1936

Drilling for placer deposits of gold and platinum in the jungles of Colombia

Theodore Owen Seiberling

DRILLING FOR PLACER DEPOSITS OF GOLD AND PLATINUM IN THE JUNGLES OF COLOMBIA

BY

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A

THESIS

submitted to the faculty of the

SCHOOL OF MINES AND METALLURGY OF THE UNIVERSITY OF MISSOURI

in partial fulfillment of the work required for the

Degree of

ENGINEER OF MINES

Rolla, Mo.

1936.

Approved by C. R. Forbes

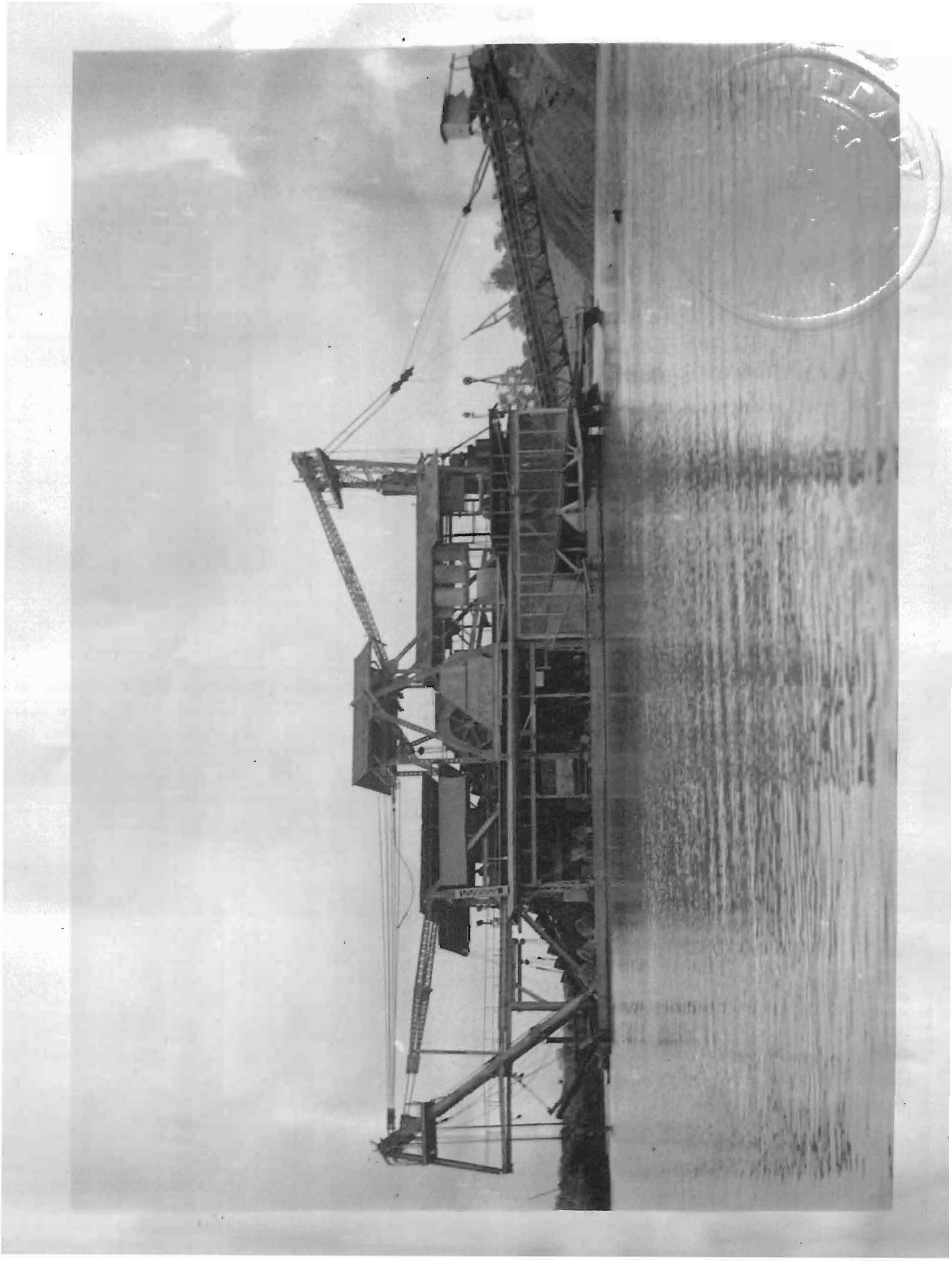
Professor of Mining.

F O R E W O R D

In the following report I have made no attempt to "white-wash" or to exaggerate conditions as I found them in the Choco. In plain language I have endeavored to give the reader a picture of the obstacles met, and overcome by the engineer in his search for placer deposits of gold and platinum with the prospect drill in the jungle.

Theodore Owen Seiberling

Plate I



THE GOLD DREDGE FOLLOWS THE TRAIL BLAZED BY THE PROSPECT DRILL

CONDOTO-OPOG ODO FLAT, 1936

C O N T E N T S

LIST OF ILLUSTRATIONS

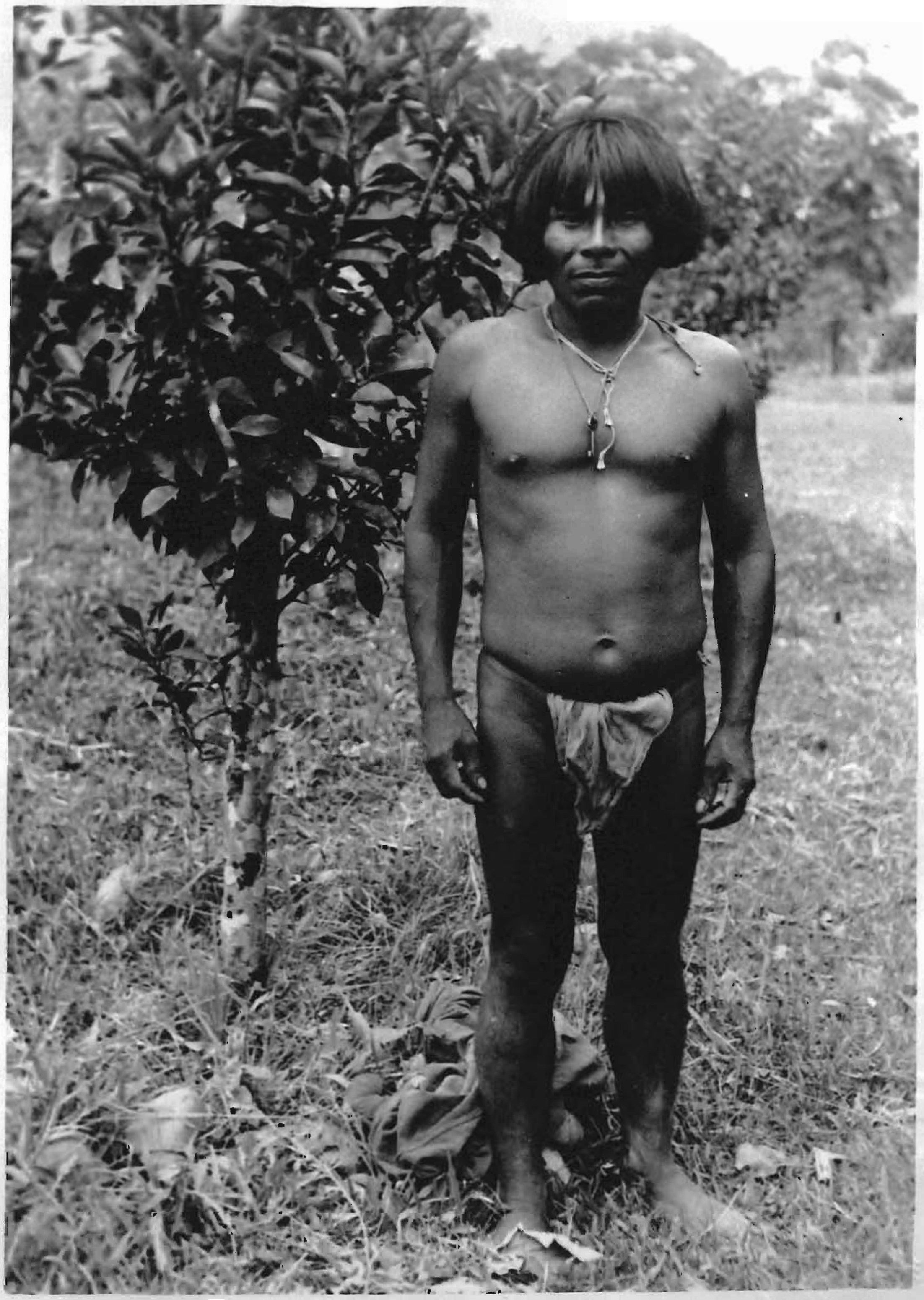


Plate II

J.W.L.

THE DASHING "D ON JUAN" OF THE CHOCO JUNGLES

He discarded his blowgun to pose for the photographer, and was rewarded with an empty beer bottle.

INTRODUCTION

In the early 15th century Pizarro led his band of Spaniards against the legions of the Inca in what was known as Peru. He captured the emperor, and forced this great Indian nation to its knees. He braved the thousands of miles of sea and the trackless jungles for just one thing. Not for land, nor women, nor religious purposes, but for gold; and that is what he got, gold..... and blood.

After a few years Pizarro and his followers had skimmed the cream of the Indians' hoards of golden images and ornaments. Then it became necessary to mine their own gold. Other Spaniards came as time rolled along. These were miners, not soldiers like Pizarro and his original band. The thousands of conquered Indians made ideal slaves and kept the golden flood pouring into the coffers of Spain....or some pirates' chest.

More and more Spaniards came and widened the search for gold. A trail from ocean to ocean was discovered in the northern part of the continent. It was an ancient Indian trail which followed a great river from the Atlantic to the continental divide, then less than a half dozen miles over the divide, which was less than 600 feet above sea level, to another river which flowed into the Pacific Ocean.

Along this trail gold was found on both sides of the divide. On the Atlantic Side gold was found in veins and free in the river bed. On the Pacific Side gold was found only in the stream beds and gravel banks as placer deposits. However, it is well to note that the gold on the Pacific Side was difficult to recover due to a very heavy grey mineral. It was impossible to separate the two minerals by panning alone, and this was a great handicap. This grey mineral was first discovered in a small stream known to the Indians as Platinero, and so the Spaniards called this mineral "platina", and sent a large sample to the King of Spain. No one could identify it, so the king pronounced it "young gold", and sending it back to be planted so that it would grow and turn to real gold, proved that he backed his convictions.

After this, the platina or platinum was separated from the gold and was planted in one of a few specified places, so that later after enough time had elapsed, it could be dug up as gold.

The years rolled along, and the Spaniards and their descendants with the aid of thousands of slaves kept the golden flood pouring into Spain. It was found that natives of Africa made much better slaves than the native Indians, so thousands of negro slaves were imported to replace the more spirited and war-like Indian. These

Plate III

"BANANA BULL" OF THE CHOCO

The aboriginal Indian of the jungle has not made much progress in the las t 1000 years.

negro slaves were at best very poor specimens of humanity, even compared to the jungle Indians in the lower portions of the continent. It is well to remember that the Incas had a fairly high civilization while the jungle Indians were a different race all together, and had nothing save a thatched hut, a dug-out canoe, a few hollow gourds, blow guns, bow and arrows, a few women, and numerous children.

The power of Spain waned with the passing of time until she no longer could control her colonies in the New World. The Spanish blood mingled with the Indian and negro, resulting in a race of men not complimentry to any of the three original races. In the highlands lived the pure-blooded descendants of the Spaniards and a few high class Indian tribes. In the low, dense jungle and along the coasts lived the black and jungle Indian or aborigany. Between these extremes lived the mixed bloods, a combination of all the bad qualities of the three original races.

Then came the so-called liberation and various countries were formed. Among these was the United States of Columbia, a huge expanse of territory, part of which today consists of the Republic of Panama and the Republic of Columbia.

The Northwestern State or territory of the Republic of Columbia is the Choco. It is bound on the west by the Pacific Ocean, on the north by Panama, on the east and south by other Columbian states. The entire Choco is one great, dense jungle, streaked by muddy rivers and spotted by steamy swamps. The excessive rain fall, the low altitude, the nearness of the equator, the dense vegetation, and absence of roads, make it one of the most desolate, unhealthy sections of the earth. Through the Choco winds the trail from ocean to ocean. To examine this trail as a possible inter-oceanic canal route, came John C. Trautwine and his party in about the year 1850. In the year 1852, Mr. Trautwine's report was published, and from this report are given the following abstracts dealing with general conditions in the Choco as they existed at that time.

"ABSTRACTS FROM THE

PUBLISHED REPORT (Published 1852) OF THE EXPLORATION FOR AN INTER-OCEANIC CANAL ROUTE BY THE WAY OF THE RIVERS, ATRATO, SAN JUAN, AND SAN PABLO, IN THE UNITED STATES OF COLOMBIA BY THE EMINENT JOHN C. TRAUTWINE, CIVIL ENGINEER.

Speaking of the semi-civilized negroes and Indians, of these, the former generally pay for their purchases in gold dust, and the latter in the produce of their little "rosas", or patches of cultivated ground. The Indians here are strongly adverse to searching for gold, probably a consequence of their traditional sense of the horrid barbarities which its possession entailed upon their ancestors at the time of the Spanish conquests. They conceal all knowledge of rich localities, and even take the trouble to obliterate evidences of their existance, when it is in their power to do so. The blacks, not being burdened with such disagreeable reminiscences have no scruples in hunting gold; indeed, it constitutes the principal active occupation of the greater portion of them; many are refugees from justice from every part of the Republic, who find a secure retreat from pursuit in the fastnesses of the forest-covered mountains in the defiles of which their searches are conducted.

It is needless to remark that their operations are carried on without the aid of science or system. Each one hunts for himself, and a calabash or wooded bowl comprises the inventory of his machinery. Aiming at nothing more than barely to supply the absolute necessaries of his vagabond existance, (which exact but few more appliances than those possessed by the beasts of the forests), it may be imagined that his exertions are light, and their result correspondingly insignificant. Still, Dr. Key informed me that in consequence of the numbers employed in this avocation, the gold dust annually brought into Quibdo, amounted in value to about $200,000. It is carried to the stores in very small quanities, frequently tied up in a leaf by the tendril of a vine.

The store-keepers are careful to apprize the gold hunters of its real value, as estimated in coin. By this means strangers are prevented from making great bargains in the precious commodity, as they would have to pay for it, very nearly its actual value; whereas, the store-keepers themselves, obtain it in barter for their goods, upon which they fix prices "ad libitum".

From the immense extent of country in which gold here exists in large quantities, in combination with the inducements offered to immigrants by the Government of New Granada, I cannot doubt that when the lapse of a few years shall have served more fully to extend the knowledge of these facts, and excitement and influx of foreignèrs to the slopes of the Western Cordilleras will take place, exceeding even those attendant on the discoveries in California and Australia.

Here, not only gold, but platinum abounds; and in sections of the Republic more to the eastward, mines of silver and copper have for a long time been profitably worked. Most of the platimum is, at present, derived from the vicinities of San Bablo, Novita, andLloro. Near Bogota, (the seat of the Government of the Republic) are the celebrated emerald mines of Mussa, and no doubt can exist that when the country shall have been subjected to a proper geological examination mineral treasures will be found as richly disseminated as in any known part of the earth.

Gold has, I believe, been nowhere found to the west of this transition ridge of partition; but to the east of it, from below the latitude of San Pablo, it is everywhere, occurs in the diluvial gravel up to the very foot of the ridge. Near the head of the Surucco I saw negroes washing rich gold gravel at an elevation of some 30 feet above the level of the stream. These I conceive to be incontestable proofs that the goldbearing diluvium has been spread over this region at a period subsequent to that of the elevation of this ridge. If so, it is inferable that the Western Cordilleras, themselves, have undergone, at least, a partial upheave since the elevation of the partition ridge, as otherwise it would be difficult to suggest a tenable theory for the dispersion of diluvium.

We stopped for a short time at the hut at which our men had, on the preceding day, obtained the boat we were now using; on my remarking to the colored master of the house, that the appearance of the soil indicated the presence of gold, he told me that the women of his family were at that moment washing for it in the immediate vicinity, and on my expressing a desire to see the operation he somewhat reluctantly offered to accompany me to the spot. This we found to be a deep deposit of gold-gravel and whitesh clay, at least 25 feet thick, that being the height to which we ascended it above the level of the stream.

As our party emerged from the bushes on one side of the field of action we caught a glimpse of the loose ends of some half a dozen diapers "streaming like meteors to the trouble air", as the sable damsels who wore them, startled by our approach, suddenly dashed into cover on the opposite side.

The old man, however, after much persuasion and assurance from our patron, that we (the Doctor and myself) intended him no harm, took up one of the wooden bowls, and filling it with gravel, washed it hastily and presented the results for our inspection. In doing so, he trembled to such a degree that I thought he would let the bowl drop. He evidently mistook us for government spies, or some other obnoxious officials; and to my questions as to how much a person could collect in a day, he replied in a deprecating tone, not more than one or two dollars.

Preparatory to setting off, I ascended the San Pablo for a few hundred yards from the Tambo, to bathe. While enjoying this luxory, I was startled for an instant by the apparition of a venerable, grave-looking, white haired negro woman, who came wading slowly down the creek, holding a small totuma, or calabash bowl, carefully in her hands. In the surprise of the moment, I might have mistaken her for a respectable old baboon, taking a morning stroll, with a cocoa nut in its paws, had it not instantly occurred to me that the animal, with all of its sagacity, had not yet adapted the practice of wearing diapers, or smoking segars."

Today in the Choco we find conditions practically the same as in the days of Trautwine. Even if the emissaries of Pizarro were able to travel the ancient trail again from ocean to ocean after a lapse of four centuries, the only unfamiliar things that they would see would be the modern equipment of a large dredging company and the greater amount of cast-off clothing worn by the natives.

Plate IV

"FARMER BROWN AND FAMILY GOING PLACES"

The "push" canoe is th e onl y mode of travel in the Choco

Today, the greater majority of the negroes wear portions of shirts and trousers -- some even wear shoes at important social events like funerals and baileys. Even the Indian has advanced to the point of wearing a shirt to town if he is fortunate enough to own such a garment. His woman or women also usually wear a portion of cloth around the breast as well as the hips when in town or a village. His children are not handicapped by such conventions.

As in the days of Trautwine, the negroes' chief occupation is sitting in the doorway (if he has a doorway) of his thatched hut, scratching, and watching the river run, while his women and brood of children pan gold and platinum. When they have enough to buy rice, platinos and cigars for the next day, they too retire to the shade and sit, scratch and look. Perhaps, once in a while they might even think of something to say to each other.

It might be of interest to note that each individual still hunts for himself without the aid of science or system. A good example of this non-cooperative spirit is illustrated by a robbery of a dredge. After capturing the practically unarmed winchman (an axe is of little value when pitted against sixteen machetes) and totally unarmed oiler, a gang of sixteen natives proceeded to pry open a

Plate V

PANNING FOR GOLD....AND THEIR MASTER'S CIGARS

Native miners on the RIO SAN JUAN below Andagoya, 1936 sluice room, short-circuit the guard wires, and rob the rich beam sluices. Each native made a dash for the richest area, attempted to elbow his neighbors out of the way, and get all of the amalgam possible. "Each man for himself and to hell with the hindmost" seems to be the only system that they follow.

Mr. Trautwine forecasted a great future for the country in the way of gold rushes. Even he underestimated the mineral resources of Colombia, but his gold rushes have failed to come to pass. It seems that the so-called inducements offered by the Government have been replaced by restrictions meant either to keep foreign capital out of the country, or else to feather the nest of numerous black and tan politicians.

And so today we find a country over-run by ignorant, greedy, unscrupulous, grasping, mixed-blooded politicians; a great country very rich in mineral resources, timber, fertile lands, thundering rivers, and existing in the age of Columbus; a country of swamps, mountains, jungle, rivers, bounded on two sides by great oceans, and populated by beasts and men, but little farther advanced. To this country comes the engineer and prospector of today. Like Pizarro and the conquistadors of old, he comes not for religion or women, but for gold. He is equipped with dredges and monitors, rather than galleons and cannon. His broad sword has been replaced by the machete, his daggerby the hypodermic needle, and his pike by the prospect drill.

DEVELOPMENT OF THE WARD TYPE HAND DRILL

About 1915 an English Company started dredging operations on the Pacific Side of the continental divide in the Choco. It was chiefly interested in the platinum deposits in the vicinity of the Condoto and Opogodo Rivers. Its dredges were very small and inefficient, but its gravel reserves fairly rich. There was no particular need of extensive prospecting, for then platinum was worth well over one hundred dollars per ounce. Nearly all gravel was "pay dirt".

A few years later an American Company entered upon the scene. Soon they became interested in the same deposits, and as a bitter fight was being waged at the scene of the operations, the London and New York offices reached a financial agreement. This settled everything except the native sentiment which was very strong against the Americans. It still exists today, and is the greatest obstacle to be overcome.

Among the American engineers was a man named Ward. His chief assignment was prospecting, for the rich platinum deposits were soon to be exhausted. He, as well as the other engineers, encountered great difficulties with the drilling equipment. Test pits were out of the question due to the swampy nature of the ground. For this same reason it was very difficult to transport and operate either the core or churn type of prospect drills which were on the market at that time. It was necessary to have a drill which could be quickly dismantled into one man loads, for it is impossible for a mule to travel in the jungle, let alone a caterpillar tractor. Then the fuel problem was difficult. The wood had to be dried for months before it would burn properly. Then there was no coal or oil to be had, but there was an abundance of man power. Therefore, a portable hand drill seemed to offer the only solution. Six inch casing was found to be too heavy for his purpose, and so he designed a portable hand drill using four inch casing which answered nearly every requirement. It could be carried knocked down in a large canoe by river. On land the crew could carry the parts without too much difficulty. It could be assmbled and put in operation in less than fifteen minutes. It was also possible to mount this drill on a large platform built on two large canoes for river drilling.

The casing, drill stems, driving cap, cutting shoe, casing coupling, chisel bits, bolts and nuts, and many other parts could be purchased as standard equipment from any large engineering firm such as Oil Well Supply Company, New York Engineering Company, etc.

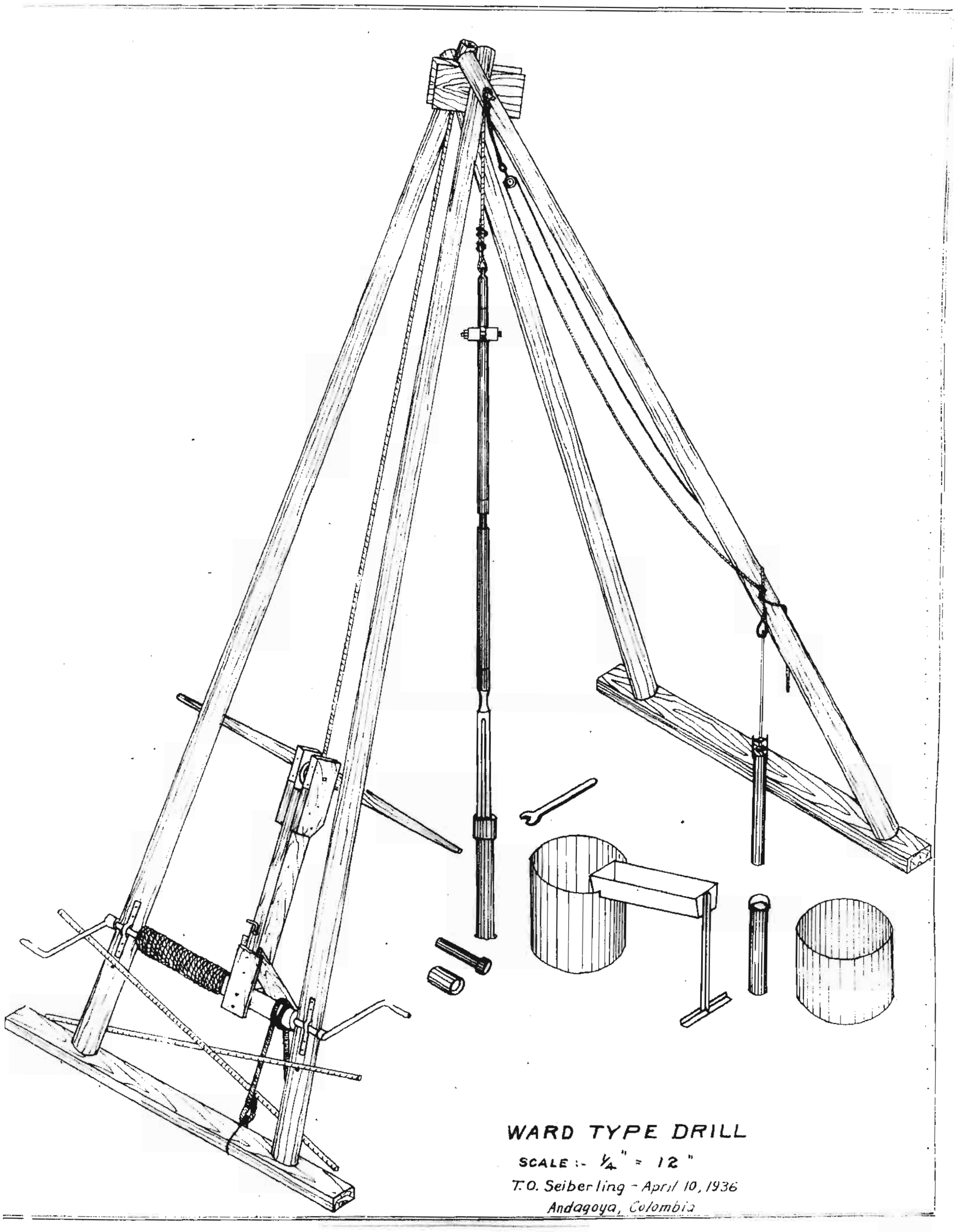


Plate VI

TOL

THE PROSPECT DRILL BLAZES THE PATHWAY FOR THE GOLD DREDGE

Repairs could be made in the Company machine shop such as rethreading casing and drill stems, sharpening bits, etc. Other parts like winches, winch handles, iron straps, and even the pulling head and hammer could be made directly in the machine shop.

For drills located a considerable distance from the machine shop, the driller was furnished with a small portable forge and equipment to sharpen his own bits and make minor repairs. Also, the driller could cut his own rig poles, cross arm for walking beam, and rig bases in the jungle.

After more than ten years of active service in the field there have been but few important changes in the construction of the original drill. The Ward Type Drill of today (See Plate No. VI) consists of a derrick on which is mounted the main sheave and winch. The derrick consists of four wooden poles about six inches diameter at the base and twenty-five feet in length. The lower end of each pole is notched and set in a slot in the rig base. Eight inches from the upper end of each pole, a hole is bored to admit the main sheave axle. In ordinary drilling this main sheave axle is a bar of cold rolled steel one and one half inches in diameter. However, in firmly cemented gravels, or where there are numerous small boulders where the driving is very hard, it is necessary to use a two inch axle. On this axle is mounted the main sheave. It is ten inches in diameter, groved for a 5/8 inch wire rope, and is fitted with a bronze bushing. Also, on this main sheave axle, but on the outer end is hung the pump rope pulley for ½ inch sand line pump rope.

The rig bases consist of the winch base and the front base. The bases are generally cut in the jungle when needed. The principal difference between the two bases is that the slots for the notched end of the rig poles are five feet one inch between centers for the winch base, and seven feet for the front base.

The winch is attached between the winch poles by means of iron straps bolted to the poles. The center line of the winch is three feet, two inches above the surface of the winch base.

The winch consists of a drum, the shaft, and two handles. The drum is five inches in diameter and four feet in length. It will hold one hundred (100) feet of 5/8 inch wire rope. The winch is prevented from turning when there is tension on the wire rope by placing a pole under the handle as shown in the assembly drawing. (Plate No. VI)

The walking beam consists of the body, a tail piece and two legs bolted to the lower end of the body to form a V-shaped saddle, a triangular wear block to fit in this saddle, and two cheek pieces bolted on the upper end of the body. The inner surface of these cheek pieces is protected by iron wear plates. Between these cheek pieces is a six inch pulley with bronze bushing, on a $\frac{3}{4}$ inch machine bolt as an axle. On the under side of each cheek piece is bolted an iron strap. The walking beam cross arm is fastened to the beam by means of these iron straps. All parts of the walking beam and cross arm, save the metal parts, are composed of a durable wood. They are made in the company carpenter shop. However, the cross arm often is cut and shaped in the jungle.

The sand pump consists of a four foot piece of cold drawn tubing three and one-fourths inches ($3\frac{1}{4}$") outside diameter with a flap valve at the lower end. Inside this tubing or pump cylinder is a plunger with a tight filling disc of leather or rubber. The plunger slides through a swivel top which is bolted to the pump cylinder. The upper end of the plunger has an eye to which is attached the sand line pump rope.

The drill tools consist of a rope socket, two drill stems, a pair of driving blocks, and a drill bit. The rope socket and drill stems are made from two and seven-eighths inches (2 7/8") diameter cold rolled steel shafting. The driving blocks are forged in a blacksmith shop, while the bit is purchased from The Oil Well Supply Company. The driving cap, pulling head, and pulling hammer are made from nickel steel shafting in the machine shop. The casing, couplings, and casing shoes are ordered from the States.

The panner's equipment consists of two tubs, a trough, a measuring tube, a measuring rod, three bateas or wooden pans, a sample can, a sharp knife, and the log book.

The fishing tools consist of a casing break detector, wedging chisel, and bull-dog casing spear. However, it is common practice to use a cane with a nail in one end to locate broken casing. In the case of lost tools, a chisel is dropped and wedged firmly against the lost string. Then the entire casing is pulled, and the too ls recovered.

PARTS LIST

WARD TYPE HAND DRILL

PARTS NAME	NUMBER REQ'D	SIZE or MATERIAL	ORIGIN
DERRICK			
rig poles	4	wood	cut in field
rig bases	2	wood	cut in field
cross arm	1	wood	cut ni field
CASING			
casing lengths	12	C. D. St. Tubing	N. Y. order
couplings	11	do.	N. Y. order
casing sh oe	1	wrought St.	N. Y. order
DRILL TOOLS			
drill stems	3	C. R. 2 7/8" Dia.	Mach. shop
drill bits	1	wrought steel	N. Y. order
rope socket	1	old stem	Mach. shop
WALKING BEAM			
beam frame	1	wood	Carp. Shop
6" pulley	1	steel	Mach. Shop
cross arm clamp	2	iron	Blacksmith
cheek wear plates	2	iron	blacksmith
leg wear plates	2	iron	blacksmith
cable clamp	1	irom	blacksmith
crank nut	1	iron	blacksmith
washer for clamp	2	iron	blacksmith
PULLING TOOLS			
pulling head	1	nickel steel	Mach. shop
pulling hammer	1	nickel steel	Mach. shop
DRIVING TOOLS			
driving head	1	nickel steel	Mach. shop
driving blocks	1 pr.	iron	blacksmith
block b olts	2	iron	blacksmith
nuts	2	iron	N. Y. order
wrench	1	iron	blacksmith
WINCH			
winch complete	1	steel	Mach. shop
winch handles	2	iron	blacksmith
winch brackets	2 sets	iron	blacksmith
cable	100 ft.	wire rope(5/8")	N. Y. order
brake rope	11 ft.	1½" manila	N. Y. order
cotter keys	2	¼ x 2 inches	N. Y. order
MAIN SHEAVE			
10" pull ey	1	steel (for 5/8" wire rope)	N. Y. order
axle	1	1½" C. R. steel	Mach. Shop
cotter keys	2	3/8 x 3 inches.	N. Y. order
sheave boards	2	wood	Carp. Shop

P A R T S L I S T (continued)

PARTS NAME	NUMBER REQ'D	MATERIAL SIZE or	ORIGIN
PUMPING EQUIPMENT			
pump complete	1	steel	Mach. shpp
valve leather	1 sq.ft.	American leather	N. Y. order
coppe r rivets	12	3/16 x 5/8 in.	N. Y. order
pump rope	100 ft.	½" sand line	N. Y. order
pump trough	1	Galv.iron	Mach. shop
measuring tube	1	steel	Mach. shop
measuring rod	1	Galv. plate	Mach. shop
PANNER'S EQUIPMENT			
panners tubs	2	Galv. iron	blacksmith
bateas	3	wood	native made
sample can	2	tin can	cook house
FISHING TOOLS			
casing break detector		steel	Mach. shop
bull -dog spear	1	steel	N. Y. order
wedge	1	steel	Mach. shop
MISC. TOOLS			
chain t ongs	2	#33 & # 34	N. Y. order
monkey wrench	2	8" & 10"	N. Y. order
cold chisel	2	8 "	Mach. shop
ball pein hammer	1	2 lb. Wt.	N.Y. order
sledge hammer	1	10 lb. Wt.	N.Y. order
carpenter outfit	1	saw, hammer, etc.	N. Y. order
assorted nails	10 lbs .	assorted	N. Y. order

This PARTS LIST comprises the complete equipment for one dri ll. It includes no spare parts.

Plate VII

THE NATIVE MINER IN ACTION

RIO SAN JUAN, 1936

PRE-DRILLING PROCEDURE

The chief purpose of this introduction was to give a general idea of the jungle of the Choco, and conditions existing in this jungle which are rarely encountered elsewhere. Placer deposits of gold and in certain sections platimum are found all the way from the beds of the present drainage system to the top of the continental divide. On the summit of the divide itself, the writer has seen native mines in the ancient gravel beds and clay banks. However, up to the present (with one exception) only ground which could be dredged without too much difficulty has been drilled extensively. In one locality a rich channel was discovered on the divide itself. Several hundred holes were drilled in an attempt to valuate this channel which extended several thousand feet through the jungle. Its greatest width was thirty feet and it hardly averaged fifteen feet in most places. It might be well to realize that a prospect drill has limitations, and that no matter how nice a map looks in an office after the engineer draws in the theoretical location, and ancient stream channel does not necessarily run in a straight line, or follow the present drainage system. Of the hundreds of holes drilled less than fifty actually encounter the channel. For the cost of five of these wasted holes, an instrument could have been purchased which even under the worst possible conditions would have given some indication of the location of this channel. Just because it had never been used for this purpose before by the company, is hardly sufficient reason why an Askania Magnetometer should not have been given a trial. Science and invention have progressed somewhat in the last twenty years. However, the writer is endeavoring, not to sell Askania Magnetometers, but to point out the fallacy in that old proverb, "If it was good enough for Grandpa, it is good enough for me". It is well to be conservative in drilling, dredging and mining in general, but there is a limit. When "being conservative" passes that limit, it becomes rank folly.

Drilling for physically as well as economically dredgeable deposits limits the scope of activity to the beds of fair sized streams and to flats whose bed rock elevation is only a few feet above normal river level.

The limits of dredgeability of a river are determined by the prospect drill. Due to the fact that the coarser gold settles out first, the upstream limit of dredgeability is usually the physical limit. That point in a stream bed beyond which a dredge can not operate due to natural features such as high bed rock, large boulders, narrow bed rock canyon, etc., is known as the physical limit of dredgeability. The point in a stream bed below which a dredge can not operate at a profit due to the fine grains and settling out properties of the gold is known as the economical limit of dredgeability.

Before a drilling program can be properly carried out, it is necessary to have a fairly accurate topographical map of the district to be prospected. In the past it had been customary to make a magnetic survey of the river and principal streams emptying into it. First the engineer located stations with a transit using magnetic bearing and stadia distances for control. Then using these stations as control points, he proceeded to plane table the river banks at a two hundred feet-one inch scale and a contour interval five feet. Since the jungle in most places over hangs the river edge, the finished map consisted of the river bed and branches, exposed bed rock, the location of the river banks, contour crossings, and the engineer's estimate or guess of the height of the bank and distance inland to the hill line. In case he was unable to see a hill line he wrote on the map "No hill line visible". If he could see it, he guessed its distance and sketched it in.

Plate VIII

"MY RODMEN "

Peons like these are necessary to cut a path through the jungle for the engineer.

The finished plane table sheets were sent to the engineer's office where the map draftsman proceeded to fit them together and make a base map. The accuracy of this map depended upon several factors such as the integrity of the field engineer, the amount of magnetic interference, the care of the draftsman, and the amount which the celuloid plane table sheet shrunk or expanded.

The engineer in charge then proceeds to lay out his drilling program upon a copy of the map. There are many systems of the layouts, but the one most commonly used is drill lines in pairs in the river bed. The interval between the two lines is generally four hundred feet. The interval between the pairs is generally two thousand feet. The drilling starts with the pair of lines located just below the observed upper limit of physical dredgeability and progresses down river until the lower limit of economical dredgeability has been definitely passed. If this preliminary drilling indicates sufficient yardage which could be dredged at a profit, the regular detail drilling program is then adopted. This consists of definitely locating the upper and lower limits of dredgeability of the river by drill holes. Then the river flats are investigated.

The base maps gives a general idea of the location and extent of the flat. If it is a small flat one line of holes if drilled at one hundred feet intervals at right angles to the general trend of the river and through the center of the flat to the hill line. A large flat will have a line near each end and one through the middle. If this drilling indicates a pay channel or [redacted] area on the individual flat, it is drilled until the extent of this area can be plotted on the map with some degree of accuracy. If the flat is rich and the bed rock well below river level, drill lines at eight hundred foot intervals are considered sufficient. If the flat is definitely low grade no more drilling is done and the flat is marked as too low grade to be dredged.

If the preliminary drilling of a flat indicates "pay gravel", yet the bed rock is uneven, the values unevenly distributed, or the surface of the bed rock is above the limit for normal dredging at river level, it is necessary for much detail drilling.

If the bed rock is uneven or has not been eroded down to a plane surface any high points or ledges must be located. A medium sized dredge should have about eleven feet of water for flotation. It is supposed to dig one foot of bed rock in order to recover gold from the bed rock surface and shallow pits and crevasses in this surface. Digging bed rock, even soft shale, is very detrimental to the digging machinery as well as the percent of full buckets. Therefore, with high bed rock it is necessary to either avoid, dig, or else raise the water level of the dredge pond ten feet above its surface. Any of these three alternatives cost money, and so it is necessary for reliable data before a decision can be made.

If the metal is unevenly distributed it is necessary to outline the barren or low grade areas. Only intensive drilling can do this.

If the elevation of the surface of the bed rock is above the level for dredging at normal river level, it is necessary to determine if an inland pond is feasible, the desired elevation of the pond level, and the dredge entrance and exit. Only extensive drilling has been used to determine this data to the present time. However, it is the opinion of the writer that the science of Geophysics would prove to be of much assistance in this situation. It is very probable that the "Meggar" or some other type of ground resistivity testing machine or even the magnetometer would aid, especially in locating a ledge or channel in the bedrock.

As previously mentioned, in the past it had been customary to rely upon a magnetic survey. The drill lines and the holes themselves were located on the map by this method after they were drilled. In the last few years due to the change in the price of gold, it became necessary to do more drilling. Some of the formerly low grade flats became economically dredgeable. it was then necessary to locate the former drilling in the field. There were no traces of old drill lines due to the amazing rapidity with which the jungle growth covered the clearings.

In the meantime, the co-ordinate system of mapping had been adopted. A base line had been established and from this line doubled angles as well as the needle were read. The stadia rod was still used for distances due to the almost impossible situation of attempting to chain across the wide swift rivers. Permanent iron stakes were located in the field. They were then located on the maps by co-ordinates. A control traverse was run along the important rivers. Stadia distances, doubled angles, magnetic bearing, and rod readings were recorded in the field books. A solar observation was taken every twenty-five stations in order to correct for any errors in reading the angles. These notes were sent in to the office where they were calculated and checked. Any detected error was reported to the field engineer who immediately reran the points in question. The surveyor also located any outstanding points and creek mouths with the transit. Then the total latitude and departure of each iron stake was calaulated, based on corrected distances and calculated bearings adjusted to the solar observations. Each stake was plotted on a new base map. Then the old plane table data was placed over this new data. It was amazing to note how much the rivers had changed their courses. Creek mouths had moved several hundred feet through bed rock banks in less than ten years. It was impossible to locate some of the old drill lines within several hundred feet of their proper locations. It would hardly be proper to say that one river valley in particular looked as though it had undergone several thousand years of active erosion in just a few years. It almost looked as though there had been much guessing and little surveying on the original survey.

With the adoption of this co-ordinate system the engineer in charge of prospecting could lay out his proposed drilling program on a map which could be oriented in the field without any difficulty. From each iron stake at least two others could with the instrument be seen.

Since distances and bearing had been calculated, the field engineer could start at any desired point on the river and always have a base line to start on and one to tie in on for his drill line surveys. These in turn were calculated and plotted on the map. In the end each individual drill hole had a definite location by co-ordination, and could be re-located within a few feet if necessary.

When a new river was to be prospected, the first step for the driller or field engineer was to assemble a crew and equipment. The usual drill party consists of the engineer, his assistant (either a junior engineer, a typical tropical tramp, or a Swede), a cook, two drill crews, and a peon cook. The equipment consists of two complete drill rigs and tools, a few spare parts, a portable forge and equipment, several canoes of various sizes, clothing, food, medical supplies, water barrels, camp equipment and supplies, surveying instruments, machetes, axes, etc.

The driller or field engineer is usually an American engineer who has had considerable jungle and drilling experience. Past experiences indicate that reliable results are to be desired.

The driller's assistant is a white man. He might be a junior engineer sent out with the driller to gain his experience (and spurs), or the last drifter that asked for a job. These drifters are either the "blowed-in the bottle" type of typical tropical tramp, and European refugee, or just a Swede looking for a job. A junior engineer costs the company One Hundred and Fifty Dollars ($150.00) per month as salary and any of the others may be secured for two and one half pesos per day. It is obvious what a great saving can be made in hiring a drifter--if he doesn't run off with the company pay-roll or rob a dredge. In just a few weeks the drifter (if he lasts that long) becomes a regular "engineer". He usually can speak better Spanish than the driller and mixes easily, even readily, with the natives. He can survey with the best of the junior engineers (even if he doesn't know what it is all about) and gets the desired results in every case. A good and true illustration of this is: One day a certain assistant of uncertain antecedents had an accident. His canoe swamped and he lost a drill sample which he had not had time to concentrate. He had the log however and saw how many colors of gold and platinum he was supposed to have.

Knowing that it was necessary to turn in the results as soon as possible, he had a native miner pan the required number of colors from the river gravel and turned them in as the drill sample.

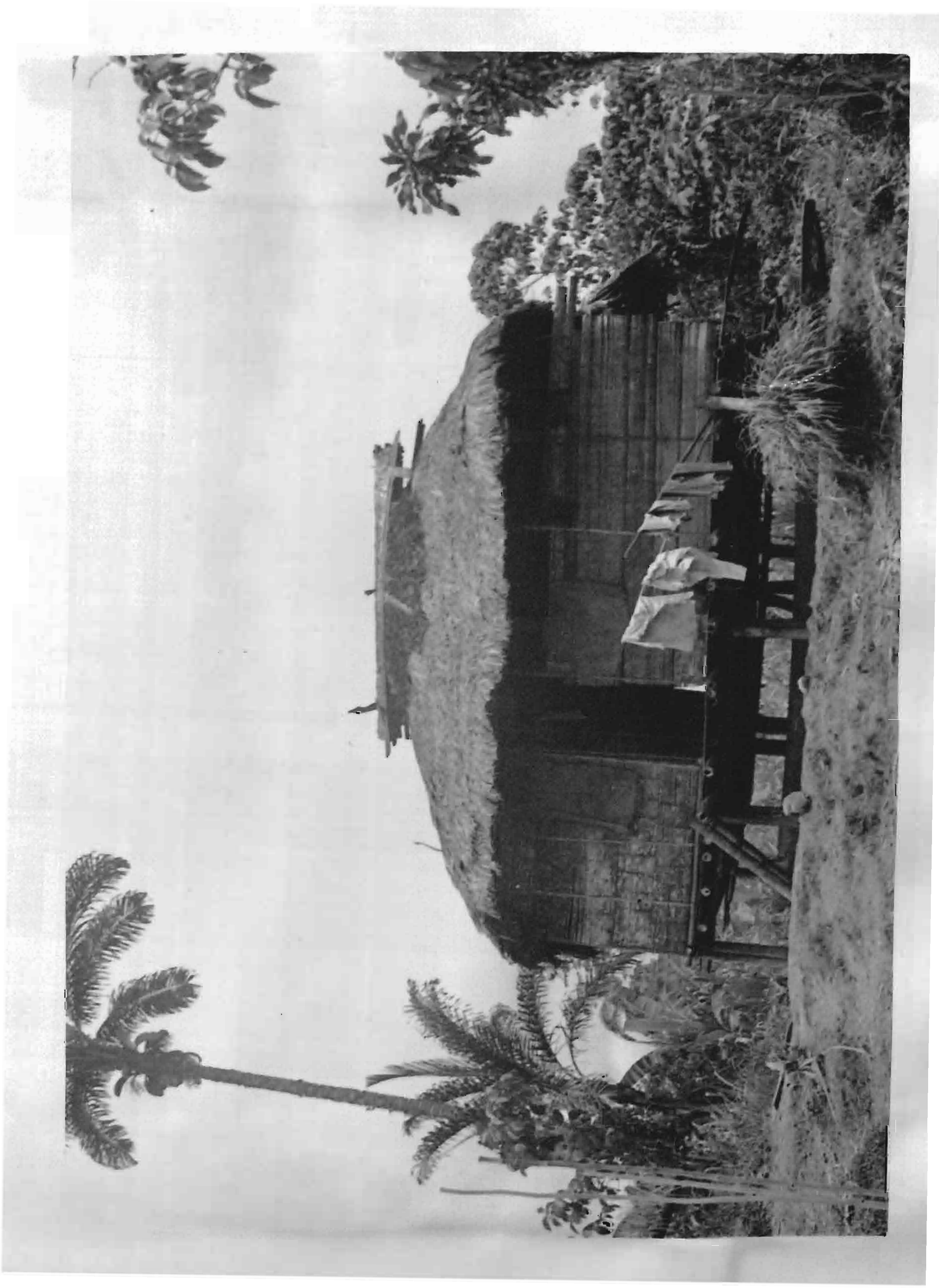
The average drill crew consists of thirteen peons. The head peon is the drill captain, the second in command is the panner. Then there are eight "cacheros" or peons who operate the walking beams, and three survey peons. These survey peons are rodmen, cut trocha or clear the drill line ahead of the drills, act as canoe men and messengers, and assist in building the camp and moving the rig.

The drill captain's duties are to keep discipline, oversee the moving and setting up of the rig, keep the rig in operation, pump the cutting from the hole and regulate the drill cycle.

The panner's duties are to keep the drill log, pan the cuttings down to a certain stage of concentration, and call the driller's attention to any unusual occurence.

Upon arriving at the area to be prospected, the driller selects a camp site in a suitable locality and proceeds to build the prospecting camp. While building this camp, he and his crew must live in local native huts

Plate IX



TYPICAL NATIVE HUT

Living here the driller must be on his guard against chinches as well a s chicken-roosts.

with the owner and all of his family. This in itself is quite an experience, especially if there are any tigers in that vicinity. Besides the owner, his woman or his women, his or anyhow the women's children, and his sons' women and children, the rest of his household consists of perhaps half a dozen scrawny chickens, a couple of ducks, a few mangy mongrels and perhaps even a goat or two. These, of course, sleep in the hut so that the tigers will not get them. Under the hut live the few pigs that he may be fortunate enough to own.

The driller and his assistant have folding cots covered with mosquito netting. At night it is necessary to flood the particular area where the cots are to rest with disinfectant in order to discourage the chinche bugs, also he must keep a weather eye peeled on the chicken roost. It is rather embarrassing to discover upon awakening that the chickens are roosting over one's cot. The natives have one good quality anyhow. They are very hospitable, and though they do not invite one to spend the night in their house, they never object to his just moving in if the person will give them a few coins or can of something to eat. If the engineer has a strong constitution, a poor sense of smell, and a broad outlook on life in general, he is assured of a peaceful night's sleep - - - if the dogs do not fight under his cot or the chickens move their roosting place. There is one danger that should not be overlooked. If the chinche bugs bite a white man, he is very apt to have a serious case of relapsing fever in a short time. The bugs carry the germ of the fever. In Colombia, especially the Choco, they have Santa Maria, Santa Terecia, and in fact all of the Santas save "sanitation".

DRILLING PRACTICES

After the engineer's camp has been constructed of poles with a palm leaf roof and thatched walls, the driller is ready to proceed with his drilling program.

Usually the first step is to drill the river. On the map given to him along with his orders is the location of each drill line. The driller mounts his rigs on especially prepared barges or balsas made of two large canoes. Aplatform is constructed for the "cacheros" or walking beam operators. The rigs are then pulled and poled up the river to the first line.

The driller or his assistant locates a stake at each end of the line on the river bank. These stakes are tied-in to the regular river traverse. The transit is set-up over one stake and a back sight taken on the far stake. It is customary to locate a drill hole about twenty-five feet from each bank. Then holes are spaced on line between these holes at as near seventy-five foot intervals as possible. The number of holes depends upon the width of the river, but in all cases the interval between holes in the individual line is to be equal.

The drill barge has winches and cable fastened to the bank as well as an anchor to hold it in position. A long steel bar is used also if the water is not too deep.

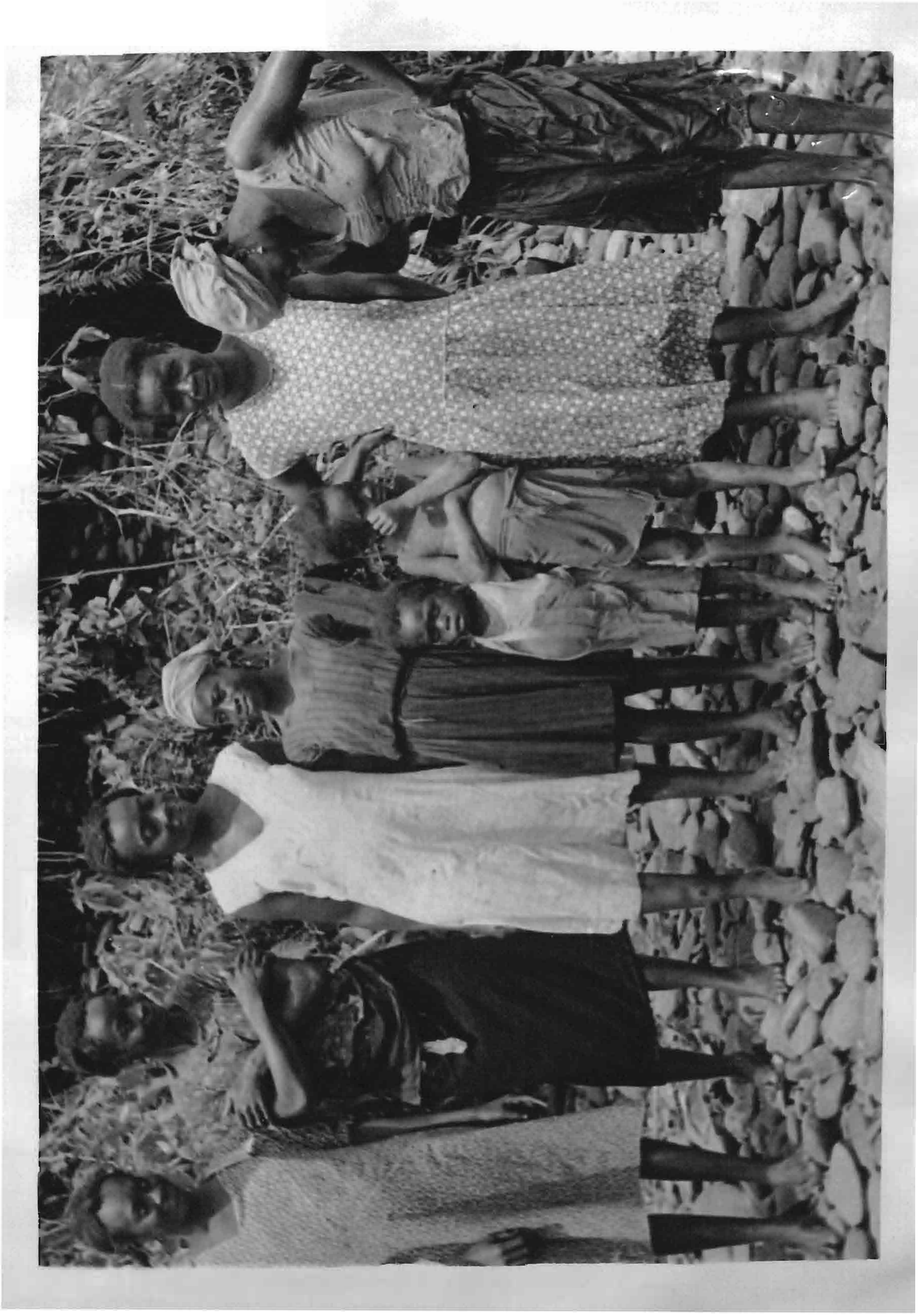
It is maneuvered into the correct position by means of the winches and bar. The position or location of the hole is found by holding a stadia rod on the barge where the casing will go. The engineer at the transit directs the movement of the barge until the rod is in the correct location. Then the barge is firmly anchored in position and the hole is ready to be drilled.

In land drilling, the rig is transported in canoes to the location of the drill line. The engineer locates a stake on the river bank where the line intersects the river by means of the transit. Then the transit is set-up over this stake and the engineer sets the instrument on the bearing of the drill line as given on the map. The survey peons proceed to cut a path or "tracha" about six feet wide along this bearing line. The engineer selects the location for the first hole on this line. It is usually about thirty-five feet from the water's edge, unless there is a very good reason why it should be more inland such as bed rock exposed at the surface. Once this first hole is located, stakes are driven at one hundred foot intervals along the line until the hill line is reached or the engineer has orders not to go any farther.

River drilling offers many problems, chief of which are drifting logs and floods. A ten foot rise in less than an hour's time is not uncommon. As soon as the river starts rising the barge must be moved to the shore in a protected spot. When the river goes down to normal stage, it is quite possible that the casing has been bent or broken off by logs. It must be re-drilled.

Land drilling offers an entirely different type of problem. The heat, rain, solitude, rotten food, fever, mosquitoes and sand flies, snakes, ants, mud, and the like are bad enough, but it is the native that offers the real problem. On land we have the case of the legal owner in Bogota or some large city. He is a high class Colombian and will gladly give drilling permits ...for a price. Then we have a few middle class men to whom the owner has leased or sold the land. Each will gladly give drilling permits ...for a price. Then we have the "fly-in-the-soup" or the bush nigger squatting on the land. He is a very low type of humanity at best and acts accordingly. He has his little hut built on the river bank where he can sit while his women and children pan gold and platinum for his rice and cigar money. He is very content, all of his desires and necessities are satisfied. Since his

Plate X



NATIVE MINERS ON THE RIO SAN JUAN, 1936

The Choco is truly the lazy man's paradise, only the women and children mine for gold and platinum.

hut occupies a piece of land it is only natural to assume that the land is his private domain. At first he possibly realizes that the land belongs to some citizen living in a far city, but in a year or so this fades from his mind. In his own mind he becomes sole owner and a lot of papers and legal matter are not necessary.

To this man comes the driller. He gives the man a cigar, remarks what a nice home or house the man owns, and finally asks if he has any objections to a drill line crossing his ground. The owner at once swells visibly with importance and assures the driller that he has no objections at all.

The driller locates the first stake on the bank and turns off the bearing. The peons immediately start clearing out the line while the owner looks on in wonder. Soon the clearing peons come to a banana plant. Instantly, the owner voices an objection and motions them to detour so as not to injure the plant or usually plants. Unfortunately, a drill line is supposed to be a straight line. However, the owner remains firm in his refusals, and so the driller offers him five centavos for the plant. That is a different situation altogether. The owner gladly sells the plant and offers numerous other plants at the same rate. The owner becomes the firm friend of the company, for the time being.

Soon the clearing gang come to another man's territory. This man does not care to have his land drilled and so there is no use to cut out the line any farther. The driller points out that no harm and much benefit will be derived and upon the receipt of an extra cigar, the man gives his consent. The line is cleared on to the beginning of the hills or to where bed rock is exposed at the surface near the hill line.

In the meantime, the drill rig has been erected over the marker for the first hole, or perhaps it has already drilled a hole or two. The first owner begins to realize that he is a very important person. His land must be very rich or the "crazy gringoes" would not spend so much money to drill it. Therefore it is only fair that they pay him a small amount to drill his land. He immediately orders the drillers to stop drilling and get off of his territory. He swears by all of the Saints that the driller is trying to rob and cheat a poor man out of his rightful and just dues. He demands five pesos for each hole drilled.

If the driller has a fair command of the Spanish language, he can argue the owner into a peaceful and contented state, and with the aid of another cigar, make him a friend for life. By this time the drillers have advanced to the second man's property.

This man has had time to do some thinking and arrives at the same conclusion and decision as the first man. He is very firm and even a cigar cannot lure him to the right side of the fence. He must have five pesos for each hole and not a cent less. He does not want his land drilled, and he does not care to discuss it farther.

There is one company rule never broken. A native must not be paid anything for drilling permits. Otherwise no free permit would ever be secured. This applies to the squatter only.

It finally becomes necessary to remind the owner that he is only a squatter and has no rights whatever. This is the finishing touch. The owner orders the driller and crew not to set foot on his land and backs it up with a lot of threats.

Here again, the experience and resources of the driller are called upon. He can either "reason and threat" the owner into a peaceful mood where he will accept another cigar and a "special" price for his banana plants, or he can halt the operation and go for the local Alcalde or official for drilling permits.

The Alcalde is shown the actual owner's permit and is requested to see that the squatter does not molest the drilling procedure any farther. The Alcalde looks and thinks everything over carefully and says, "Mañana".

"Mañana" or "to-morrow", the Alcalde probably is too busy to be bothered, or else he just says, "Mañana", and resumes his interrupted "siesta".

The engineer can overcome most hazards and obstacles, but "Mañana" costs money when you have about thirty men waiting until an Alcalde feels in the mood to write out a paper and sign his name to it. There is no known method of getting efficient service out of an official short of offering him a "gift". For the good of the Companies' future, such "gift" must not be made, less they become a habit.

If one attempts to drill without permission of the Alcalde, it has been found to be rather unhealthy for all concerned. First, the drill crew becomes worried and leaves in a body. Then the rigs are discovered all chopped up and parts missing. A complaint to the Alcalde gets little sympathy. Little satisfaction is to be had "arguing" with the owner (and all of his friends). Nobody knows anything about who did this or that. All that they know is that they do not want the land drilled and at times they make it very plain.

If one waits until the Alcalde gives a permit, then everything is fine. The drilling progresses nicely, except for the cable getting cut, or part of the rigs being carried off at night.

Once this first line is drilled, the remaining lines are fairly "easy drilling". The various owners put up plenty of arguments, but usually succumb in the end. They realize that since the driller can get a permit from the Alcalde, he is not to be stopped. Therefore, it is best to remain on friendly terms in order to reap the benefits of the future and any gifts of the present.

It is to be understood that there are many other obstacles to drilling in the Choco. Mosquitoes, for example are sometimes responsible for a drilling program being abandoned. If both the driller and his assistant get the fever at the same time, the rigs must be shut down until they return from the hospital. A few cases of this, and it becomes necessary to either give up prospecting that particular territory or else wiping out the mosquitoes and fever. This is an almost impossible job unless one adopts measures used in building the Panama Canal. Unfortunately, there are no marines handy to impose sanitation upon the unwilling native.

Firmly cemented gravel and boulders offer plenty of difficulties to the drilling procedure. It is some times necessary to attach an extra set of driving blocks when driving casing through cemented gravels. This, besides being very hard on the drill crew, quickly tears the rig to pieces. The main sheave bends, the casing bends, the driving head tends to flatten out, and the bits must be changed more often.

When a boulder, too tough to break and too large to be driven to one side, is encountered it is usually necessary to move the rig a couple of feet and redrill the hole. Often two or three re-drills are necessary. This soon runs into money, besides slowing up the drilling program. Often a boulder will deflect the casing if at considerable depth. This soon causes the tools to become jammed in the bent portion. The only remedy is to pull the casing to recover the tools, and redrill the hole.

Pulling broken casing, fishing for lost tools, and similar events are very trying in patience, but offer no more difficulties than those in any other country.

DRILLING PROCEDURE

The first step in the operation of drilling a hole is to erect the derrick over the hole marker. To do this, the four rig poles are laid out on the ground in their proper position. The main sheave axle is thrust through the hole in two legs, and the main sheave placed in position. Then the axle is thrust through the hole in the other two legs and cotter keyed in place. The end of the wire rope is passed several feet over the main sheave and the pump rope pulley attached to one end of the axle.

The rig bases are placed in appropriate locations and cribbing placed under them until they are level. Then three peons grasp each leg of the derrick while others assist in raising the end containing the main sheave until it is out of their reach. They then rush to the ends of the poles and fit them in the slots of the rig bases. The derrick is then shifted about until it is in a fairly stable position.

The winch is attached to the legs in its regular position, the handles attached and cotter-keyed in place, and the rope socket clamped in place on the end of the cable which had been passed over the pulley. The drill stems with the driving blocks attached on the upper stem are screwed in place. Then a peon grapps each handle of the winch and hoists the string of tools up until they nearly touch the main sheave. A pole is thrust under the handle of the winch to keep it from turning when released.

The drill captain inspects the rig and directs the shifting and cribbing until it rests firmly and evenly in place. Large stakes are driven into the ground against the rig bases until it cannot shift on the cribbing. The rig then is ready for operation.

The tools are lowered until the end makes an impression on the ground, then they are pulled up once more. A long length of casing with driving head and casing shoe attached is then erected so that the impression in the ground is located in the center of the casing shoe.

Then using the measuring rod, a chalk mark is made and numbered on the casing, starting with the bottom of the casing shoe as zero.

While the drill captain and panner hold the casing as nearly perpendicular as possible, the drill crew grasp the walking beam cross arm. Two peons operate the winch and allow the drill tools to drop until the driving blacks rest on top of the driving head. Then they place a pole under the winch handle and tighten the cable clamp on the walking beam. This latter tends to keep the walking beam in position.

The drill crew or "cacheros" pull down on the walking beam cross arm a few inches and release it. By pulling down on the walking beam, the drill tools are hoisted up an equal distance. Upon being released, the tools fall and transmit their momentum to the driving head by means of the driving blocks. This in turn drives the casing into the ground. The first few strokes are very short so that the Captain and panner will be able to keep the casing exactly perpendicular. It is absolutely necessary that the casing be started in as nearly perpendicular plane as possible, otherwise, after a few feet of casing have been driven, the tools scrape and no longer fall freely within the casing.

In most land drilling, the first five to fifteen feet of the earth's surfact consist of a soil and decaying vegetation. This is barren ground and so the casing is always driven to gravel. As soon as one length is nearly driven another length is coupled onto the first length, the measurements continued in chalk on new casing, and the driving head screwed on top as before. It is to be noted that in a few places gravel is encountered

Plate XI

Negative by P. Haugan

"CHISELING IN THE CHOCO"

The Ward Type Hand Drill in action.

on the surface. In this case the casing is only driven a foot or two depending on the amount of sand in the gravel. The casing must be driven until it will stand by itself. Once the first casing is firmly set in gravel the regular drill cycle is started.

The regular drill cycle consists of driving casing, removing the driving blocks, lowering the tools until the bit touches the surface core, making a chalk mark on the wire rope at the top of the driving shoe, chiseling the core down until within a couple inches of the bottom of the casing shoe, marking the wire rope again at the surfact of the driving shoe, pulling the tools, and pumping out the core.

The distance between the two chalk marks on the wire rope represent the amount of the core to be pumped and is known as "pump". The distance between the original surface of the core and the bottom of the casing shoe is known as the "rise". The actual distance in which the casing was driven is known as "drive". The actual length of pipe below the surface of the ground is known as "pipe" and can easily be determined by measuring from one of the chalk marks on the casing to the surface of the ground.

The drill captain does the pumping. As soon as the tools are hoisted out of the casing after chiseling and measuring, he lowers the sand pump into the casing. Water is poured into the casing in case there is not enough already there. Then with vigorous jerks, the drill captain pulls on the pump rope. The plunger with leather flap is pulled up forming a vacuum in the bottom of the pump. The flap valve on the bottom of the pump flies open and broken material, water, and any metal is sucked into the pump. The valve settles down and the captain pulls the pump out and dumps it into the pump trough. More water and a few more pumpings clean out the broken material in the casing. Another drill cycle is commenced and repeated until bed rock is encountered. In firm gravel the average drive is about one foot. However, it is important to note that when a layer of sand is encountered, the casing should be driven until it encounters a more solid material. For this reason a four foot drive is not uncommon. The sand will not remain firm at the bottom of the hole. In the act of pumping, the sand will continue to run into the casing from the bottom and possibly cause a serious error. A large volume of material possibly bearing gold and platimum has "salted" the core. To avoid this, if possible, the casing should be driven to firm material.

In the mean time the panner has been recording the various data in the drill log. After a core has been pumped and dumped into the pump trough, the panner proceeds to wash it into the measuring tube which has the same inner diameter as the casing. He then measures it by means of the measuring rod. This material represents the solids pumped from the casing. It is well to note that a considerable amount has been lost as slimes overflowing from the tube.

The panner then proceeds to dump the material from the measuring tube into his batea or wooden gold pan. He pans this material, counts and records the colors of each metal as well as the size in the drill log. His log has columns for three sizes of colors. Number 1 represents a small nugget of gold as large ar larger than a pin head. Number 2 represents a granule between the size of a pin head and the size or diameter of a pin shaft. Number three represents the colors which are smaller in diameter than the shaft of a pin. It must be remembered that a panner is a native and has little or not idea of the sizes and weights which are used by panners in the States. Also if these panners got together it is doubtful how many would agree on the division between a small Number 2 and a large Number 3 color. Therefore, an ordinary straight pin is convenient to give a native panner a standard for sizes.

It is customary to drill one foot of bed rock in order to determine if there are any valves distributed through it. If the bed rock contains gold or platinum and is soft, it should be drilled to the lower limit of occurence of the values. It must be remembered that the chief objective of the prospect drill is to obtain as reliable and as complete data as possible of subsurface conditions.

As soon as the driller decides that enough bed rock has been drilled, he orders the captain to pull casing and proceed to the next hole. Meanwhile, the driller inspects the drill log for errors, and keeps an eye on the panner as he repans the tailings from the first panning. Often the driller or his assistant repans these tailings in order to check up on the native panner. While the panner is a more educated and intelligent type of native, it is absolutely necessary to keep a close check on his work. No gold or platimum should be lost if it is a color large enough to be visible.

When the panner has panned and repanned his tailings he gives the sample can containing the concentrate to the driller or his assistant. One of these then proceeds to concentrate this down to the point where the individual colors can be picked up on the point of a sharp knife and deposited in a drop of water on a clean piece of paper. Any visible color of gold or platinum must be included in this concentrated sample.

Then the drop of water is absorbed by a blotter leaving the sample containing all of the colors recovered from the hole and a few specks of sand. It is not practical to clean the sample in the field and so it is sent to the engineering office to be cleaned under a microscope and weighed on a balance. It is well to note that in districts where no platinum occurs, it is common practice to use mercury to recover the gold from the concentrate. Then it can be more easily cleaned in the office.

The drill crew have proceeded to pull the casing and move to the next hole. To pull casing, the bit is removed from the string of tools. Then the pulling hammer is screwed in place. The driving head is replaced on the casing by the pulling head.

The winch and walking beam cross arm are manned and put in motion. This time instead of the "cacheros" jerking the string of tools up and permitting them to fall free, to drive or chisel, the pulling hammer is jerked sharply against the pulling head, thus transmitting the momentum of the rapidly rising string of tools. The casing is pulled and removed piece by piece until all casing and the casing shoe have been recovered. Then the rig poles are lifted from their slots in the bases and the rig lowered to the ground, It is dismantled and moved to the next location ready to be set up and put in operation. The entire operation of taking down the rig, dismantling, transporting a hundred feet to the next hole, setting up, and making ready to drill takes on an average of less than twenty-five minutes.

THE DRILL LOG

In many cases the "bedrock" is only a thick, hard layer of clay. Very commonly this clay contains a considerable portion of the gold and platinum. As a rule this clay is practically impossible to wash or break up in the revolving screen of the modern dredge. The writer has seen numerous native miners working the tailing behind a dredge. They find balls of this clay containing gold and platinum in paying quanities. In their bateas, they are able to knead and finally dissolve this clay, and so recover the values. In this same manner, the drill panner kneads and pulverizes the clay from the drill sample. Since the dredge can recover only a portion of gold and platinum from clay, a considerable deduction should be made in the valuation of a drill hole where a large percent of the metal occurs in clay. However, in the writer's somewhat limited experience in the valuation of dredgeable ground, no attention whatever has been paid to the type of bedrock or the distribution of values as indicated by the drill log.

The drill log is not only a record of the drilling procedure, but also when complete, contains most of the

Rig No. 2

NAME OF COMPANY

ADDRESS OF COMPANY

PROSPECT DRILL LOG

LOCATION Rio San Nicolos, Red Horse Flat

LINE NO. 12 HOLE NO. 3-R DATE April 20, 1936

Depth of Water FT.	Water .10	Pipe FT.	Pipe .10	Drive FT.	Drive .10	Core Data Rise FT.	Rise .10	Pump FT.	Pump .10	Box Meas. .10	No. of Colors Pt. 1	Pt. 2	Pt. 3	Au. 1	Au. 2	Au. 3	Remarks
		4	0	4	0												Barren Soil
		6	2	2	2	1	8	1	8	2.1							Sand and fine gravel
		8	0	1	8	1	6	1	6	1.4							Coarse sand and gravel
		9	0	1	0	1	5	1	5	1.1						..	Little sand, coarse gravel
		11	0	2	0	1	6	1	6	1.3			:			:.:	Coarse sand and gravel
		13	0	2	0	1	1	1	1	1.1			.			..	" " " "
		14	0	1	0	0	7	0	7	0.6							Firm sand and gravel
		17	0	3	0	2	5	2	5	1.8							Sand and gravel
		18	6	1	6	1	9	1	9	1.8							Fine sand and gravel
		21	0	2	4	2	1	2	1	1.6			.			..	sand, gravel, and clay
		22	0	1	0	0	8	0	8	0.9			..		•	.:.	Sand and white clay
						April 21, 1936											
		23	1	1	1	0	9	0	9	0.7			:.:			::	Sandy clay, boulder fragments
		24	0	0	9	1	2	1	4	1.0			..		•	:::	boulder fragments, bedrock (0.6)
		25	0	1	0	0	6	0	6	0.8							Bedrock (1.0)
				10	4			9	4								

Depth: Elev. Collar 541.3′ Co-or. N 32,125 E 17,471

Water None Area Meas. Box

Soil 4.0′ Core Ratio = $\frac{\text{Meas. Volume}}{\text{Calc. Volume}}$ $\frac{1.62 \times 10.4}{9.4}$ =

Gravel 19.4′ Calc. Volume = $\frac{\text{Const.}}{\text{Depth}}$ $\frac{200 \times 1.79}{24.4}$ = 4.[illegible]

Total to B.R. 23.4′ Gr. Pt. in Hole 0.028 Gr. Pt. per Cu. Yd. [illegible]

B.R. Penetrated 1.6′ Gr. Au. in Hole 0.275 Gr. Au. per Cu. Yd. 4.034

Total Depth 25.0′ Elev. B.R. = 517.9 Norm. River Level = 528′

Remarks:- Bedrock is a soft, grey shale similiar to that encountered in the first two holes in this line.

Lost Time :- 3 hours fishing for broken cable.

24.2¢ per Cu. Yd.

PANNER Jake Rounds DRILLER J.K. Lea

Drawn by – [illegible]

Plate XII

The prospect drill log makes a very convenient data sheet for future reference.

data necessary for the calculations used in evaluating the area surrounding the drill hole.

Plate No. XII is an example of a drill log commonly used in the Choco, plus a few revisions by the writer. The drill log is of course recorded in Spanish, for that is the only language understood by the native panner. Each rig has a number for identification.

As previously mentioned the usual drilling organization is composed of two complete rigs and crews. These rigs work together so that the driller can supervise the operations of both rigs without too much difficulty. It is to be understood that a rig while drilling a hole must be under the supervision of either the driller or his assistant at all times. While the native crews are perfectly capable of operating the drill in all stages and conditions of drilling, they absolutely can not be trusted alone to do anything. The driller or his assistant must keep a close check on the panner as he records data in the log for a single error in the log would make a redrill necessary. An erroneous log and a reliable sample are of no more value than a correct log and the sample panned out of the river bed previously mentioned.

The drill log is divided into four main divisions coming under the headings of DEPTH, CORE DATA, COLORS, and REMARKS.

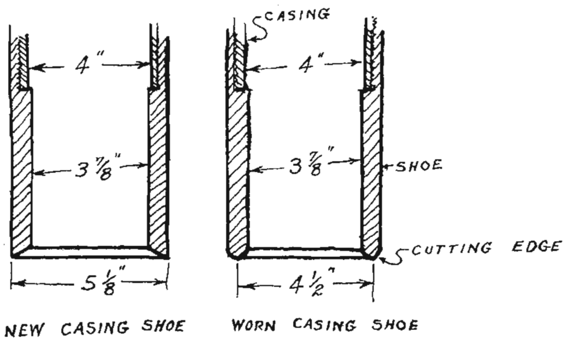
Under DEPTH heading we have three divisions, WATER, PIPE, and DRIVE. The WATER column contains the depth of water above the surface of the ground at the end of each drive. In ordinary land drilling there is no water recorded unless the hole happens to fall in a small stream. However, in river drilling this is a very important column. Here, the elevation of the top of the barge or drill balsa is determined by a transit. Immediately, a measurement is taken from the top of the barge to the bed of the river at the point where the casing shoe will fall. This measurement is recorded in the WATER column for the first drive. The elevation of the barge is also jotted down above this. If the river is considered to be at the normal stage a notation is made, "River about normal", otherwise the notation is made according to the engineer's estimate of river stage. Later, depth of water at normal river level will be calculated and recorded.

PIPE is a record of the distance of the cutting surface of the casing shoe below a marker on the surface of the ground at the collar of the hole, at the end of each drive. In the river drilling, it is the distance of the cutting surface of the casing shoe below the top of the barge.

DRIVE is a record of the individual advancement of the casing during a "drive".

Under the CORE DATA division, we have three separate columns, RISE, PUMP and BOX MEASURE. Each is a measurement of the material in the casing or pumped from the casing into the measuring box.

RISE is the measurement of the material within the casing and above the cutting edge of the casing shoe after each drive. It is to be noted that many factors tend to vary this rise. First, the inner diameter of the cutting edge of a new casing shoe is five and 1/8 inches while the inside diameter of the casing is four inches. This naturally would tend to give a greater rise than drive in ordinary material such as fine gravel. Soon the sharp cutting wears off and we have the case of a blunt edge four and half inches in inner diameter. This possibly would tend to give a slightly greater rise than drive. We might also have the case of fine sand and water. As the casing shoe is driven through this material there is a great tendency for it to rush into the casing and cause an abnormal rise. This great influx of material tends to give erroneous results. Fortunately, however, there usually is not much gold or platinum in this fine material. However, it must be considered in calculating the grains per cubic yard. Another common case is to have a small boulder wedge into the casing shoe and not be broken due to a stratum of loose material below the boulder. If it is fairly small, it will tend to crowd the loose material aside and give no rise in the casing. If it is large and tough it will cause the casing to "jump" or settle with the stroke of the driving blocks and then spring up when they are raised for a new stroke. If the casing shoe is unable to break the boulder and it is small, the bit must be used as a last resurt. This is one of the few cases where a chisel bit is permissable to be used near or below the cutting edge of the casing shoe. It is obvious that some error will enter in here in most cases. The boulder has packed or pushed loose material aside. When it is broken, especially with the bit, material is very apt to rush into the casing,



for the usual two or three inches left as a core guard has been destroyed. In many cases the hole must be re-drilled. A boulder is the most common reason why a hole has been abandoned. It either bends the casing off of the vertical plane so that the drill tools stick, or else it does not permit a reliable sample to be taken.

PUMP is a record of the material or core in the casing chiseled and pumped out after a drive. It is to be remembered that customary practice is to leave from two to three inches of core as a sort of plug to keep fine loose material such as sand from rushing into the casing.

BOX MEASURE is a record of the amount of material pumped and washed into a tube having the same inside diameter as the casing. Many different factors enter in here, so that after all the BOX MEASURE is just a record of the solids pumped, and has little meaning save to indicate the amount of slimes in the sample. The solids remain in the tube to be panned, but the mud, fine silt, and other "slimes" are lost or floated out by water.

In the column "NUMBER OF COLORS", we have a rough record of the number, size, and location of the various grains of gold and platimum recovered from the drilled material. The sizes are of course only the panner's estimate and as so, can only be taken as a comparative sizing. The number and especially the location are important data. From these data the distribution of the values can be determined at a glance. As mentioned before, a higher per cent of recovery can be made from gravel containing uniformly distributed values, than from an area where values are concentrated on or in bed rock. A foot of bedrock is customarily dug under normal conditions by the dredge in order to recover this bed rock concentration. The actual recovery depends upon the skill, experience and care of the winchmen. However, it is not the purpose of this paper to elabotate upon skill and care of some winchmen, or the lack of it in others, be they from Oroville or Condota.

Under"REMARKS" we have a drive by drive record of the material encountered by the casing shoe. This is valuable datum, for from it can be determined the type of material the dredge will be expected to handle. The amount of sticky, unwashable clay, the number and size of boulders, the type and character of bed rock, the depth of overburden, and the depth of bedrock below

Plate XIII

THE WINCHMAN TOO, MUST BE A HARDY SOUL

Clearing the jungle ahead of the dredge is one of the big problems in the Choco of today.

normal river level are important factors especially if one is designing a dredge to operate in a new district.

In the bottom division of the drill log (See Plate No. XII) we have numerous data which need no comment. Elevation of collar, depths, remarks, lost time, bedrock elevation, normal river level, and coordinates of drill hole are determined and entered in the log by the engineer. Containing these data, the drill log becomes a very convenient reference sheet in a condensed form. It might be well to add that the actual drill log is somewhat larger than Plate No. XII which represents a reduction of an actual drill log/redrawn with names, locations, and remarks revised by the writer. The actual log is not so crowded for space. Also, the lost time is generally recorded on the back of the log. The log is recorded and signed by the panner who turns it over to the driller. The driller signs it as soon as he has checked over the entries and decided that it is correct.

The log is folded around the drill sample and sent to the engineer office. It passes on to the laboratory where the sample is cleaned, weighed and recorded as grains platinum and grain gold in hole. It is then returned to the office for calculation.

THE DRILL SAMPLE

As soon as the drill sample is received and recorded in the office, it is sent to the laboratory where it is placed in a drying cabinet. When enough samples have accumulated, a junior engineer or laboratory assistant is detailed to clean and weigh the metals.

It is customary to place the sample on a white slide or plate under a low power microscope. With the aid of a delicate camel's hair brush, the engineer sorts the sample into three piles. One consists of the tails, one of platinum, and the other of gold. The tails are carefully examined and then discarded. Each of the metals are carefully weighed to the nearest 0.001 grain on a gold balance and the weights recorded as GRAINS PLATINUM IN HOLE and GRAINS GOLD IN HOLE on the drill log.

In case mercury has been used to collect the gold from the concentrate, the microscope and camel's hair brush are replaced by fire and acid. Dilute nitric acid and the amalgam are placed in a small crucible and gently heated until the mercury is dissolved. Then it is washed thoroughly with hot water containing a few drops of alcohol. The gold is then dried and annealed over an alcohol burner and is ready to be weighed. It must be remembered the mercury must not be used to collect the gold from the concentrate if there is any platinum occurring in the district to be drilled. Otherwise, the platinum would be lost in the discarded material, for platinum under ordinary conditions will not amalgamate with mercury.

The sample represents the amount of gold and platinum recovered from a cylinder of material having a theoretical diameter equivalent to the inner diameter of the cutting edge of the casing shoe, and a length equivalent to the distance drilled.

COMPUTATION OF DRILL-HOLE DATA

Before attempting to compute drill-hole data, it is necessary to arrive at the casing shoe factor. Since the inside diameter of the casing is 4 inches while the inner diameter of the cutting edge of the shoe varies from 5 1/8 inches in a new shoe to 4 1/2 inches in one, in a dull condition, it is obvious that the factor will only be an approximation.

The casing shoe factor is to be taken as the length of the drive required to cut a cubic yard of material. Therefore a new shoe would give a theoretical factor (theoretical for the fact that no two drives of equal length in different material will give the same rise) of 188, while that of a worn shoe would be 243. Since the shoe changes from a sharp to a dull state 200 is usually accepted as a sort of "mean." This 200 is far from desired accuracy, and so it is desirable to reduce it from a variable to as nearly a constant as practable.

The interior area of the casing is 12.57 sq. inch, while the area of the casing shoe at the 200 state of wear would be 19.44 sq. inch.

The theoretical core use for given drive would be the ratio of the area of the core to the area of the cutting edge. For a 1 ft. drive we would have

Drive: Rise : : 12.57 : 19.44

1 : Rise : : 12.57 : 19.44

We find rise = 1.54 ft. for each 1 ft drive. This figure, 1.54, represents a theoretical rise assuming that the material drilled is of uniform composition and remains of the same density or state of compaction after entering the casing. It is of course obvious that several factors have not been considered. First of all, the cutting edge of the casing shoe is not a knife edge, but a fairly blunt surface. Due to the shape of this edge, the material is compacted and crowded into a cylinder of smaller diameter. Then it passes into a cylinder of slightly larger diameter where it tends to expand. This expansion or "swell" of the core of course is a variable depending upon several factors and conditions. Experience has indicated that a factor of 5 per cent is acceptable as representing the agerage of "swell" in the core. Introducing this factor into our calculations, we have (1.54 + 5% of 1.54) a factor of 1.62 (carried to the nearest handredth). For all practical purposes this factor may be accepted as a constant. Thus, a drive of 1 ft. gives an ideal rise of 1.62 ft.

Another fact to be considered is that the colors are recovered, not from the rise but the pump or material actually pumped. While the Rise and the Pump are supposed to be equal, it happens that under certain conditions these figures vary. Therefore, it is customary to use the Pump rather than the Rise in the calculations.

We are interested chiefly in arriving at the figures of Grains Per Cu. Yd. of each metal. In many localities, the colors are found concentrated at various depths, rather than being uniformly distributed or else concentrated on bed rock alone. It is common practice to consider only the Drives and corresponding Pumps where colors are found in the calculations. In this manner, much of the error due to abnormal rises and great influx of material in said is avoided. As mentioned before, this relatively fine material as a rule is more or less barren. In this same manner the wide awake calculator could carefully note an abnormal concentration of colors after bed rock has been reached. Often the casing shoe will encounter a small crevasse or seam in the bedrock. Upon pumping out the core, much material in the crevasse or seam bearing the rich bed rock concentration of colors will be drawn into the casing. This is obviously a form of "salting" and a proper notation should be made in order to partially avoid the "high hole" in later computations.

The first step in calculating the drill log in the engineer office is to enclose the portion or portions where in the colors were found in brackets with a red pencil. Then he proceeds to total the Drive and the Pump enclosed in the red brackets.

$\frac{\text{Drive}}{\text{Pump}}$ X 1.62 gives a core ratio factor. This factor multiplied by our 200 constant and divided by (Total to Bed Rock + 1 ft.) gives the calculated volume factor. This when multiplied by Grains of each metal in hole gives a product in Grains Per Cu. Yd. As noted before, it is customary practice to carry this product to the nearest 0.001 grains.

The final step in calculating a drill log is to arrive at cents per cubic yard. It is necessary to arrive at the value of each metal in cents per grain.

$\frac{\text{100 X dollars per fine ounce X fineness}}{480}$ will give the exact figure. However, the exact fineness is not known, the price of platinum varies, and even the price of gold sometimes varies. It is common practice in calculations to accept 5.75 ¢ per grain for platinum and 3.40 ¢ per grain for gold. Of course, these are just approximations, and on the conservative side.

RIO SAN NICOLOS, RED HORSE FLAT.

TABULATED COSTS FOR DRILLING HOLE NO. 3-R, Line 12.

Time required to drill hole......................8 hours.

Depth of hole.................................. ....25 feet.

COSTS	COLUMBIAN PESOS
One driller wages	11.00
One drill captain, wages	1.82
One pannar, wages	1.50
Eight "Cacheros" total wages	13.40
Three "bogas" or rodman, wages	4.30
Ten banana plants	.50
One palm	1.20
47 stalks of corn	.47
Total actual drilling costs	33.99
Drillers food for one day	2.00
Drillers cooks wages	1.00
Peon cooks wages	1.00
Porportion of cost of engineer camp	1.20
Porportion of cost of Peon camp	1.30
Medical supplies and costs	2.30
Wear and tear on drill parts	8.50
Misc. expenses	1.10
Total other costs (estimated)	18.40

Total cost of drilling hole..... 52.39 pesos or $29.95 US

Cost per foot .... 2.09 " " $ 1.19 "

(±)
1.75 pesos equals $1.00 U.S.

The above tabulation includes only the costs of drilling one hole in the field. Overhead, upkeep of machine shop, freight, preliminary surveying expenses, office charges, and the like are not encluded. Also, at best the above expences are only estimated. No two holes will have the same costs per foot drilled due to different conditions.

It was impossible to secure the actual costs of drilling in the Choco, but the above estimate is fairly liberal as far as the actual field expenses run. For example, in average ground a rig will hardly average 25 feet per day. In hard ground the rig will do well to average 15 feet per eight hours day when one considers time lost in moving, transportation, repairs, arguing with the native owners, etc.

FIELD REPORT

The driller is required to submit a monthly field report to his superior. This report is merely a formality which has little value save to the accounting department. It is to be understood that the driller sends in his logs, samples and a detailed report of the drilling progress at least once a week unless he is located a great distance from the engineer office.

The monthly field report consists of two main divisions, Lost Time and Performance (see sample report on page 86).

Under Lost Time most of the items are self explanatory. However, "no labor" might require a few words since it deals with the power or moving force of the drill. As mentioned before, the native negro of the Choco is a very poor speciman at best. If any or all members can possibly think up an excuse for not coming to work which they think or hope will satisfy the driller, the result is evident. The drill cannot operate without man-power. For that reason the driller has developed a sort of "case hardened" frame of mind from listening to the excuses offered, and often sends the "victim of Circumstances" home for a certain length of time or fires him

FIELD REPORT

RIO SAN NICOLOS Examination

Month of December, 1935

LOST TIME

	Drill No. 1 Hours	Drill No. 2 Hours	Drill No. 3 Hours	Total Hours
Transportation	2:45			
High river				
Fishing		6:00		
Lack of Equipment	26:25			
Repairs	0:25	1:20		
No Labor				
Moving	5:00	6:05		
Miscellaneous				
Total	34:35	13:25		
	(4.3 days)	(1.7 days)	(days)	(days)

PERFORMANCE

	Drill No. 1	Drill No. 2	Drill No. 3	Total
Possible Drill Days	23	23		
Drill days worked	18.7	21.3		
Percent working time	81.5	92.7		
Number of Holes	10	13		
No. per poss. drill day	.435	.565		
No. per drille day worked	.535	.610		
Total feet drilled	278.6	332.0		
Av. feet per hole	27.9	25.6		
Feet per poss. drill day	12.1	14.5		
Feet per drill day worked	14.9	15.6		
Man hours worked				

REMARKS : Two days, December 24th and 25th, were taken off for the Christmas Holidays.

JKdea

Engr. in Charge of Field Party.

as a good example. In either case, the erring one is left without resources and either starves or steals until he can get back to work. He is one of the unfortunates who does not have a house and woman or women to pan for him. Otherwise, there would be no objective for him to work in the first place.

Under "miscellaneous" comes the time lost in attempting to get drilling permits or arguing with irate owners. During the first month in a new district this may contain a large portion of the lost time.

Under "remarks" come the unusual events such as important holiday, or serious accident and the like.

C O N C L U S I O N

The prospest drill is a machine with which data of subsurface conditions of placer deposits can be obtained in a rapid manner at a low cost. Since prospect drilling in the Choco is chiefly concerned with placer deposits suitable for dredging, these data consist of:

1. Average value of the deposit in grains as well as cents per cubic yard.
2. Average depth of gravel
3. Elevation of bed rock in relation to the normal river level.
4. Type and character of bed rock.
5. Distribution and character of values.
6. Composition and character of the various strata of material between the surface of the ground and bed rock.

It must be realized that the prospect drill like other machines has limitations. Some of these for example are:

1. Only a perpendicular hole can be drilled.
2. The core cannot be recovered intact.
3. It cannot operate successfully in ground containing large boulders.
4. The Ward Type Hand Drill is limited to testing placer deposits less than 100 ft. in depth.
5. The Ward Type Hand Drill was not designed to test rock formations.

The reliability of drilling results depends upon numerous factors, some of which are:

1. The integrity of the driller and his assistant.
2. The care which is exerted in all of the various steps in obtaining a sample.

3. The amount of supervision of the native crew.
4. The accurately recorded drill log.
5. The number of holes drilled.
6. The experience of the engineer in calculating the results.

The Choco offers problems more difficult to overcome than the ordinary obstacles met in drilling in a jungle country. To meet and overcome these problems depends upon the driller himself, rather than the type of drill or method used in prospection. The Ward Type Hand Drill has been tried and found to give satisfactory results in all cases in the Choco, save where the ground was too deep, the boulders too large, or the driller or his superior not qualified for the job.

It is doubtful if the Hand Drill can overcome the deep ground or large boulder problem due to the requirement of heavier equipment. This puts it out of the hand drill class, and so a different type of drill is the answer..... a power drill using heavy six inch casing. This power drill could not be used in the jungles, for it is too heavy to carry by hand. Cribbing for a roadway would be a considerable expense as well as a big item in the lost time column of the field report. Therefore, a drill for each condition seems the most logical answer and it has been successfully

Negative by P. Haugen

Plate XIV

MOVING THE RIG

In the Choco the drill must be transported in one-man loads tried out in the last two years in Colombia. An Armstrong Bucyrus power drill using six inch casing and mounted on a barge gave satisfactory results in a deep river. The hand drill gave satisfactory results in the jungle.

Getting a satisfactory assistant, driller or superior is a very simple job if one is willing to pay the price. However, it is well to remember that any man, be he a plumber, a photographer or an engineer is only worth his hire. Any man can get "results". It is just a question of whether one wants just "results" or reliable data. The gold dredge is an efficient miner, but a very costly prospector.

Dredge No. 1.

Plate XV

THE DREDGE IS AN EFFICIENT MINER, BUT A VERY COSTLY PROSPECTOR

RIO SAN JUAN, 1936

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