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# The Latouche mining method as used at the Alaska Juneau Gold Mine

Willard Alexander Gallemore

# THE LATOUCHE MINING METHOD
# AS USED AT THE
# ALASKA JUNEAU GOLD MINE

by

Willard Alexander Gallemore

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A

T H E S I S

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in partial fulfillment of the work required for the

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ENGINEER OF MINES

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Approved by C.R. Forbes
Professor of Mining

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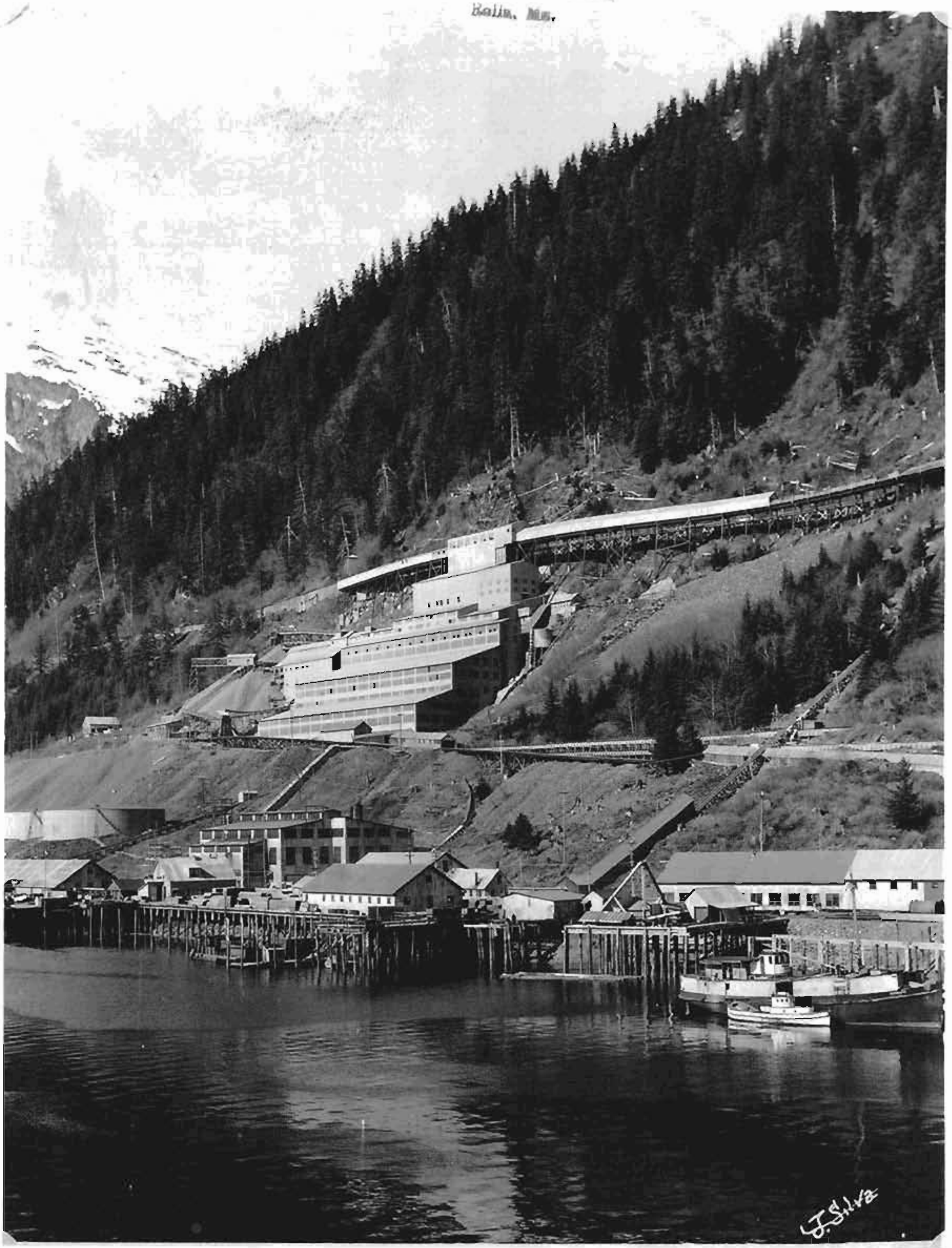



GENERAL VIEW OF MILL AND SURFACE SHOPS

# INTRODUCTION

The Latouche Mining Method has been used at the Alaska Juneau Gold Mining Company only since 1933, and is used in that part of the mine below the main tramming level. It consists of a series of radiating "long holes" (21 feet) drilled from stope raises, over the back of the stope. These holes break the rock into the stopes, from where it goes through bulldoze chambers to oreways leading to chutes on the No. 10 Level. On this level, the ore is drawn into Granby Cars, trammed to the Main Shaft, and hoisted to No. 4 Level. On this level, it is loaded into ten-ton cars, and trammed directly to the mill with the ore from the rest of the mine.

The Latouche Mining Method is not very widely known or used. The purpose of this paper is to describe the method in general detail, as used at this mine.

## HISTORY OF THE NORTH ORE BODY

Prior to 1911, "the mine" of the Alaska Juneau Gold Mining Company consisted of several open pits on the ore outcrop at an elevation of 1,200 feet. The footwall of the ore was Nugget Gulch Fault, and the ore was cut off on the west end by Silver Bow Fault.

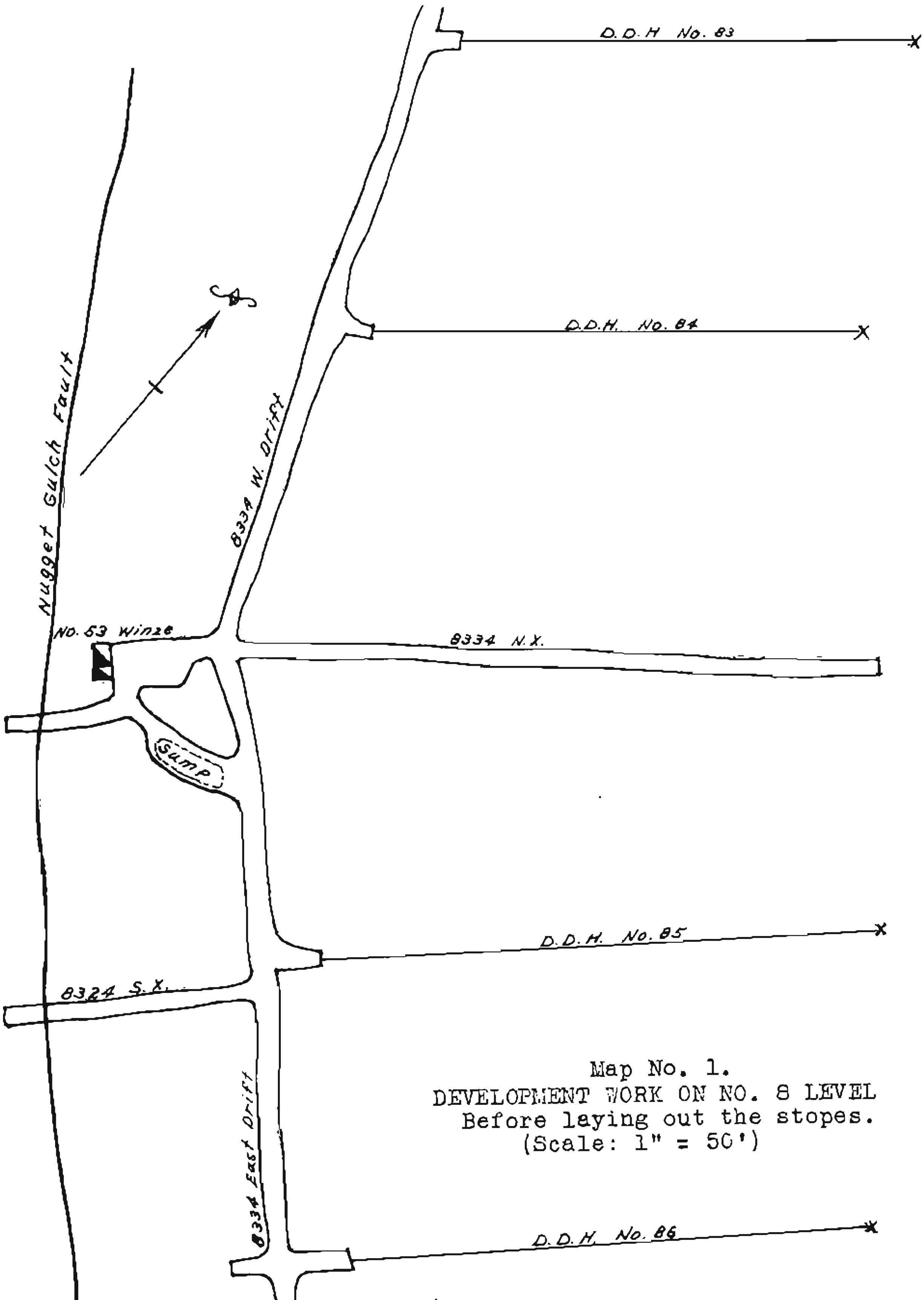
Since all surface conditions indicated continuation of the ore at depth, the company determined in 1911 to drive an adit at an elevation of 400 feet, following Silver Bow Fault to a point beneath the surface workings--a distance of 7,000 feet.

As this adit was driven, the part of the ore cut off by Silver Bow Fault was found 4,000 feet from the portal. Here was a band of ore 44 feet thick, which was found to assay much higher in gold than the old surface workings; the average for the 44 feet was $6.00 a ton. The adit was driven farther, and the ore body sought was found at 7,000 feet from the portal. The original ore body was then called the South Ore Body and the new ore body at 4,000 feet from the portal was called the North Ore Body. The North Ore Body does not show on the surface and might never have been found but for the driving of the adit.

Development of the ore above the adit level (called No. 4 Level) in the North Ore Body was started immediately. A manway raise was driven up to the surface (1400 feet) and manway levels driven from it at 200-foot vertical intervals. In the ore thus proved were cut two stopes, 50 feet above No. 4 Level. These stopes were cut entirely across the ore body from footwall to hanging wall, taking in all the commercial ore. As the stopes were worked, the barren hanging wall caved into them, diluting the ore so much that the stopes were abandoned. They were reopened in 1934, when the price of gold was advanced to $35 an ounce.

After these stopes caved, no further consideration was given the North Ore Body, and all attention was concentrated on the South Ore Body. In 1930, however, the company decided to explore the North Ore Body below No. 4 Level. If this ore were high-grade enough to pay the additional cost of hoisting, it could be mined. Accordingly, a two-compartment winze was sunk in the plane of Nugget Gulch Fault, which dips 60 degrees to the northeast. Because the collar of this winze was near No. 53 chute of the old caved stope above No. 4 Level, it was called No. 53 Winze.

As No. 53 Prospect Winze was sunk, levels were started from it at vertical intervals on 150 feet. This interval was not strictly adhered to, and many of the levels are at odd elevations. No. 5 Level is at 300 elevation; No. 6, at 150; No. 7, at 0 or sea level; and No. 8 at -150 feet. The next level was cut at -550 feet elevation, and called No. 10 Level; but later three levels were cut between No. 8 and




Map No. 1.
DEVELOPMENT WORK ON NO. 8 LEVEL
Before laying out the stopes.
(Scale: 1" = 50')

No. 10, at elevations of -250, -400 and -500 feet, and called No. 9, No. 950 and No. 10 Intermediate Levels.

The average of all samples taken in the winze and in the Level Stations was $4.00 a ton. To determine the limits of the relatively "high-grade" ore body, drifts were driven both east and west from each level statioh. At various points crosscuts were driven from these driftx, both into the foot-wall and into the hanging wall. Diamond drill holes were used in lieu of crosscuts on some levels. Assay value of the ore was determined from grab samples in the drifts and cross-cuts and from samples of the sludge and core in the diamond drill holes. These assays were plotted on horizontal plans of each level, called Assay Maps.

These assay maps showed the ore to end abruptly at Nugget Gulch Fault on the footwall side, and to diminish gradually to waste about 300 feet in the hanging wall. East of the winze, the values dropped as Silver Bow Fault was approached; west of the winze, the values continued to the property line. Vertically, the ore continued from No. 4 Level to No. 10 Level, with no indication of stopping.

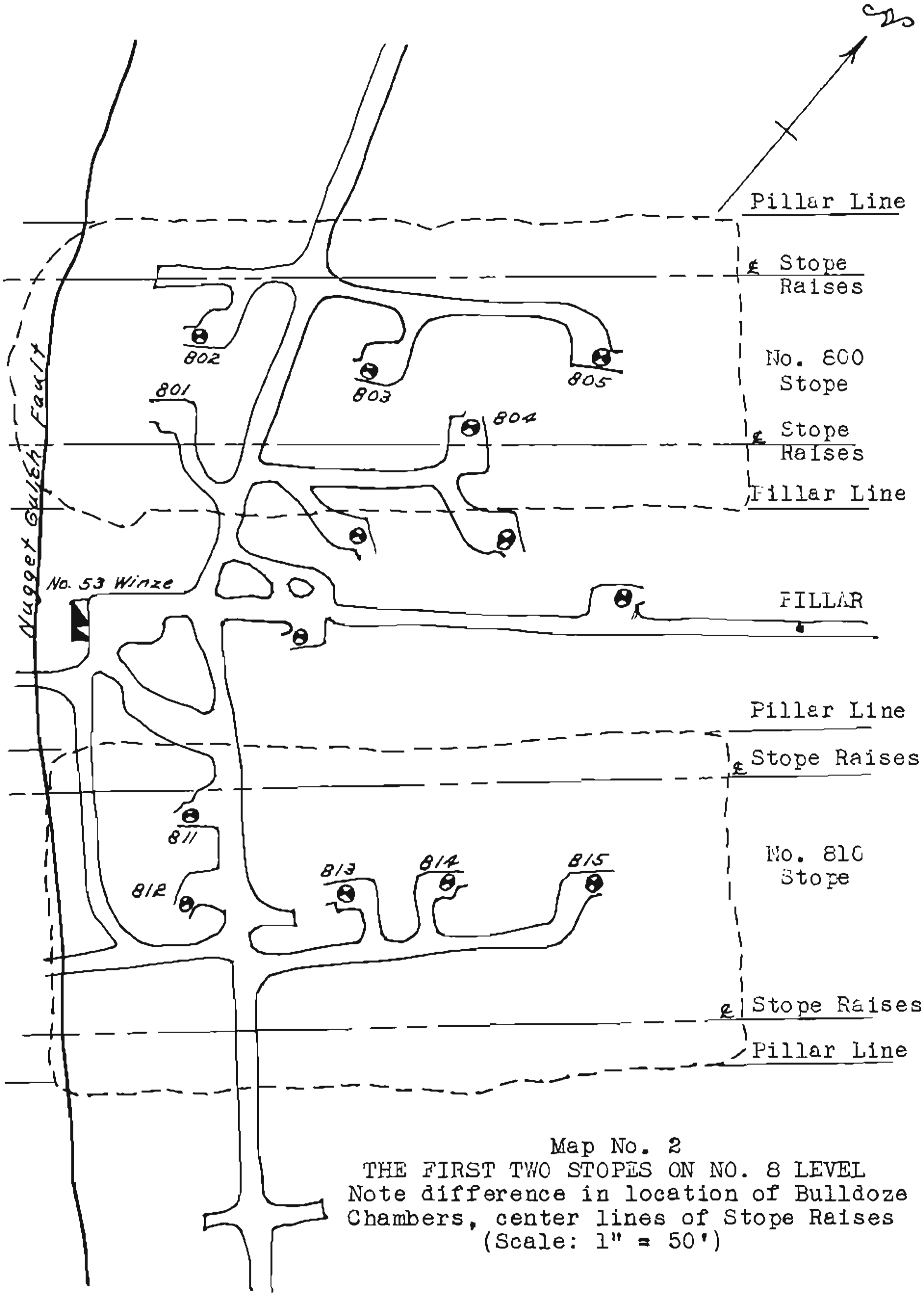
To aid in development, ventilation and hoisting, another 60° winze was sunk 1,000 feet east of No. 53 Winze. This winze, consisting of two hoisting compartments and a ladder-way, was called No. 91 Winze. Stations were cut on No. 6, No. 8 and No. 10 Levels, and connected to the drifts from No. 53 Winze.

After locating the limits of the ore body, the problem of stoping presented itself. How could this ore be stoped and not endanger the workings above on No. 4 Level? If the stopes were permitted to cave, would not the low-grade hanging wall cave, too, thus diluting the ore? This eliminated the use of the caving method used in the South Ore Body. Back stoping could not be used because of the high cost, and also because of the danger to the miners. After long consideration, the Latouche stoping method was approved. With this system, the stopes could be kept small enough to prevent uncontrolled caving, and yet large enough to get a low cost per ton mined.

## HISTORY OF THE LATOUCHE MINING METHOD

The Latouche Mining Method was so named because it was developed in Latouche Island, Southwest Alaska, at the Beatson Mine of the Kennecott Copper Corporation.

The ore outcropped on the face of a large bluff 2,000 feet long and 450 feet high. Mining was being carried on by Glory Hole methods when the Kennecott Copper Corporation acquired the mine in 1922. An adit was driven 50 feet above sea level through the ore, and chute raises were driven from this main level to intermediate levels 40 and 100 feet above. Grizzlies were installed on the intermediate level 40 feet above, and raises driven on through to the surface. These raises had to be enlarged before the surrounding ore could be broken into them, or serious hang-ups would occur. The enlarging process was started in a raise about 10 feet above the grizzly and the raise enlarged to 10 or 12 feet in diameter. This was done by using a stoper drill, and working up on the broken rock. The ground had such tendency to cave, due to the numerous slips and schist belts, that even with an opening of 10 or 12 feet in diameter, the work was hazardous and many serious accidents resulted. To avoid the danger involved in the use of a stoper operated from the broken rock pile with unsafe ground overhead, a staging was placed in the raise and from this, using a jackhammer type of machine, flat holes were drilled into the walls of the raise. This solved the problem. Later, in order to drill longer holes, a small bench or station was cut in the raise and steel up to 15 feet in length was used, with more ground put on the holes. Eventually, it was found that raises could be carried up 30 feet in diameter and that the vertical distance between the benches could be increased up to 20 feet. The tonnage broken per machine drill shift, or per labor shift, was much higher than obtained in the regular Glory Hole mining. The powder consumption per ton of broken ore was also considerably less. It was decided, therefore, to utilize this scheme in mining the ore below the main level. Thus was evolved the "Latouche Mining Method," which was used exclusively at this mine from 1923 until the mine was closed in 1927.



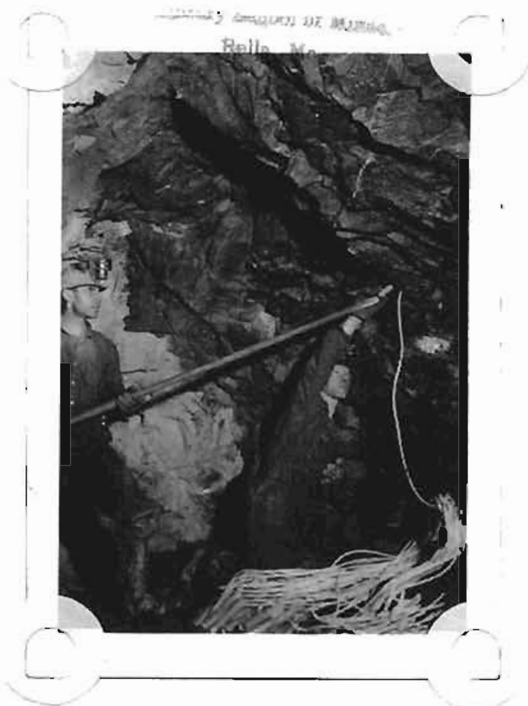

Map No. 2
THE FIRST TWO STOPES ON NO. 8 LEVEL
Note difference in location of Bulldoze
Chambers, center lines of Stope Raises
(Scale: 1" = 50')

THE LATOUCHE METHOD AT THE ALASKA JUNEAU MINE

In applying the Latouche Mining Method to the ore body here, only the main principle of the system was used, the size and shape of the stope being changed to fit local conditions. In addition to the changes made at the beginning, other changes have been made from time to time in order to take advantage of knowledge gained from cutting the previous stopes.

Stopes are cut from footwall to hanging wall, and as wide as is possible to control caving. The first stope was cut 100 feet wide; later stopes were cut 130 feet wide. Each stope has five bulldoze chambers, two being side by side near the footwall end of the stope, and the other three in a line extending to the hanging wall end of the stope. Since each bulldoze chamber is a draw-point, there are five draw-points for each stope. The stope area is divided into four almost equal parts; the three hanging wall parts are assigned one draw point each, and the footwall part is assigned two draw-points (see sketch, Map No. 3). Cut-out raises are then driven from each bulldoze chamber on a slope of 40°. One raise is driven straight ahead from the chamber to the limits of its draw area. Branch raises are driven from it to the side limits of its draw area, and a back-cut-out raise is driven to the other end limit. This back-cut-out raise connects with the back-cut-out raise driven from adjacent draw-points. All these raises are driven with wet stoper

Drilling Side-Swipe
Holes

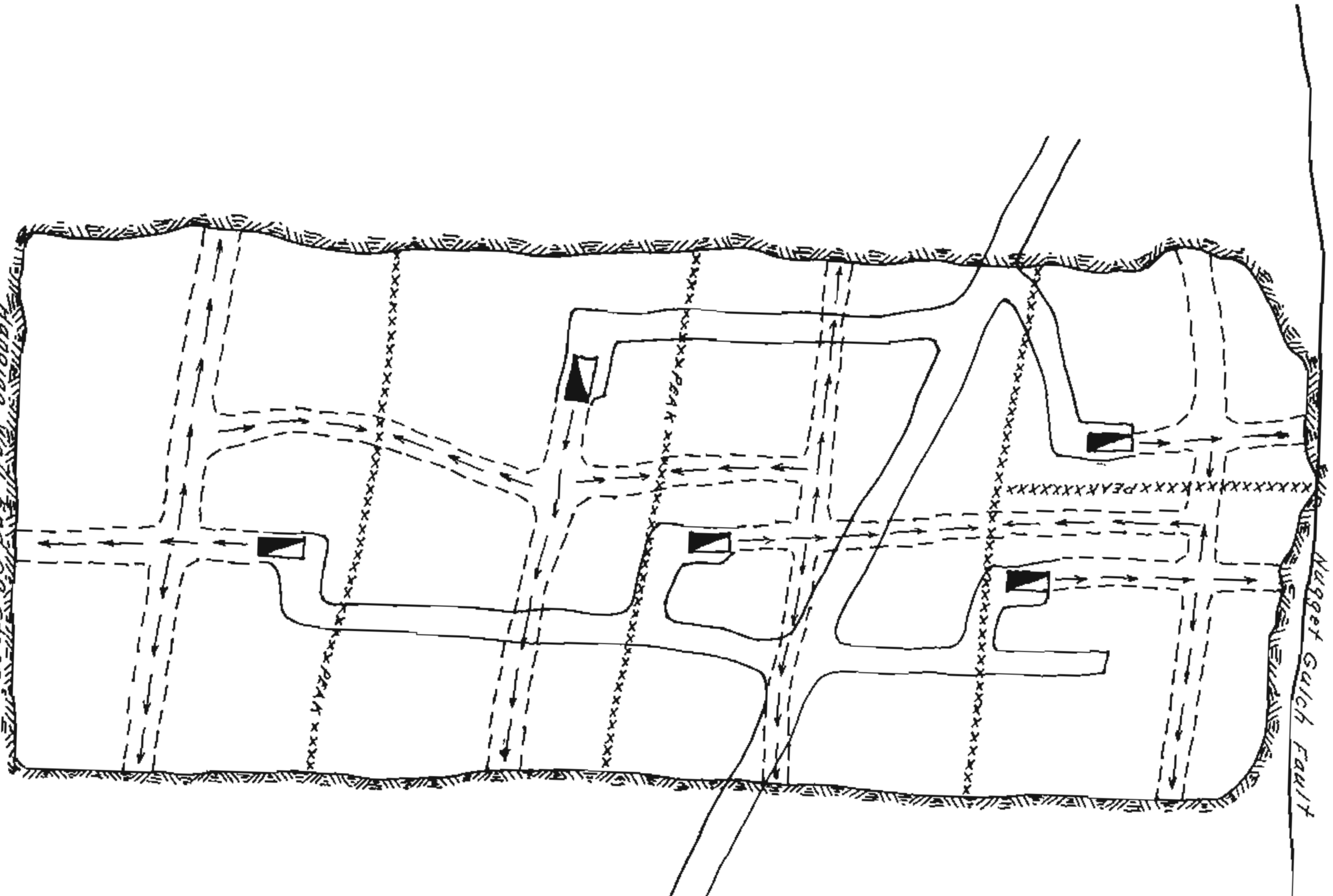


Loading Side-Swipe
Holes



Drilling Side-Swipe Holes

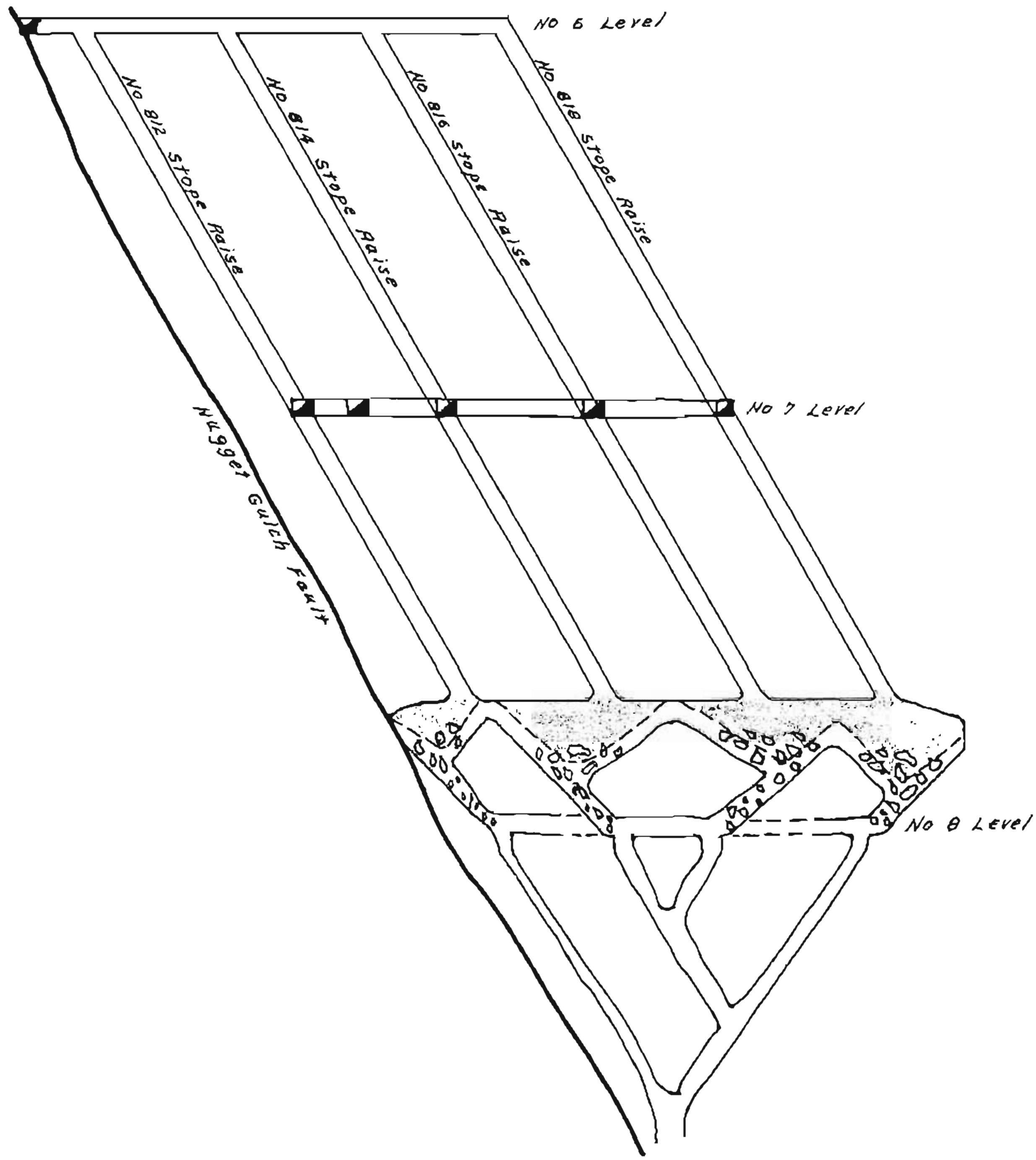
CUTTING OUT A STOPE



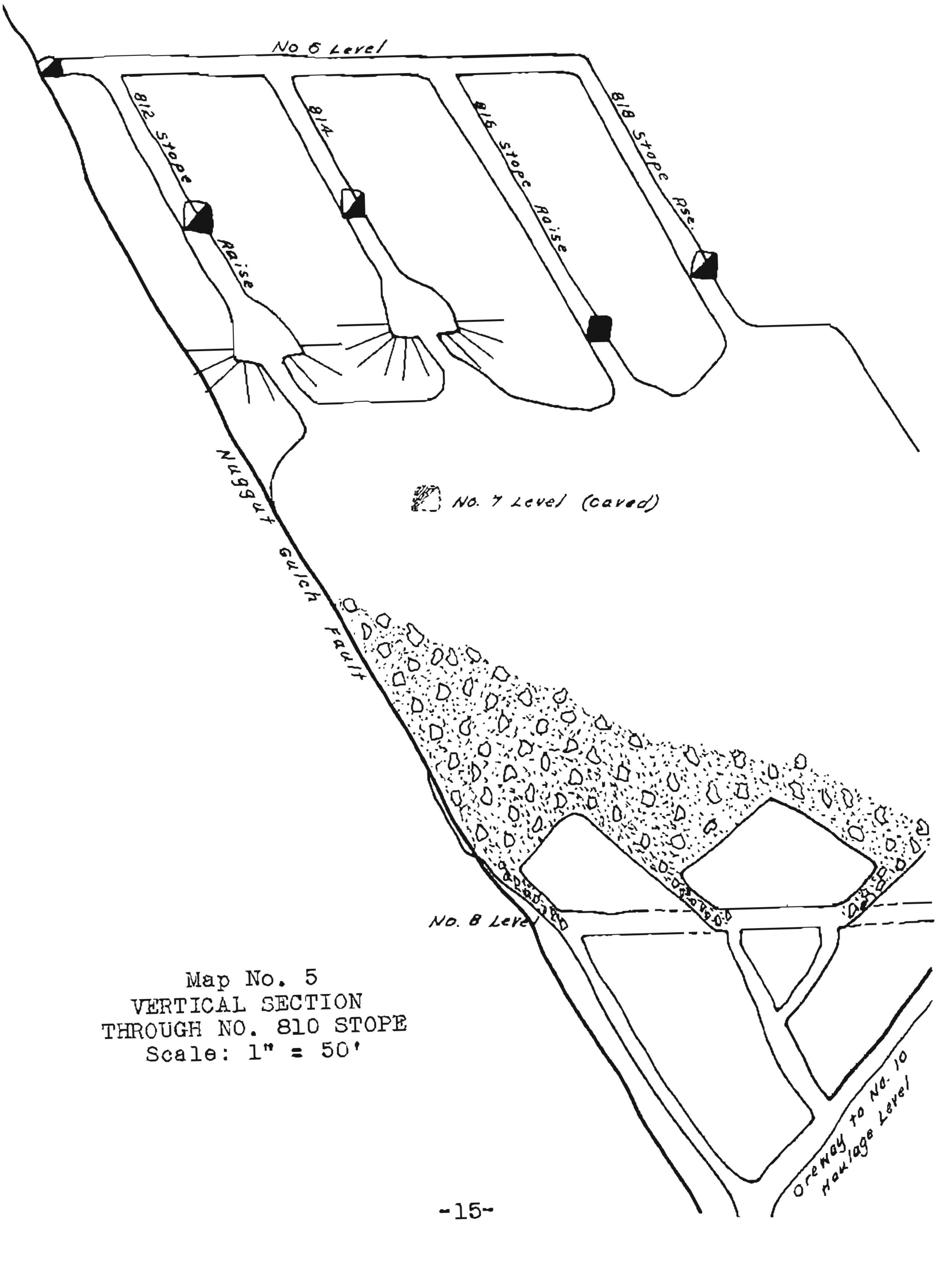

Map No. 3
CUT-OUT RAISES IN NO. 800 STOPE

××××××Dividing peak between two draw-holes → → → Direction of cut-out raises, driven 40 degrees up slope drills, using eight-foot steel for finishers. After the raises are completed, the stope is cut out by side-swiping the raises. As cutting out progresses, the low-hanging bellies formed on the back of the stope are drilled with 20-foot steel and blasted down; this is done so the miners will not have to work under these bellies, as serious accidents have occurred when bellies caved unexpectedly. Island pillars are left along the peaks of the draw-hole areas, to support the back of the stope until ready to put the stope into production.

After the cutting out is completed and the island pillars are drilled, stope raises 5 x 5 feet in cross section are driven from the back of the stope to the next higher level. The spacing of these raises is very important, as they are the basis of the Latouche Mining Method. They must be spaced close enough together to permit no caving, yet as far apart as possible, to keep the development cost at the minimum. In the first stope cut out, the raises were spaced 60 feet apart, and 25 feet from the sides of the stope, but it was found that uncontrolled caving resulted, and the arrangement was changed to eight raises to the stope, spaced at 50 feet center-to-center, and 10 feet from the sides of the stope. This latter arrangement gave better breaks of the stations, and also made a better pillar line, as the stations were then on the pillar line.



No 6 Level
No 812 Stope Raise
No 814 Stope Raise
No 816 Stope Raise
No 818 Stope Raise
No 7 Level
Nugget Gulch Fault
No 8 Level




Map No. 5
VERTICAL SECTION
THROUGH NO. 810 STOPE
Scale: 1" = 50'

The raises are driven on a slope of 60°, paralleling the formation. They are driven single-compartment, untimbered; the miners get to and from the face on heavily constructed ladders hung on short lengths of drill steel drilled into the footwall of the raise. In spite of being constructed of 3 x 4 fir timbers with one-inch pipe for rungs, the ladders are frequently damaged by blasts and falling rock, so when the raise is completed by the miner, he removes all the old ladders. After the ladders are all out, the pillars in the stope are blasted, and further entrance into the stope is prohibited.

Starting from the level above, new ladders are placed in the raise by company timbermen. These ladders are hung on cross-stulls, and butted together so as to form one long ladder the length of the raise. Skids are nailed to the ladders, and a small skip installed. An air tugger hoist, located on the level above, operates the skip.

Coming down from the level above, the miner places a staging of 3 x 4 timbers with two-inch thick lagging, in the raise at a point marked by the mine foreman, 30 feet above the back of the stope. On top of this staging, the miner places a series of wooden blocks and puts lagging on top of these, making a double staging about three feet apart. This second staging is used to stand on while drilling the upper part of

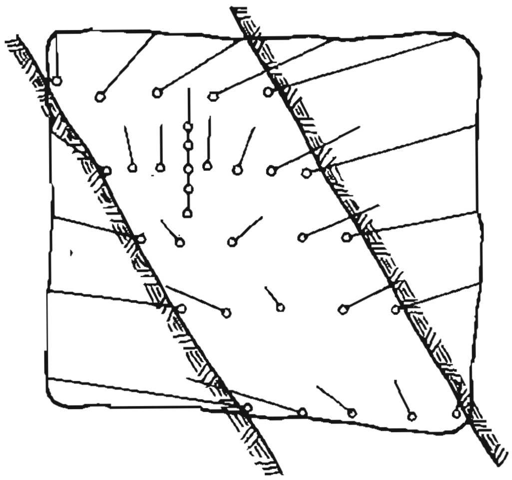


Diagram 1.
Location of holes in first rounds from the raise. One round is drilled on each side of raise.
Scale: 1" = 5'

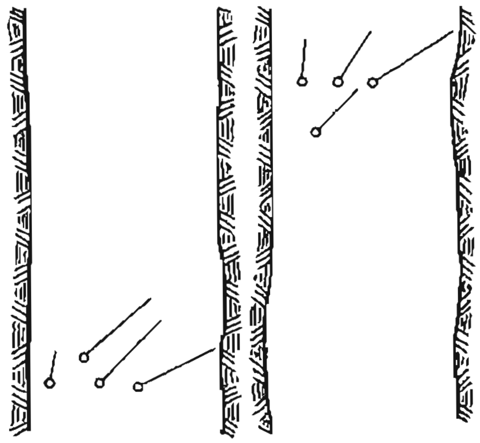
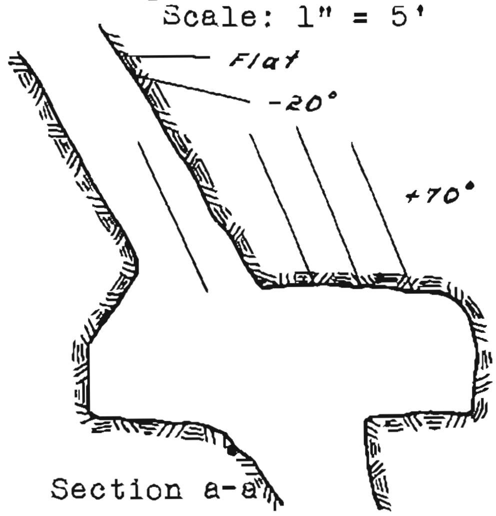


Diagram 2.
Footwall Hanging Wall
Plugs drilled in walls
Scale: 1" = 5'




Section a-a

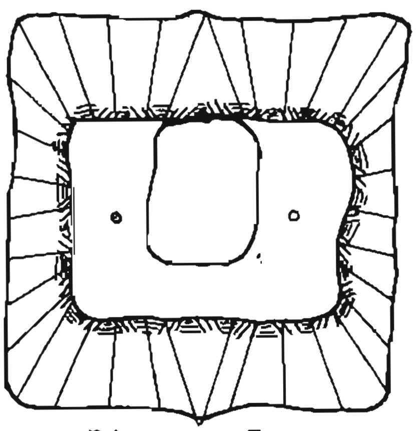


Diagram 3.
Holes to make station full size horizontally
Scale: 1" = 10'

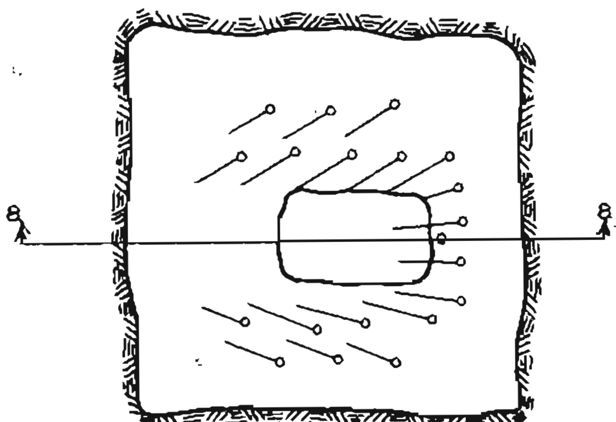


Diagram 4.
Stoper holes drilled in back of station.
Scale: 1" = 10'

the rounds; it is then removed and the lower staging used to drill the lower parts of the rounds. A horizontal Leyner bar is placed flat from the footwall to the hanging wall of the raise, four feet above the upper staging. Two arms are used on this bar; one 36-inch arm vertical acts as a vertical bar for the second arm, which is 21 inches long and placed horizontally from the vertical arm. With the machine on this arm, the upper parts of a round on each side of the raise are drilled. The arms are then swung under the bar, and the lower parts of the rounds are drilled from the lower staging.

The rounds described above are not drilled on the slope of the raise, but are drilled to make a vertical wall on each side. The upper holes on the hanging wall side are drilled looking into the hanging wall, and the lower holes on the footwall side are drilled looking into the footwall. A finger (Cornish) cut is used (see Diagram 1.). Some short plug holes are necessary to square up the upper hanging wall and lower footwall of the raise, as shown in Diagram 2.

After these rounds are blasted, and the faces cleaned out (most of the muck falls down the raise during blasting), a vertical Leyner bar is set up on each side of the raise and holes are drilled as shown in Diagram 3. These holes make the station full size horizontally (21 x 21 feet), but it still has to be made 21 feet high. To complete the station

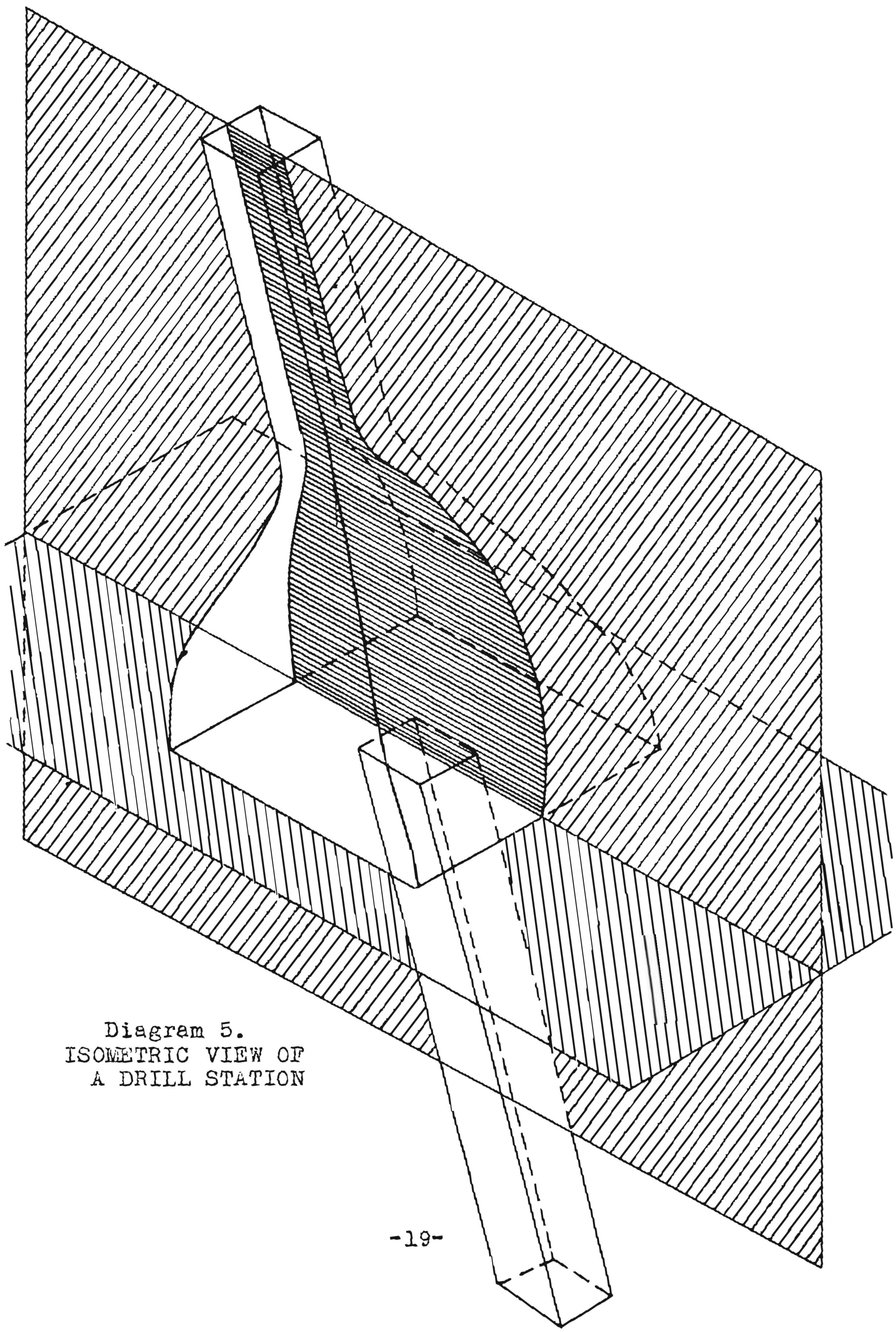


Diagram 5.
ISOMETRIC VIEW OF
A DRILL STATION

vertically, stoper holes are drilled into the back of the station, all around the raise opening. These holes cannot be drilled long enough to make the station 21 feet high, so flat holes are drilled into the hanging wall of the raise from a horizontal Leyner set-up, exactly 21 feet above the bottom of the station. Reliever holes are often drilled below these flat holes, the relievers looking down 20°. (See Diagram 4.) When all these holes are blasted and the muck removed, the station is complete. The station is not cut 21 feet high all over, but only near the raise in the center, so that a 21-foot drill steel can be swung at any angle. An isometric view of a completed drill station is shown in Diagram 5.

From this station, 21-foot holes are drilled radially in all directions. (See Diagrams 6, 7 and 8.) A 210-pound water Leyner drill with a 4½-inch bore is used to drill the holes. Most of these drills are Denver-Gardner, model 17L, although some Ingersoll S70 drills are used. The drill is mounted on a tripod, of which two types are used. One type weighs 115 pounds; the other weighs 150 pounds. The heavier type is preferred by most miners. Both types have 3½-foot legs, with extension adjustments for an additional two feet. To prevent the tripos tipping over backwards while drilling, 100-pound weights are put on each leg, although these are often omitted from the rear leg. Two weights are sometimes

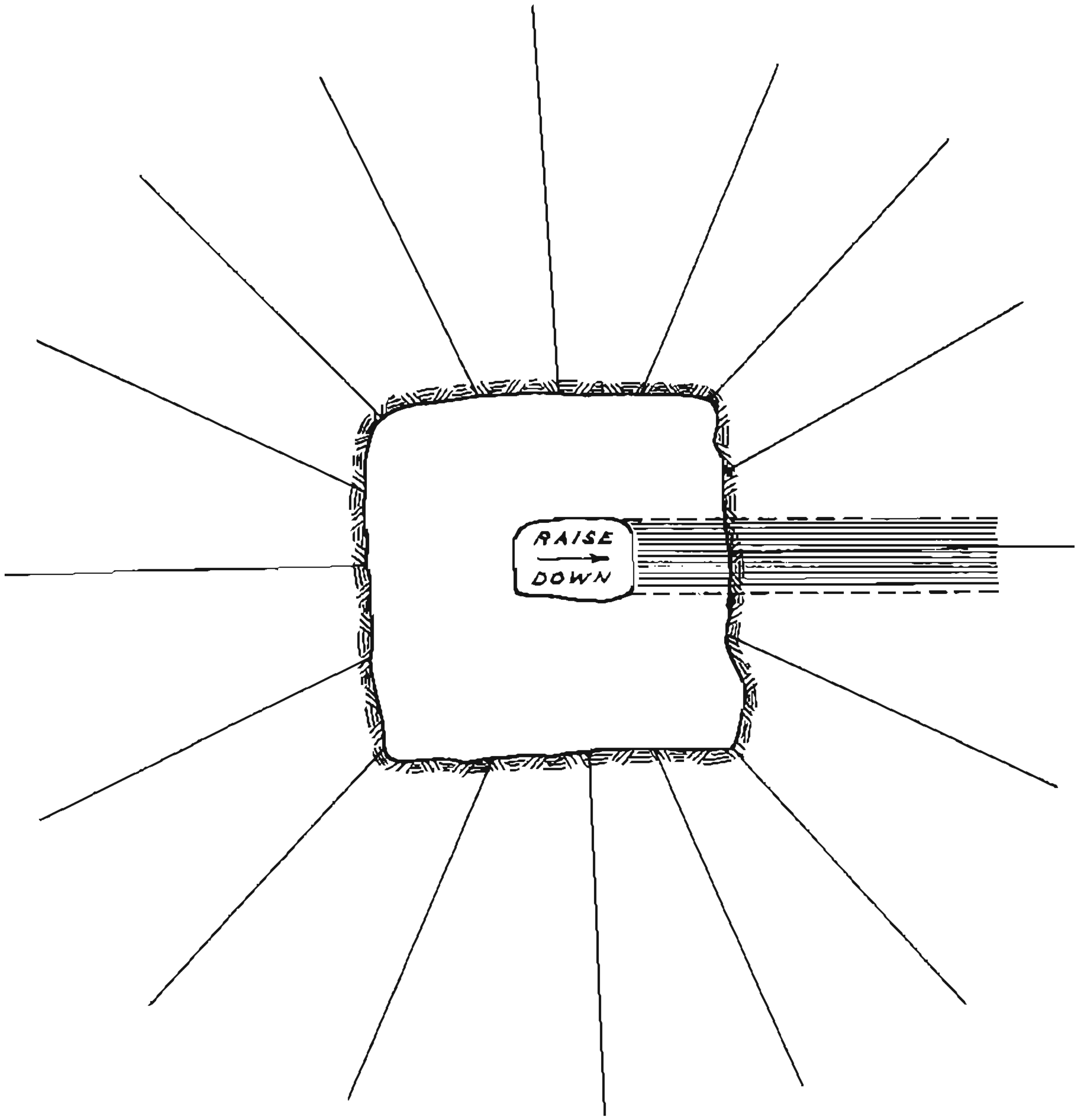



Diagram 6.

PLAN VIEW OF DRILL STATION
Showing the arrangement of holes in plan

Scale: 1 in. = 10 ft.

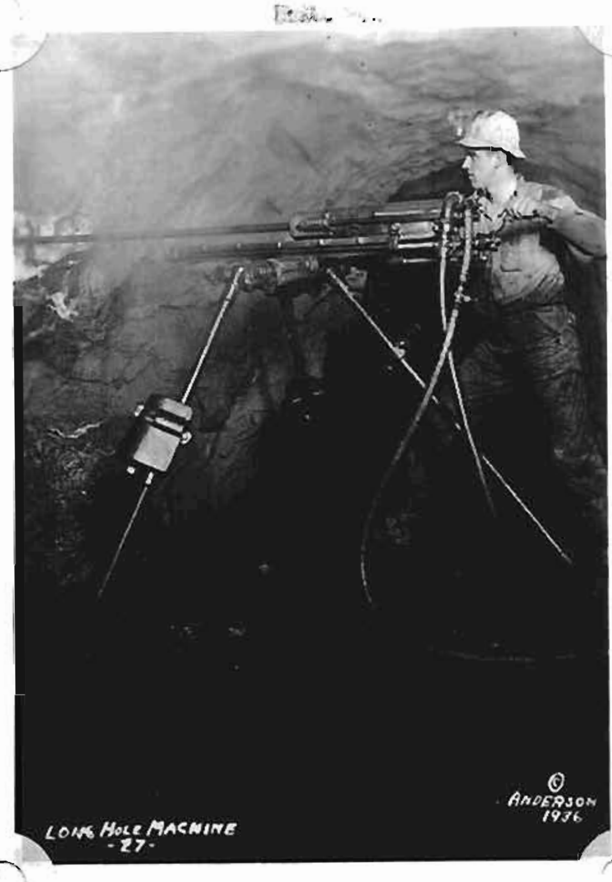
required on the front legs. Air pressure at the drill varies from 90 pounds to 100 pounds per square inch, gauge pressure. Drilling speed varies from 9 inches to 15 inches a minute, according to the character of the rock, and (in small extent) to the bit size.

Round, hollow, lugged steel, $1\frac{1}{4}$ inches in diameter, is used in drilling. This steel is the only round steel in the mine, the ordinary drilling steel being hexagonal. This steel is purchased in long lengths, which are cut into the required drill lengths. The bit end is threaded for detachable bits and lugs are put on the shank end. All this work is done in the shops here. The shortest length is 30 inches; the longest, 22 feet. Eight changes are used, each change being approximately 34 inches longer than the preceding one.

Detachable bits are used in drilling the "long holes" in the stations. Both Timken and Ingersoll-Rand jack bits were tested in the stations, with the result that Ingersoll-Rand bits are used exclusively. While the Timken bits cost slightly less, the jack bits drilled slightly faster. But the big thing in their favor was their durability. Timken bits, being tapered or "stream-lined" to fit the steel smoothly, were weak at the shoulder, and excessive breakage resulted. Only four sizes of jack bits are purchased--2 5/8", 2 1/2", 2 3/8" and 2 1/4", with a gauge change of 1/8". In order to get the eight changes necessary to drill a 22-foot hole, re-ground bits are used. The average bit can be re-ground

With Vertical Bar Set-Up

With Tripod Mounting




DRILLING LONG HOLES
Two Types of Mounting for the Long-Hole Leyner Drills

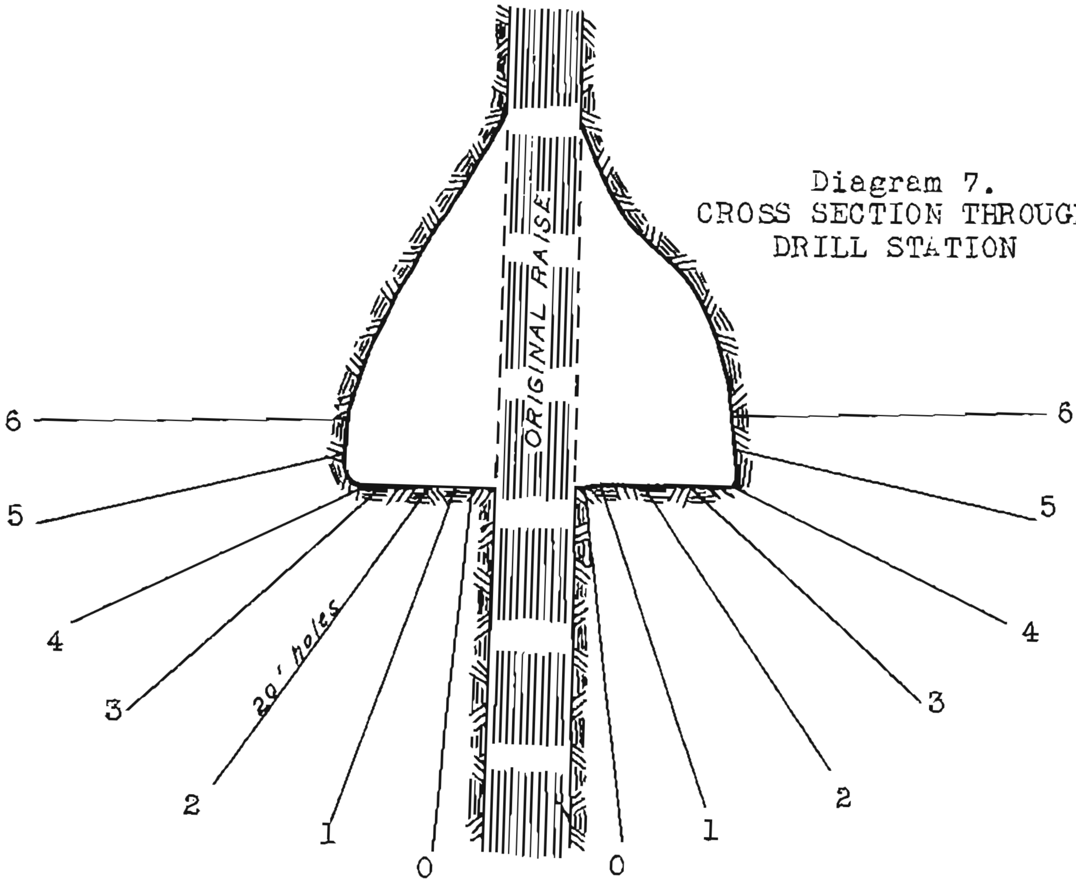



Diagram 7.
CROSS SECTION THROUGH
DRILL STATION

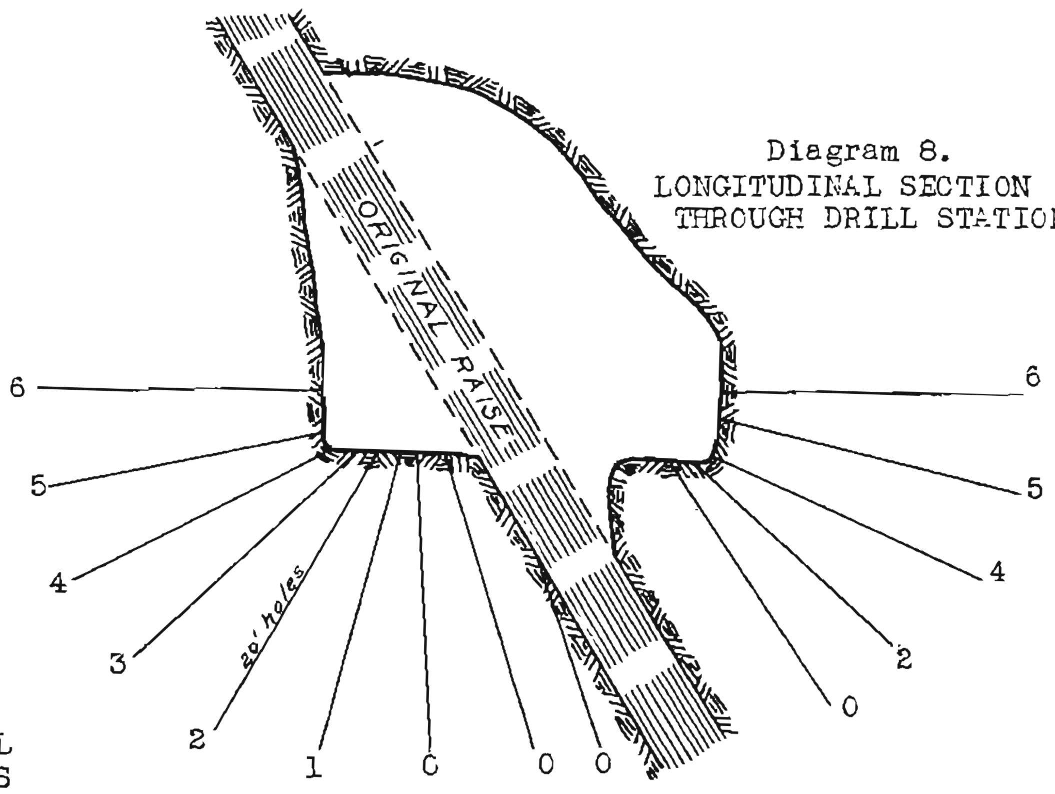



Diagram 8.
LONGITUDINAL SECTION
THROUGH DRILL STATION

VERTICAL
SECTIONS
Scale: 1" = 10'

three times, and each re-grinding takes about 1/8 inch off the gauge. Many bits are re-ground more than three times; however, the gauge is never ground less than 1 3/4 inches. Using re-ground bits, the gauge change is never exactly 1/8 inch, but is frequently as small as 1/16 inch. When this small gauge change is used, the steel sometimes must be driven into the hole with a sledge hammer, and the miners try to avoid this as much as possible. About 80% of the new bits purchased are of the largest size, and the other 20% are of the smaller size.

When the Latouche Mining Method was first used at the Alaska Juneau, contracts for drilling were given the old-time miners. These men had definite ideas as to how many feet drilled was a day's work, and very seldom exceeded this figure. Later, younger men were tried in the stations. In a short time these men had almost doubled the footage drilled per machine-drill-shift. Since the work was under contract (20 cents per foot), this made the difference between running the contract in debt, and making $10 to $12 per day. The main advance made by the younger men was to drill a complete 21-foot hole vertically or on any slope without blowing out the hole with a blowpipe. This was accomplished by careful adjustment of the feed-water while drilling, so that not too much and not too little water was introduced into the hole. By thus eliminating the use of the blowpipe, the actual drilling time per shift was almost doubled.

When a hole is finished, it is blown out with the blowpipe, and plugged with a pointed wooden plug to keep it clean until time to load it. However, in spite of this precaution, some water and mud always gets into the hole, so all holes have to be blown out again just before loading.

Before the miners became accustomed to this method of drilling, the holes were not spaced uniformly. Each hole had to be surveyed for bearing, dip, and length. A transit survey was made of each station, and this data obtained. Then plan and cross-sections were made of the station, showing each hole. From these maps, the firing order and charge of dynamite for each hole were determined. A blueprint was then sent into the mine so that the holes could be loaded and fired in the order determined. This was a lot of work for an already overworked surveyor, so the practice of surveying the holes was discontinued as fast as the miners became familiar enough with the method to drill the holes with more or less regular spacing. The holes still have to be measured for length in order to determine the miners' pay for drilling. The drilling is still done by contract, although the price per foot has been cut from 20 cents to 15 cents.

When the station is drilled out, all equipment is removed, the holes are blown out with a blowpipe, and the bottom of the station is cleaned with the blowpipe. The holes are loaded by company workers (not on contract) with 60% DuPont gelatin dynamite. No. 8 electric blasting caps are used in six delays. The holes are connected in series-parallel and blasted with a 440-volt circuit. Lead wires are run from the station up the stope raise to the Winze Station. Here they are connected to the permanent wires in the winze. The circuit is closed by a master switch at the collar of the winze. Blasting is usually done at the beginning of the day shift (7:00 a.m.), and the mine is shut down for the remainder of the shift to allow time for the smoke and fumes to clear out. All men are checked out and put on the shift train, and all the electric connections are checked over by the Mine Foreman before the master switch is closed for the blast. Neither the noise or concussion is excessive on the Main Level.

10-Ton Skip in
Dumping Position

Skip Tender at
Loading Pocket

Main Hoist Looking down Cable Raise

VIEWS OF HOISTING OPERATIONS

# HOISTING

During 1932 and 1933, ore from the Deep North Ore Body was hoisted in the original No. 53 Prospect Winze. Late in 1933, No. 91 Winze was completed. This winze was also on a slope of 60°, with two hoisting compartments, and used two 5-ton skips in balance. The ore was hoisted here until the Main Shaft was completed in 1935. This Main Shaft is a vertical shaft of four compartments--two for hoisting ore, one for ladders and pipes, and one for a man-cage. The compartments are 5½ feet square inside the timbers. The ore is hoisted by two ten-ton skips operating in balance, and traveling at a top speed of 1,000 feet per minute. This speed is maintained only a few seconds until the skip is automatically slowed down as it approaches the dump, and at the same time the other skip approaches the loading pocket.

The skip is filled from a measuring pocket, designed to hold ten tons of ore. This operation takes only a few seconds. Electric signals connect the loading pocket station and the hoist room, and a telephone also connects the two.

Hoisting crew consists of one hoistman and one skip tender, on each shift. These two men can hoist an average of 15 skips (150 tons) of ore an hour, although the record for any one continuous hour is 30 skips.

## TRAMMING

Ore from all the stopes in the Deep North Ore Body goes to No. 10 Level in oreways. Here it is drawn through under-slung are-gates into 4-ton Granby Cars (actual capacity 3.4 tons). Ten of these cars compose a train, and two trains are operated on this level.

A train crew consists of enough men to operate the two trains: two motormen, one stope tender, two loaders, and one chute puncher.

The trains are pulled by electric trolley motors, operating from a 550-volt trolley wire. This wire is unguarded and maintained at a height of 7 feet from the track. The track gauge is 30 inches, and 50-pound rails are used.

TONNAGES

| Year | Stope | Tons | Per cent of Mine Tonnage | Assay Value | Entire Mine Assay Value | Entire Mine Tonnage |
|---|---|---|---|---|---|---|
| 1933 | 800 | 152,030 | 3.72 | | | |
| | 1000 | 73;400 | 1.80 | | | |
| | Devel. | 60,560 | 1.48 | | | |
| | | 285,990 | 7.00 | $2.128 | $0.899 | 4,085,960 |
| 1934 | 800 | 73,270 | 1.70 | | | |
| | 810 | 52,730 | 1.23 | | | |
| | 1000 | 203,450 | 4.73 | | | |
| | Devel. | 67,240 | 1.50 | | | |
| | | 396,690 | 9.16 | $1.337 | $0.894 | 4,302,600 |
| 1935 | 800 | 112,510 | 3.02 | | | |
| | 810 | 150,030 | 4.02 | | | |
| | 820 | 18,750 | .50 | | | |
| | 1000 | 149,170 | 4.00 | | | |
| | 1010 | 17,550 | .47 | | | |
| | Devel. | 4,190 | .11 | | | |
| | | 452,200 | 12.12 | $2.893 | $1.397 | 3,729,660 |

(Note:- Assay values for 1935 based on a gold value of $35.00 per ounce; others at $20.67 per ounce.)

## COSTS AND MISCELLANEOUS DATA

| | Average per Station |
|---|---|
| Total labor costs | $ 737.53 |
| Total Explosives cost | 546.81 |
| Total station cost | $1284.37 |
| Average tons broken | 8,490 |
| Cost per ton | $ 0.15 |
| Pounds of powder per ton | .36 |
| Tons broken per machine drill shift | 183 |
| Average number machine drill shifts | 46.4 |

Cutting-out Station

| | |
|---|---|
| Total labor cost | $ 408.92 |
| Total explosives cost | 140.36 |
| Total station cost | $ 544.34 |

| Drilling long-holes | Average per station |
|---|---|
| Labor cost | $ 361.61 |
| Average number machine drill shifts | 27 |
| Number of holes | 112 |
| Number of feet of holes | 2,009 |
| Pounds of powder | 2,070 |
| Footage drilled per machine-drill shift | 75.8 |

| Bits | Average per Station |
|---|---|
| Footage drilled per bit, new bit ....... | 3.75 |
| Footage drilled per bit, reground ...... | 3.00 |
| Cost to re-grind one bit (direct labor). | $0.1408 |
| No. bits used per month, new ........... | 306 |
| No. bits used per month, reground ...... | 413 |

View Showing About 2/3 of
"Glory Hole"

Closer View of Part
of "Glory Hole"

TWO VIEWS OF THE "GLORY HOLE"
OF THE SOUTH ORE BODY