM C. DOUGLASS

Reprint 1971

WILLIAM C. DOUGLASS
Mining Engineer
1411 26th Avenue East
Seattle, Washington 98102

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OF THE

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by

William C. Douglass - October, 1964

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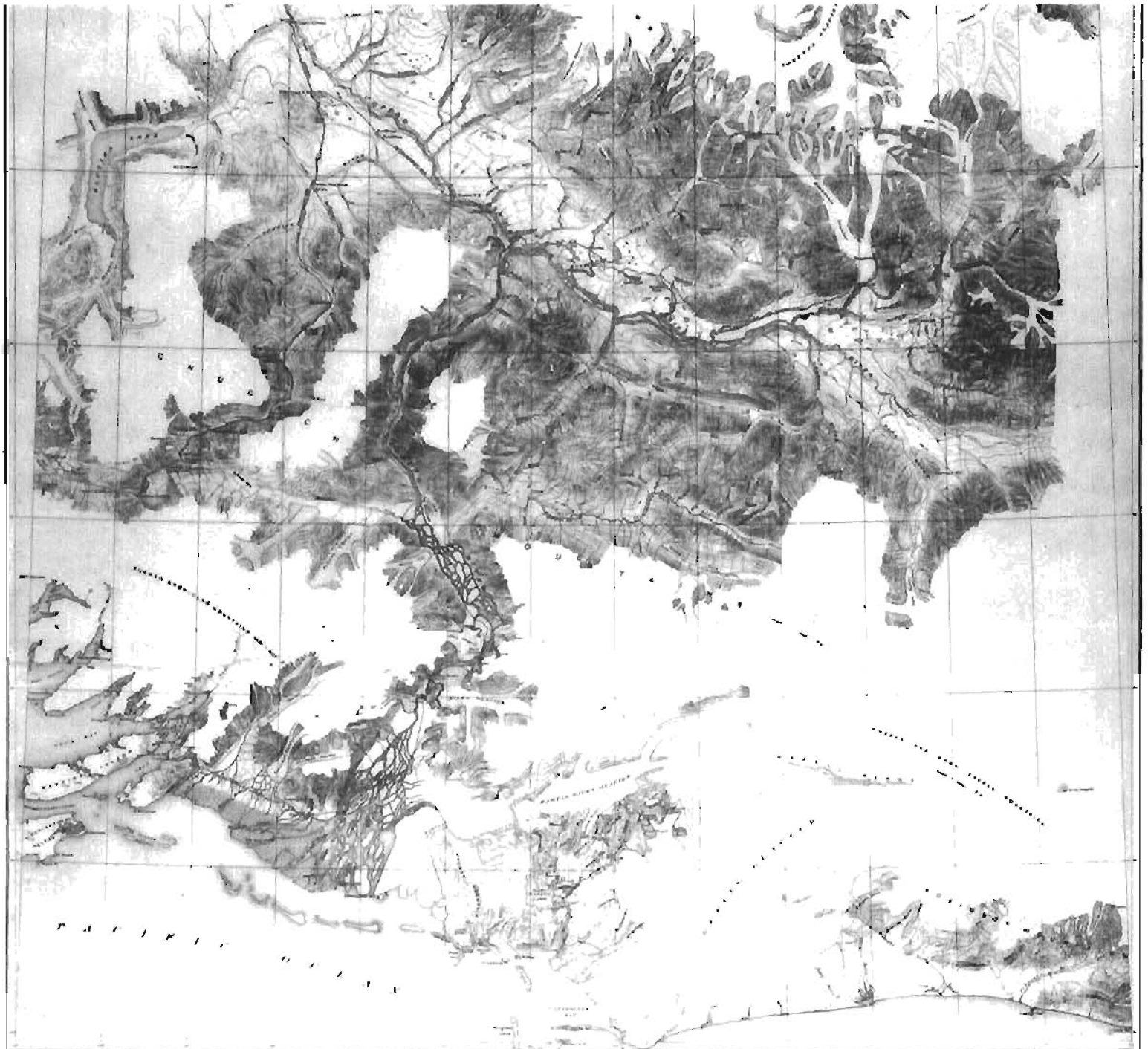


RECONNAISSANCE MAP OF CHITINA QUADRANGLE, COPPER RIVER REGION, ALASKA

A HISTORY OF THE KENNECOTT MINES, KENNECOTT, ALASKA

LOCATION

Kennecott, Alaska, where the great Kennecott Copper Corporation had its modest beginning, is located on the east side of the Kennecott Glacier, at an elevation of about 2,200 feet, on the south slope of the Wrangell Mountains. The Kennecott Glacier with a width of about four miles at Kennecott, runs in a general north south direction and heads about 16 miles to the north in an enormous ice field stretching along the east-west summit of the Wrangell Range at elevations of 13,000 to 16,000 feet. Mt. Blackburn is the highest mountain with an elevation of 16,140 feet. Four miles below Kennecott at the town of McCarthy the glacier is receding and becomes the head waters of the Kennecott River.

Near Kennecott three creeks, National, Bonanza and Jumbo, join the glacier from a north-easterly direction. McCarthy Creek also joins the Kennecott Glacier and River at McCarthy with its headwaters in the same general area as National, Bonanza and Jumbo Creeks. Nikolai Creek is a tributary to McCarthy Creek, joining it about eight miles above McCarthy.

The Kennecott River flows into the Nizina which in turn joins the Chitina about 15 miles southwest of McCarthy. The Chitina then flows west for about 70 miles to join the Copper River at the town of Chitina. From there the Copper River runs approximately south for about 130 miles to the Gulf of Alaska near Cordova.

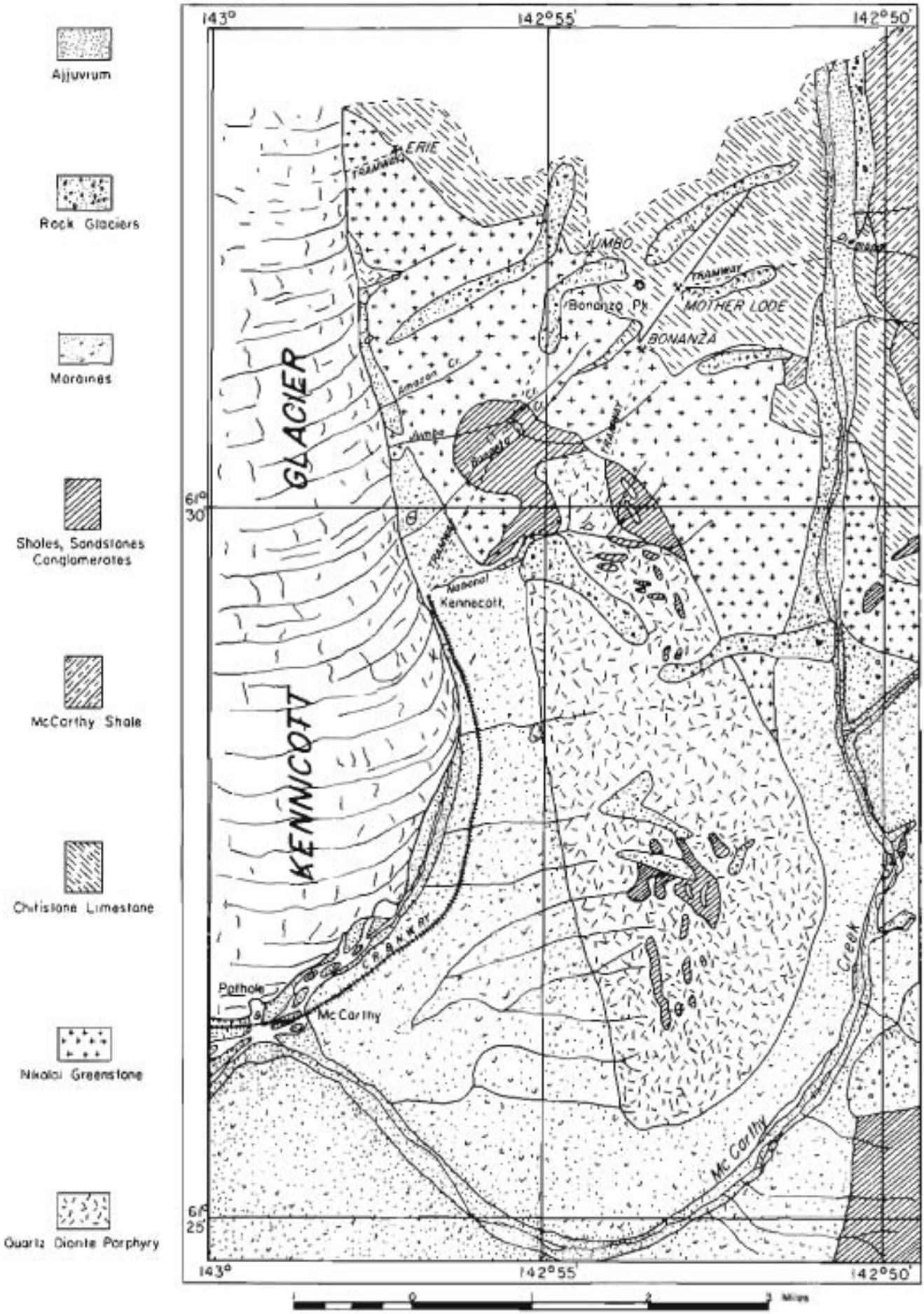
Cordova and Valdez are the two principal sea ports in this area and they are about the same distance, 120 air miles from Kennecott.

EARLY EXPEDITIONS - COPPER RIVER DISTRICT

Implements of copper were reported to have been seen in the hands of Copper River Indians by early Russian explorers and traders who visited the mouth of the Copper River long before the mineral resources of Alaska were considered to be of value.

The first interest in such resources by the U. S. Government was in 1884 with an expedition directed by the Army under the command of W. R. Abercrombie. Leaving Seattle on June 1st, Lieutenant Abercrombie, with a doctor, two other officers and a troop of 16 men, landed on June 16th at Nuchek on Hinchenbrook Island. This was the closest entry for the larger ships, and it was also the trading post used by the Copper River Indians.

The Copper is a large temperamental river, glacier-fed and joined by many glacier-fed tributaries which in the early summer months cause turbulent floods carrying large masses of ice and



SKETCH MAP OF GEOLOGY – VICINITY OF KENNECOTT

U.S.G.S. BULLETIN NO 662

boulders. Fifteen miles above its outlet into the Gulf of Alaska the river starts to fan out from its one channel to form an enormous delta having a spread of fifteen miles where it spills into the sea. The many channels through this delta are continually changing and the river is completely unsatisfactory for navigation.

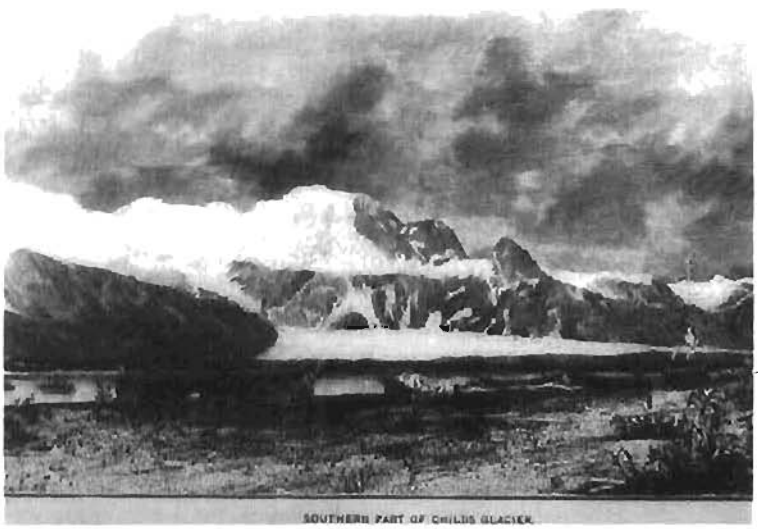
Notwithstanding the warnings of the Indians against an attempt to ascend the river, Lieutenant Abercrombie and his troop made a valiant but futile attempt. In two months' time of extreme hardship they had only reached the Childs and Miles Glaciers, about a 20 mile advance, and they then faced the dangerous rapids which were named Abercrombie. A retreat was made back to Alaganik, another Indian village close to the westernmost outlet, and from there the expedition made a sea voyage by canoes to the port of Valdez. They had just sufficient time to reach there and make a quick reconnaisance before freeze up.

A second attempt to ascend the Copper River was made in 1885 by Lieutenant Henry T. Allen under the direction of the War Department. Heeding the experience of the Abercrombie expedition, Lieutenant Allen was instructed to reach the mouth of the river at least by March, so as to ascend it on the ice. He was accompanied by Sergeant Robertson and Private Fickett. Landing at Nuchek they added Peter Johnson, a prospector to their party. Johnson's partner, John Bremner, had started up the river in the preceding year with a group of the Indians from the interior, and Johnson was extremely anxious to follow and rescue Bremner, who was rumored to be stranded in an Indian village.

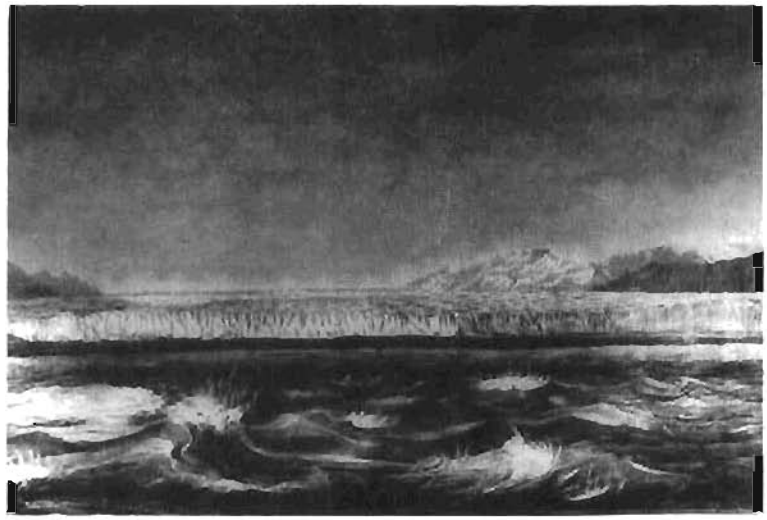
Lieutenant Allen left Nuchek on March 20, 1885, with his three white companions and three Indians. They had a rugged trip, using canoes to start from Alaganik, with their sleds loaded on the canoes, and alternating from boating to portaging for the first ten miles. The balance of the trip was nothing but hardships under difficult weather conditions, but on April 15th they reached Tarel, an Indian village just below the mouth of the Chitina River. There they found John Bremner in a destitute condition and practically starving with a small group of Indians belonging to the tribe of Chief Nikolai. With a short rest and rivival from the Allen provisions, the Indians guided the expedition to the main village of Chief Nikolai by a four-day trip up the Chitina River to the mouth of the Nizina and then following the Nizina to Dan Creek. They found that this village was considered to be in the heart of the mineral region, and the chief pointed out to them the locality of a vein which at that season of the year, April, was inaccessible. He also gave them some samples of bornite (sulphide of copper and iron) and they were informed that some other samples obtained in the district had been sent to Boston for assaying with results showing up as high as a content of 60% copper. The copper used by Nikolai and his people for utensils and bullets was found in the form of nuggets in nearby streams.

IN THE DELTA OF COPPER RIVER IN THE EARLY FALL.

START FROM ALAGÁNIK.

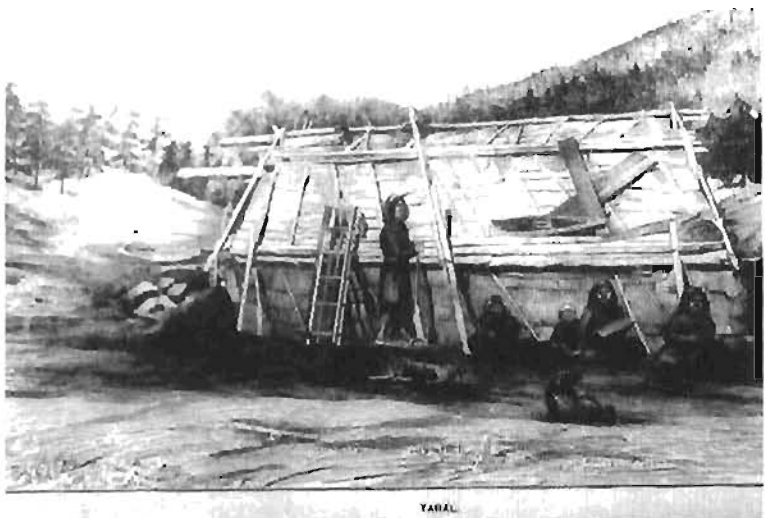


SOUTHERN PART OF CHILDS GLACIER.



MILES GLACIER

ABERCROMBIE CANYON.



YARAL

Concurrent with the discovery and activity of the Klondike, within a 100-mile radius from the Copper River and its tributaries there was a rush of prospectors to Valdez in the spring of 1898. The same W. R. Abercrombie, now a captain, was given another assignment in Alaska, this time for a military reconnaisance of the Valdez-Copper River area. During 1898 and 1899, with adequate facilities, both men and pack horses, his troop surveyed and established a military road from Valdez to Copper Center.

Frank C. Schrader, Arthur C. Spencer and Oscar Rohn, geologists of the U.S.G.S., were attached to the Abercrombie expeditions of 1898 and 1899, and they contributed valuable information to guide the prospectors. The limestone-greenstone contact that is the dominating structure along which the Kennecott ore bodies occured, was noted, studied and described by them as an important geological horizon with favorable mineral possibilities.

As a result of this activity the importance of Valdez as a year-round seaport entry for both Alaska and possibly the Yukon was widely publicized. Stephen Birch, a young mining engineer in New York City, became interested. He convinced some influential friends, Mr. and Mrs. Havemeyer, that he was serious in a desire to go to Alaska in search for minerals, and the Havemeyers and a few associates agreed to provide all expenses and arrange for a proper connection to aid him. Subsequently, through Washington connections, Stephen Birch landed in Valdez with a request to Captain Abercrombie to attach him to his assignment in a civilian capacity. The story, from some of the old timers, is that the Captain was not too happy about this request and that some further pressure had to be forthcoming from Washington before young Birch was accepted. However, from that point on Birch apparently traveled extensively with the troop and kept in close touch with the prospecting activities.

DISCOVERY OF THE MINES

The Nicolai Mine is located on the creek of the same name, a tributary to McCarthy Creek. The ore occurrence was probably the one that Chief Nikolai pointed out to Lieutenant Allen as it is visible from Dan Creek. It was revealed to Edward Gates by an Indian named Jack, who was able to find it from directions furnished by the Chief. It was located in July, 1899, with ownership by the Chitina Mining and Exploration Company, an association of nine men headed by R. F. McClellan.

This group was returning to the Nikolai to develop their property in 1900 and at Valdez they were joined by two "sour dough" prospectors, Jack Smith and Clarence Warner. Smith and Warner accompanied the Nicolai crew as far as McCarthy, where they parted from them to follow along the east side of the Kennecott Glacier.

CHIEF NIKOLAI, HIS FAMILY AND SOME OF HIS PEOPLE

CONTACT OF CHITISTONE LIMESTONE AND NIKOLAI GREENSTONE

WEST SIDE OF NIZINA RIVER NEAR NIKOLAI MINE

As one looks up at the mountains to the northeast from the Kennecott Glacier, a well-defined contour line immediately catches the eye at about 6,000 foot elevation. This is the same contact between the Nikolai greenstone and the Chitistone limestone noted and reported by the U.S.G.S. geologists. It can be traced for about 75 miles in a northwest, southeast direction from the Chitistone River to the Kotsina River.

The Nikolai Mine is close to the contact, and all members of the Nikolai group had been in close touch with the U.S.G.S. geologists and their opinions on the contact. Smith and Warner were searching for an approach to the western extension of this favorable structure from the Kennecott Glacier. They took off to the northeast at Bonanza Creek, and after following this up to timber line, about 4,000 foot elevation, they could not miss seeing the outstanding green cliffs of copper which crowned the Bonanza Mine. The story is told that the prospectors were looking for horse feed at the time and first mistook the malachite for green grass.

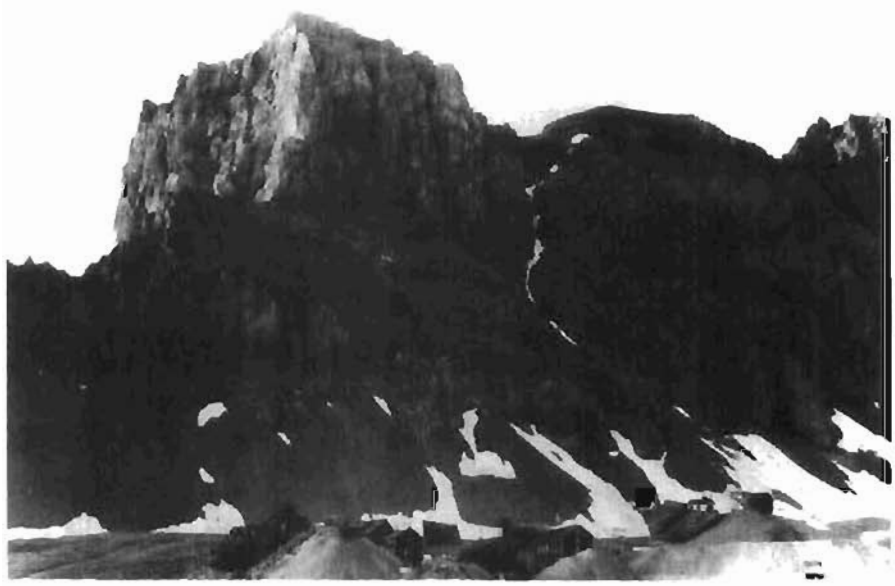
The discovery was made the first part of August, 1900, and it was so rich that Smith and Warner immediately returned to the Nikolai to bring their nine friends to see the Bonanza. It was then located by the eleven-member partner association, the Chitina Mining and Exploration Company.

Arthur Spencer of the U.S.G.S. made an independent discovery of the Bonanza shortly after, while mapping the contact, and his description of the original outcrop appeared in the "Geology and Mineral Resources of a Portion of the Copper River District Alaska" by Frank Charles Schrader and Arthur Coe Spencer, published by the U.S.G.S. in 1901.

The claims located by the stakers covered over a mile in length along the limestone-greenstone contact. The original Bonanza outcrop was described by Spencer as a true fissure vein which cut across the contact, though for some distance below the contact it was barren. The mass of the ore was in the limestone, from the contact to a height of perhaps 150 feet along the slope of the hillside, with widths varying from two to seven feet. The ore was practically pure chalcocite with solid masses exposed from two to four feet across, 15 feet or more in length and their depth not apparent. Besides the ore within the fissure there were also bedded ore bodies running off into the limestone along the planes of stratification. He stated that "the relations of the ore are such as to indicate that it was formed as a replacement of the limestone. A sample collected gave over 70 percent of copper and 14 ounces of silver, besides a trace of gold."

One mile to the northwest along the contact from the Bonanza, there was a small outcrop of chalcocite which flared on one of the limestone beds about 50 feet normally above the contact. This

BONANZA MINE



JUMBO MINE

A RAILROAD FOR THE MINES

outcrop was 15 feet long by 12 feet thick. From it, a narrow vein which broke through the bedding, contained about 18 inches of chalcocite and malachite. This was the surface expression of the Jumbo Mine which was the greatest producer of the four mines, the Bonanza, Jumbo, Erie and Mother Lode, which were eventually opened up in the district.

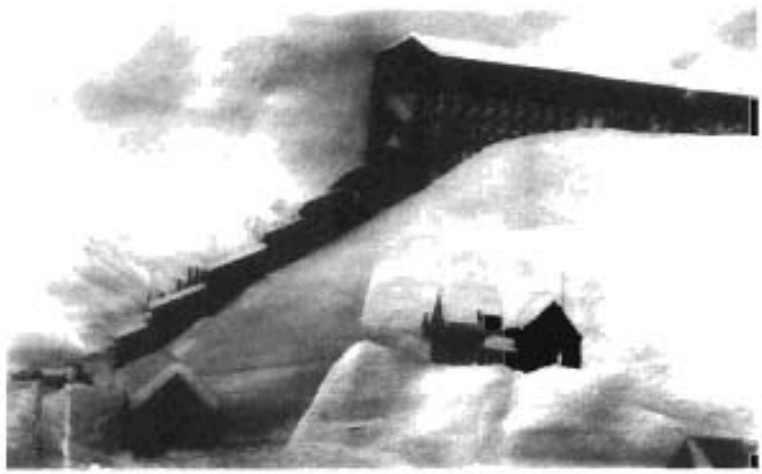
ACQUISITION OF THE BONANZA AND JUMBO MINES BY STEPHEN BIRCH

Stephen Birch was in Valdez when the members of the Chitina Mining and Exploration Company returned there in the fall of 1900. He was apparently greatly impressed by their reports of the unique outcrop of the Bonanza, and when one of the owners needed cash he bought a 1/11 interest. Stephen Birch was an energetic, determined individualist, and after visiting the property he was never diverted from his drive to obtain complete control of it. With the backing of the Havemeyers he succeeded, paying $25,000 each to the other owners. The property then passed into the ownership of Alaska Copper and Coal Company with H. O. Havemeyer as President. This company, with Stephen Birch as manager, opened up sufficient ore and favorable possibilities to interest a Guggenheim-Morgan combination. In 1908 the ownership passed to the Kennecott Mines Company, and in 1915 it became the Kennecott Copper Corporation with Stephen Birch as President.

A RAILROAD FOR THE MINES

Valdez was first picked as the best seaport outlet for a railroad and the Havemeyers started surveys from there in 1907. Further consideration brought out the importance of coal deposits at Katalla and the project was switched to that port. However, a safe harbor was not practicable at Katalla and Cordova was the next choice. In the meantime M. J. Heney, financed by Boston capital, had started to build from Cordova. Competition arose but the Havemeyers were able to negotiate a deal for the right-of-way via the Copper River Valley with retention of M. J. Heney as Construction Manager.

The railroad passed over sloughs, streams and deltas to Mile 39 on the east side of the Copper River and then recrossed it over a steel bridge at Mile 49. It then passed between Childs and Miles Glaciers into Abercrombie Canyon along its course on the west side of the Copper with magnificent scenery for 82 miles to Chitina. It was necessary to cross the Copper once more just above its junction with the Chitina River. Here, where the spring ice flows were terrific, another steel bridge was considered but found impractible, and the alternative was a pile bridge with reconstruction of new bents each year after the floods took their toll. From Chitina the road followed the west side of the Chitina River, then the Nizina and Kennecott Rivers to Mile 196 at Kennecott. Many construction problems were encountered but they were taken in stride by M. J. Heney, a great railroad builder, and his sturdy crew of engineers and construction men.



THE CONCENTRATOR AND OFFICE - 1911

BONANZA AND JUMBO TRAMWAYS

Thus the Copper River and Northwestern Railway was completed in 1911 at a total cost of $23,000,000. Its maintenance required a crew as large as needed for the mines and mill, and to keep the rails clear in the winter through the Copper River Flats, the largest rotary snow plows in the world were required.

The site for the mill and townsite were chosen on the east side of the Kennecott Glacier where Bonanza Creek joins the glacier. The elevation of this site is 2,200 feet, and it is 4 miles by trail to the mines. The elevation of the main adit level of the Bonanza Mine is 5,600 feet.

CONSTRUCTION OF MILL, TRAMWAY AND POWER PLANT

While the railroad was under construction, equipment for a 400 ton mill, a 16,000 foot aerial tramway and a power plant, was transported over the trail from Valdez by pack horses and double-ender sleds. In the Fall of 1911, the railroad was completed and shipments of high-grade ore and mill concentrates were started. The original mill was entirely gravity concentration with Hartz jigs, Hancock Jigs and Wilfley and Deister tables.

Exploration by tunnels was started at the Jumbo Prospect before the Bonanza came into production, and in a few years the Jumbo was proven to have larger and richer reserves than the Bonanza. A second aerial tramway, about 16,000 feet in length, was constructed from the Jumbo to the mill, and this mine started on actual production about 1913.

I went to Kennecott in April, 1916. At that time the Bonanza and Jumbo Tramways had a capacity of about 450 tons each on a three-shift basis. They were both running up to maximum capacity, as Kennecott was one of the important producers of copper at the start of and throughout World War I. In 1916, the Bonanza Tramway was handling about 375 tons per day of mill ore, averaging 7-1/2% copper and 25 tons of high grade, averaging 50% copper. The Jumbo Tramway was handling a total of 400 tons per day, 225 tons of mill ore at 7-1/2% copper and 175 tons of high grade at 70%. Copper production from the two mines was 10,000,000 pounds per month.

COMPARISON OF KENNECOTT AND BUTTE COPPER PRODUCTION

The following comparison is interesting:

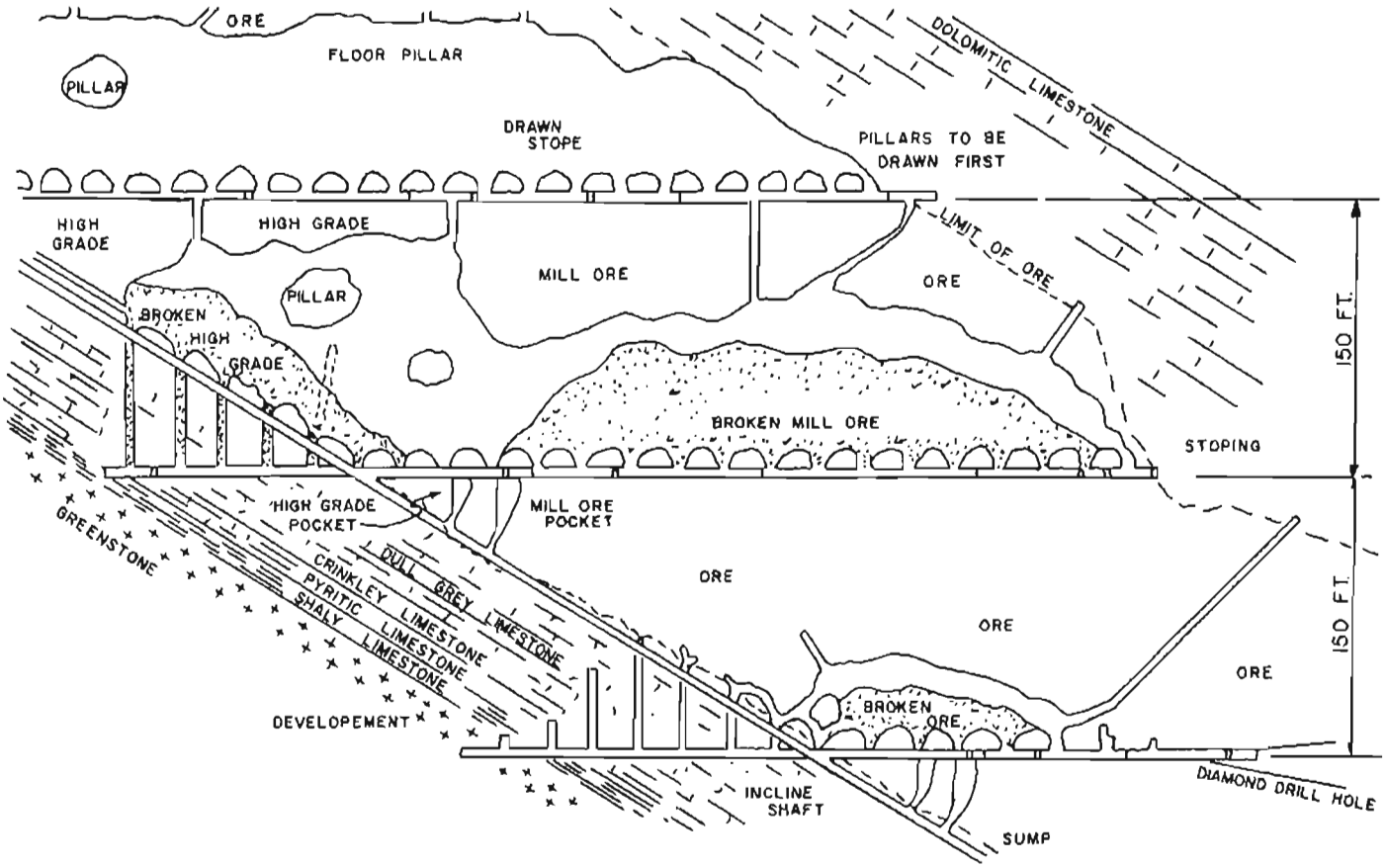
I had left Butte, Montana, to go to Kennecott. At that time, the Anaconda Copper Mining Company had 30 shafts operating in Butte, some of them down to a depth of 4,000 feet. The shafts were equipped with fast, up-to-date hoists of hundreds of horsepower each. There were 15,000 men employed in the Anaconda Company's Mines. Anaconda was producing 30,000,000 pounds of copper per month. Kennecott was

operating two small mines through single compartment incline shafts. The Bonanza Shaft was on a 30 degree incline 600 feet deep, vertically, driven along the bottom of the ore body, and it changed slopes several times. The hoisting equipment consisted of a 35 horsepower electric hoist pulling two 1-ton cars coupled together. The cars broke over a knuckle at the Main adit and were then uncoupled and trammed by hand to the tramway bins. The Jumbo Shaft was on a 33 degree incline with a dog leg in it, and 700 feet vertical depth. It was equipped with a 50 horsepower hoist and a 1-1/2 ton skip. The total payroll of the Kennecott Mines, Mill, Surface, Power Plant and staff was 550, yet these two small mines were producing 10,000,000 pounds of copper per month, one-third as much as the 30 deep mines of the Anaconda Company in Butte, Montana. The cost of Kennecott copper at that time was 4-3/4 cents per pound, delivered in New York.

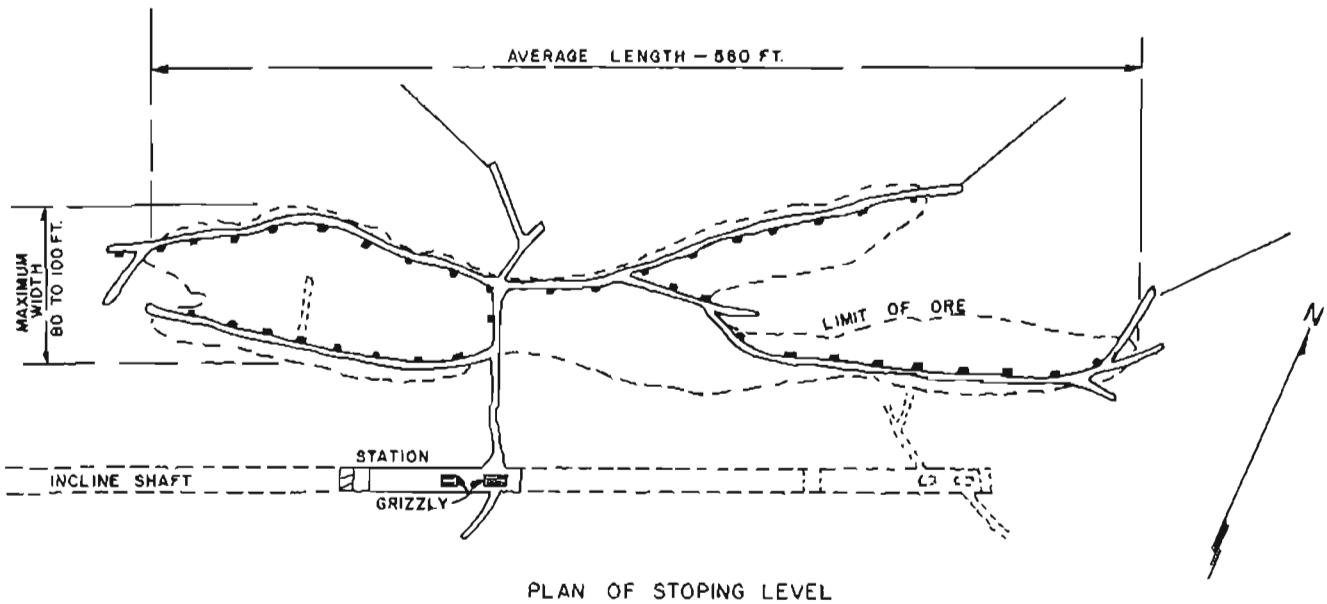
The Kennecott Mines did not at that time have a large reserve, in fact they never had more than four years of proven ore ahead of them. By 1916, the cream had been taken from the Bonanza, but the Jumbo was still going strong. The famous Jumbo high grade stope, probably one of the richest blocks of ore ever mined, extended from the 3rd to the 5th Level. It was solid chalcocite for a stope length of 350 feet, with a width of 40 feet and a height of 40 feet. There were 70,000 tons of 70% copper ore mined from this block. The high grade also contained over 20 ounces of silver per ton, when silver was fixed at $1.00 per ounce by the Pittman Act. After all the high grade had been recovered, we mined the mill ore from the sides and roof, and filled the open stope with about 150,000 tons of 13% copper ore.

DESCRIPTION OF ORE OCCURRENCE

The ore occurrences of the Bonanza and Jumbo Mines, one mile apart and with outcrops at about the same elevation 5,600 to 6,000 feet, were unique and interesting. They both occurred in fissures which broke through the various beds down to the greenstone with very slight evidence of faulting. In a few places there was ore right down to the greenstone, but the most favorable horizon proved to be about 75 feet normally above the contact. The first fifty foot thickness above the greenstone is made up of four members, the shaley, pyritic, crinkley and dull grey limestone, all usually sparse in mineral. Above them the beds of lively crystalline dolomite begin. The dolomitization increased upward and the big masses of chalcocite spread from the fissure outward into the bedding. The fissures were replacement lodes varying from 3 to 15 feet, but the spreads out along the bedding planes or faults were irregular with widths as much as fifty feet. The greatest widths seemed usually to occur at the point of strongest dolomitization, and from these widest points the ore usually tapered gradually in the

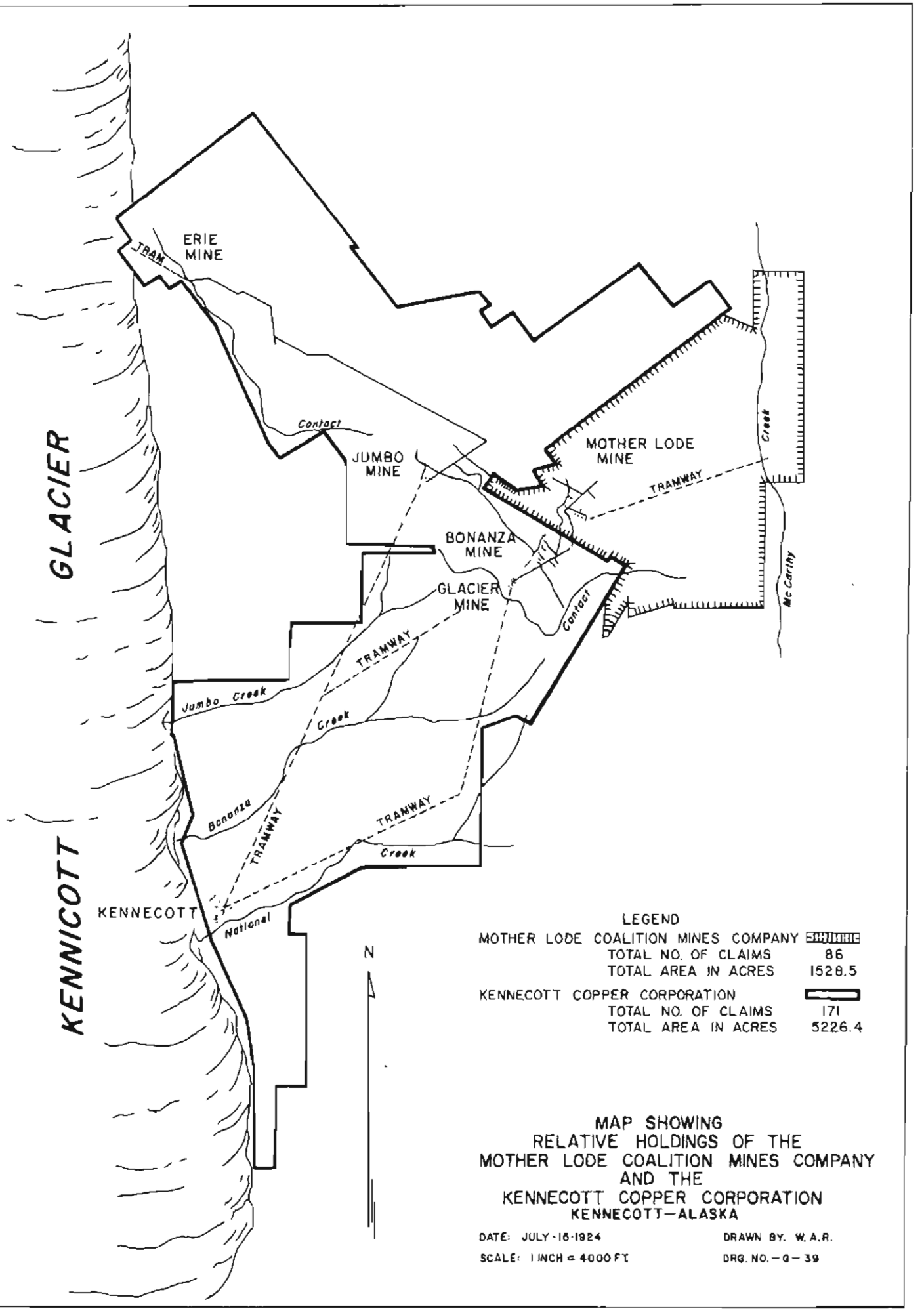


PROJECTION OF LOWER LEVELS



PLAN OF STOPING LEVEL

PROJECTION AND PLAN
SHOWING
GENERAL MINING METHODS
KENNECOTT COPPER CORPORATION
KENNECOTT — ALASKA
1923


ERIE MINE
TRAM
GLACIER
KENNICOTT
Contact
JUMBO MINE
MOTHER LODE MINE
TRAMWAY
Creek
BONANZA MINE
GLACIER MINE
Contact
McCarthy
TRAMWAY
Jumbo Creek
Creek
Bonanza
TRAMWAY
TRAMWAY
Creek
KENNICOTT
National
N
LEGEND
MOTHER LODE COALITION MINES COMPANY
TOTAL NO. OF CLAIMS 86
TOTAL AREA IN ACRES 1528.5
KENNECOTT COPPER CORPORATION
TOTAL NO. OF CLAIMS 171
TOTAL AREA IN ACRES 5226.4
MAP SHOWING
RELATIVE HOLDINGS OF THE
MOTHER LODE COALITION MINES COMPANY
AND THE
KENNECOTT COPPER CORPORATION
KENNECOTT—ALASKA
DATE: JULY-16-1924
DRAWN BY. W.A.R.
SCALE: 1 INCH = 4000 FT
DRG. NO.—G—39

upward continuation. The ore bodies had heights, normal from the bedding, up to 200 feet and with the widths of minable ore, above the high grade, tapering from an average of about 30 feet to 3 feet, they were prolific producers.

EXTENSIVE EXPLORATION DRIVES

The Bonanza Ore Body continued downward only to the 700 foot (vertical) level. The Jumbo Ore Body also bottomed on the 700 level. With this restriction of new ore at depth, it was recognized as early as 1917 that the best chances for additional reserves was from lateral exploration. An aggressive program was started in 1917 with a 5,000 foot connecting tunnel between the two mines on the Bonanza 500 level. The theory of the productivity of the dolomitic beds had not been developed at that time, and part of the Bonanza Jumbo crosscut was above the favorable horizon. (I should explain that the term 'crosscut' was applied to tunnels at right angles to the strike of the ore bodies, although such tunnels were drifts in relation to the bedding.) Even though this Bonanza-Jumbo crosscut was not in the favorable horizon for the full length, one new ore body was encountered about 500 feet west of the Bonanza Ore Body, which was eventually connected up with the Mother Lode Mine to make the great Bonanza-Mother Lode Vein. It eventually was mined for a slope length of 3,300 feet. The Bonanza-Jumbo crosscut was followed by the Jumbo-Erie crosscut, 12,000 feet in length, driven from two points, the Jumbo 1,500 foot Level and the main adit of the Erie Prospect. Careful surface mapping, under the direction of Dr. Alan M. Bateman, consulting geologist for Kennecott, had located the favorable structure, and this tunnel was kept in the dolomitic beds. Three ore bodies were opened by this work. Later, on this same level, another long crosscut was extended from the Jumbo to the Mother Lode Mine, and thence to the surface at McCarthy Creek. The favorable horizon was thus prospected a strike length of over 20,000 feet on this level.

After the two prospectors, Jack Smith and Clarence Warner, had sold their interest in the Bonanza-Jumbo Group of claims to Stephen Birch, they continued to prospect in the Kennecott area. They located another group to the north of the Bonanza, on the opposite slope of Bonanza Peak. This was about a mile distance in 'plan, but several miles by trail. They called this new prospect the Mother Lode Group. The outcrop was in the higher beds of limestone, about 1,200 feet above the limestone-greenstone contact. A rather persistent fracture of 1 to 2 feet in width, with copper stain, and weak mineralization of chalcocite and malachite, outcropped for at least 200 feet. The Mother Lode Mine was started on this showing by the Mother Lode Mines Company about 1910 or 1911. A wagon road up McCarthy Creek, for about 13 miles, and one mile of aerial tramway were constructed for transportation of supplies and ore shipments.

Several adit tunnels were driven on the vein, which opened up some commercial ore with widths up to about 5 feet. A vertical winze or interior shaft was started from the main adit with the intention of reaching the lower dolomitic beds, which were productive in the Kennecott Company's Mines. By 1919, this interior shaft had reached the 1,000 foot Level, with intermittent, limited production from several levels. The Mother Lode Company did not have a mill, so their income was dependent entirely on high grade shipments. As a result, the operations had not been profitable and a large investment had been made by the Shareholders.

ACQUISITION OF THE MOTHER LODE MINE

There were some very severe snowstorms in the area in the spring of 1919, and destructive snowslides followed. The Kennecott Mines were completely cut off from all communications with the Mill Camp for several days, as all telephone lines were down and the trails could not be used because of continuous slides. Several towers on each tramway were demolished by the slides, and the cables were carried down the mountains as much as a mile from the tramway right-of-way.

The Mother Lode Mine suffered serious reverses from the slides. Their men lived in the tunnels for a couple of days, when the slides were booming around the bunkhouse. Their tramway and power lines were badly wrecked. New capital was needed for repairing the damage and for further exploration, and a deal was made with Kennecott. Kennecott agreed to advance up to a certain sum for exploration work, for which they would receive a 51% interest, and they would have operating control. A new three-compartment incline with modern hoisting equipment had reached the 1,200 Level of the Bonanza Mine by 1919, and after this deal had been concluded, the Bonanza and Mother Lode Mines were connected by driving a 1,200 crosscut. The only ore available for shipment from Mother Lode at that time was some milling ore, about 5% copper, from the old dumps. While this was being recovered with slushers, crosscutting was underway on the lowest level, in what we considered the favorable horizon. In a few months' time, we had developed favorable widths of chalcocite, and the new Company, the Mother Lode Coalition Mines Company, paid a $.10 per share dividend on 2,500,000 shares at the end of the second year. The Mother Lode became a very profitable mine, and as mentioned above, its ore body eventually connected up with one of the ore bodies which was developed by the Bonanza-Jumbo crosscut to make the great Bonanza-Mother Lode Vein.

The main adit of the Mother Lode was the 1,200 Level of the Bonanza. From this level, the main Mother Lode three-compartment incline was started, and this eventually reached the 2,200 foot Level where the Bonanza-Mother Lode Vein finally became non productive. All the Mother Lode ore was hoisted through the Bonanza Shaft, weighted and sampled in the main level, and then transported to the mill over the Bonanza Tramway.

SNOWSLIDES - 1919

ERIE MINE

CONTACT AT ERIE

MOTHER LODE MINE

ERIE MINE

The fourth mine of the Kennecott Group, the Erie, was more or less of an eagles nest in the cliffs above the Kennecott Glacier, four miles north of Kennecott. The 12,000 foot crosscut, which connected it with Jumbo, made a producer of the Erie. An incline shaft developed the lower levels of the Erie, and a second Jumbo-Erie crosscut was driven to connect to the Jumbo 2,400 Level. This crosscut did not develop any new ore.

The capacities of the tramways were increased to 600 tons each about 1920. Mill capacity was increased to 1,200 tons per day at the same time. As the Bonanza reserves gradually became depleted, the Mother Lode supplemented it for tonnage over the Bonanza Tramways, and as the Jumbo became depleted, the Erie supplemented it on the Jumbo Tramway.

IMPROVEMENTS IN METALLURGY

While the first Kennecott Mill was only gravity concentration, an ammonia leaching plant was added in 1916. This plant was designed and the leaching process was perfected by Mr. E. T. Stannard, who later became President of the Kennecott Copper Corporation. Mr. Stannard was one of the Kennecott officials who lost his life in the horrible 'plane disaster in eastern Canada in September, 1949.

From 40 to 60 percent of the values in all the milling ore treated at Kennecott was in the form of carbonate copper. There were heavy losses of this carbonate in the gravity concentrator. The ammonia leaching plant made an excellent recovery on the coarse carbonate, down to 1/8th inch size. The finer material could not be leached as it would ball up in the leaching tanks and there was still a loss of 75 tons per day of 3% copper. After a long period of experimental work, a satisfactory method was developed for treating these fines by flotation after sulphidizing the carbonates with sodium sulphide and calcium polysulphide. By the three processes, gravity concentration, ammonia leaching and flotation, overall recovery of the copper was about 96 percent.

POWER PLANT

A limited amount of hydro-electric power (up to 400 horsepower) was developed during the summer months. However, during the winter, water was extremely scarce and the whole plant was dependent on about 100 gallons per minute of new water. Mill and power plant cooling water was used over and over until it was practically worn out. Diesel engines and steam turbines, with a total capacity of about 2,000 horsepower were operated in one power plant at the Mill Camp, using California Oil. Power was transmitted over a high tension line to Bonanza and then across the hill to Jumbo.

PRODUCTION OF ORE, METALS AND MONEY

The Kennecott Mines were worked out and abandoned in November, 1938. The total tonnage mined at Kennecott was 4,626,000 tons containing an average grade of about 13% copper. The total production was 591,535 tons of copper and about 9,000,000 ounces of silver. Based on a weighted average of each year's production applied to the average copper and silver prices for that year, the total value was about $200,000,000 and the net profit was about $100,000,000.

BIBLIOGRAPHY

UNITED STATES GEOLOGICAL BULLETINS ON COPPER RIVER DISTRICT

U.S.G.S. SPECIAL BULLETIN - "The Geology and Mineral Resources of a Portion of the Copper River District, Alaska" by Frank Charles Schrader and Arthur Coe Spencer, 1901.

U.S.G.S. BULLETIN 576 - "Geology of the Hanagita - Bremner Region, Alaska" by Fred H. Moffit, 1914. Plate 1 of this Bulletin "RECONNAISSANCE MAP OF CHITINA QUADRANGLE, COPPER RIVER REGION, ALASKA" is the most complete map available of the district.

U.S.G.S. BULLETIN 894 - "Geology of the Chitina Valley and Adjacent Area, Alaska" by Fred H. Moffit. Complete description of Kennecott Ore Deposits, pages 118-121. Also contains descriptions of all the properties and prospects along the Limestone-Greenstone Contact.

U.S. COMPILATIONS OF NARRATIVES - EXPLORATIONS IN ALASKA 1869 - 1900

This is in one volume containing the following:

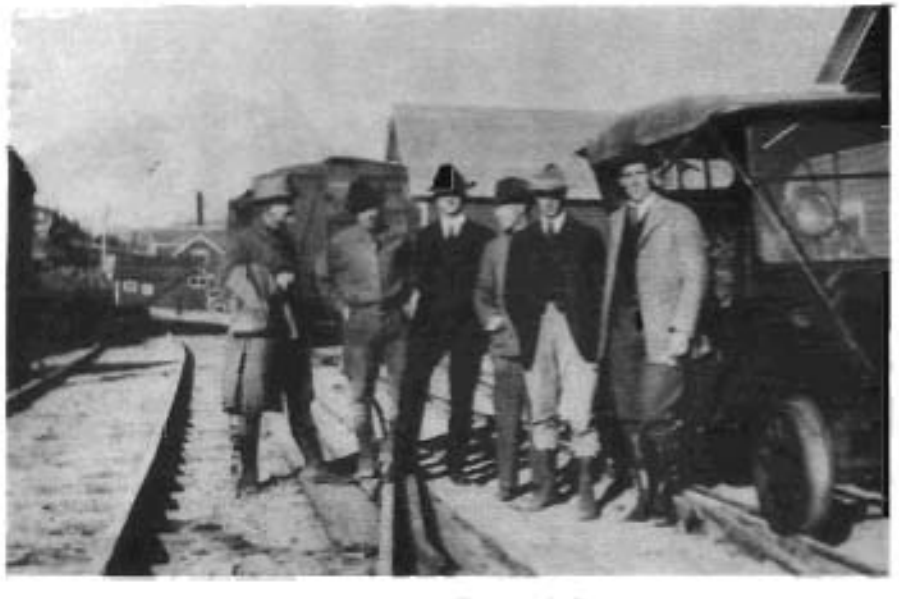
REPORT OF W.R. ABERCROMBIE, SECOND INFANTRY, U. S. ARMY, "A SUPPLEMENTARY EXPEDITION INTO THE COPPER RIVER VALLEY, 1884."

REPORT OF HENRY T. ALLEN, SECOND CAVALRY, U. S. ARMY, "A MILITARY RECONNAISSANCE OF THE COPPER RIVER VALLEY, 1885."

REPORT OF CAPTAIN W. R. ABERCROMBIE, SECOND INFANTRY U. S. ARMY,"A MILITARY RECONNAISANCE OF THE COPPER RIVER VALLEY, 1898. Also reports of members of his staff including Oscar Rohn, U.S.G.S.

REPORT OF CAPTAIN W. R. ABERCROMBIE, SECOND INFANTRY, U. S. ARMY, "SURVEY AND OPENING OF A MILITARY ROAD FROM VALDEZ TO COPPER CENTER, 1899."

KENNECOTT PLANT - LOOKING SOUTH



MODEL T FORD FOR SPECIAL SERVICE, C.R. & N.W. RY.
Left to right - Dr. Alfred H. Brooks, Chief-Alaska Br. U.S.G.S., R. L. Healy, Mine Sup't.
Mr. Murphy, Westinghouse Eng'r; W. C. Douglass, Gen'l Sup't; E. T. Stannard, Gen'l Mg'r; and
Mr. Hallowell, Asst. Sec.-Dept. Interior