1940

A preliminary report on the placer gold deposits of the Rio Acandi Seco, Choco, Republic of Colombia, South America and a possible method of their exploitation.

Emmett Lee Arnold

A PRELIMINARY REPORT ON THE PLACER GOLD DEPOSITS OF THE RIO ACANDI SECO, CHOCO, REPUBLIC OF COLOMBIA, SOUTH AMERICA AND A POSSIBLE METHOD OF THEIR EXPLOITATION

BY

EMMETT LEE ARNOLD

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.

1940

Approved C. P. Forbes

Professor of Mining Engineering

TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

PROPERTY

This property covers the valley of the Rio Acandi Seco, in the District of Acandi, Intendencia (Territory) of Choco, Republic of Colombia, South America.

It consists of four claims, or pertenencias, each straddling and paralleling the course of the Acandi Seco River. Each claim is two kilometers in width, one kilometer on each side of the stream bed, and five kilometers in length, making an area two kilometers ($1\frac{1}{4}$ miles) in width by 20 kilometers ($12\frac{1}{3}$ miles) in length, containing about 10,000 acres, the conversions being only approximate. These four claims are shown on the attached map as La Balboa, La Balboa No. 1, La Balboa No. 2 and La Balboa No. 3.

The mining rights covered are the placer rights, lode mines being subject to separate filings by the discoverers. Thus far, no lode mines have been discovered or filed on, and there are now no owners of adverse surface rights on the Balboa property.

HISTORY

It is quite possible, and perhaps probable, that the Rio Acandi Seco contributed some of the first gold shipped from South America to Spain. This region is one of the oldest settled areas of the New World.

The first permanent settlement in South America was at Cartegena, some 200 miles to the northeast. Balboa's lost city of Santa Maria, of which no trace remains, was near the mouth of the Rio Atrato, about 40 miles to the southeast of Acandi. He spent much time in the Indian settlements then located at the mouth of the Rio Acandi (approximate site of the present village of Acandi) and at the Rio

Tolo, about 1½ miles distant. This was Balboa's "stamping ground." It is insisted locally that it was from these Indians that he learned of an ocean to the westward, and from one of the peaks in the range that marks the present boundary between Colombia and Panama, rather than from a point to the northwest in Panama, that he first saw the Pacific.

Evidence of old placer workings, no doubt ground sluices, are found along the course of the Rio Acandi Seco. At the site of these old workings the boulders, large and small, are piled in long, low ridges or windrows, which offer the only evidence of the former workings. Innumerable floods have doubtless destroyed evidence of all except the larger workings. Where these old workings can be readily identified, they are found at the sides of the present stream bed and vary from about 40 feet to 200 feet in length. Stream bed workings at the present time sometimes encounter the same boulder arrangement and produce only lean values. These former workings exploited such a tiny fraction of the territory that they can be ignored in computing the value of the sections.

This work was no doubt part of the exploitation carried on by the early Spaniards; the actual labor was probably performed by enslaved Indians, the ancestors of the few Cholos and Cunas still existing in the region. The Indians at the time of the Spanish conquest were much more numerous and more highly developed than their descendants are today.

The present Indians are not miners, although the Cuna women wear gold ornaments, nose rings, earrings, bracelets and anklets. The

grave robbing business which flourishes in the vicinity of some of the gold-bearing streams indicates, however, that their Indian ancestors did mine gold, since they could have secured it in their time only by mining it, and gold nose rings, earrings, bracelets, anklets and figures of beaten gold are found in the old graves.

The region, in spite of being one of the oldest settled in South America, is now one of the world's most primitive. The Spaniards, as time went on, moved into the higher, more healthful climate of the interior, leaving this coastal area largely to the Negroes, who had originally been brought over as slaves. It is not known whether these Negro slaves were used in placer exploitation.

Generations after generations have washed gold, and made their living thereby, from the Acandi Seco and other gold-bearing streams of the general area. In part, they ground sluice, or use small sluice boxes of sawed lumber. In part, they simply pan, using a wooden pan called a batea.

For the most part, these native miners are Negroes, though some are of Spanish or mixed blood. Most of them show evidence of white or Indian blood; they have features quite at variance with the thick lips, flat noses and receding foreheads with which we in the United States associate the Negro race. One sees, also, thin-lipped, straight-nosed Negroes with high cheek bones and high foreheads.

A Colombian company has now filed on four claims covering all the workable portion of the Rio Acandi Seco, and has carried on some testing and small exploitations, mostly by hand operations. Two single-drum winches were later installed for working benches, but the river bed work was done entirely by hand.

In the hand operations, they used a small sluice box 12 inches wide by 8 feet long. This was set at about water level at the edge of the stream bed, with a small ditch or dam to furnish water, and occasionally using a short flume with the sluice box set a foot or so above water level. Teams of five to seven worked together; one loosened the gravel with an almocofre (thin, hooked tool used on a wooden handle) or a bar, and one shoveled into a batea held by a third man. The man with the batea(which held about 25 pounds) usually tossed it on to another passer. There might be as many as three or four of these batea passers, the last of them dumping the gravel into the sluice, at which was a sluice tender. In moving boulders, all hands "turned to." This method represents relatively efficient native practice.

I watched these operations at intervals over several months, and noted that recoveries just about paid labor cost. I estimated the material handled as 1/2 cubic yard per day per man. Their work was a sort of pocket hunting, finding, and following the richer channels, so their recoveries were above average values. In one bench (which appeared to have been reconcentrated) the recoveries averaged some $1.50 per cubic yard, and in one stream-bed operation, approximately $15.00 per cubic yard. (In this report, "$", and "cents" signify United States currency; Colombian money is designated as pesos or centavos.)

I watched one winch operation working a 13½-foot bench, two feet above river level. A crew of seven handled approximately 22 cubic yards per day, using one small scraper of about 1/8-cubic-yard capacity

with a single-drum winch. Two shovelers loaded the scraper, the winch pulled it to the sluice box, and two other men pulled it back to the bank for reloading. This process was manifestly pretty slow. A larger sluice box was used (24 inches wide by 12 feet long), and was set to discharge upstream against the current. The recovery was about 22 cents per cubic yard, the low values being due to the absence of crevices in the smooth crystalline bedrock.

At present, no operations are being carried on, but natives are being permitted to wash gold. About sixty of them are so engaged, washing their living out of the stream. The women and children pan, as do the men. The men average not over 1/2 cubic yard per day, bank measurement, of river bed gravels panned, and their earnings vary greatly. I have bought gold from men who averaged $15.00 per week, based on United States mint values. Others were recovering less than a fourth of that amount, and others between the two extremes.

GEOGRAPHY - CLIMATE - LIVING CONDITIONS

The local supply base is Acandi, population about 2,500, a small port at the mouth of the Rio Acandi on the Gulf of Uraba, on the Caribbean side of Colombia. Acandi is 12 miles by trail from the main camp at the center of the Balboa claims, and is about 15 miles southeast of the Colombia-Panama border, which runs slightly east of south for about half its length and then swings southwest.

The climate is, of course, tropical, with dense tree, vine, and shrub growth. The area beginning south of the Panama Canal and continuing southeast to the Atrato River is called one of the densest jungles of the world. Most trees are of the quick-growing, soft-wood

variety, useless for lumber. Scattered among them, however, are many which could be the source of good lumber: cedar, oak, guino, and laurel. Among the harder woods, there are: balsamo, mora, guayacan (not the lignum vitae variety). Plenty of timber for operations is available on the Balboa property.

Rainfall approximates a mean of 80 inches per year. The seasons are merely rainy and dry, the area being only 8½ degrees north of the equator. The dry season, which is summer to the natives because it is warmer, usually commences in January and continues into April; then comes rain which continues through May and June. Then, what is called "the little summer" brings less rain through July and August and, perhaps, September. From then, the rains usually increase, November and December (the natives' winter) being the rainy months, when floods are common. Trails become difficult, and movement of heavy machinery by trail or road is impossible.

There are no roads in this part of Colombia, nor in Southern Panama. Travel is by water or trail. The streams are navigable in their lower reaches by dugout canoes. Trails follow the beach or the streams, cutting occasionally over a ridge from village to village. Some trails can be traveled mule-back, but most of them are purely foot trails which only the jungle-trained can follow. Settlements and cultivations are found only at the beaches and along stream valleys.

This district raises many bananas; there is a plantation at Acandi from which they are exported to the United States. For local use, the natives raise rice, plantains, coconuts, cacao, some sugar

cane, yucca and yami (edible root crops), some corn, a few hogs, and a few cattle. Most of the cattle and hogs for butchering are shipped in. Very few citrus fruits are grown, although they do well.

At the Balboa property, plenty of bananas, plantains and rice, as well as pineapples, papayas, corn, beans, peas, sugar cane, yucca, yami, and perhaps other vegetables, can be raised for use at the property if desired.

The basis of the native diet is rice and plantains, and meat when it can be procured. Meat is expensive, retailing at about 35 centavos per pound.

Wild game is abundant. Besides the wild hogs, which travel in herds of three to 300, there are small deer, conejos (animals of the rabbit family weighing up to 30 pounds or more), tapirs, baboons and monkeys (many of the natives consider monkey meat a delicacy). Among the birds, wild turkeys, perdis, and large birds of the quail family are abundant. There are also a few ducks, a few birds of the prairie chicken family, and others. I have employed two Indian hunters at different times, either of whom could keep a camp of 15 supplied with meat, even without refrigeration. With refrigeration, fresh meat can be supplied quite satisfactorily. The streams contain a few small edible fish.

There are many tigers, and higher in the mountains, bear are to be found. Snakes are numerous, but rarely seen. There are boas and other non-poisonous snakes, as well as the poisonous varieties (bushmaster, coral, blood snake, and others). The small assassin called Veinte-quatro (named for the 24 hours of life one is said to have after

its bite) is not found in this area. If one wears boots on the trail or passing through snake terrain, there is little to be feared from snakes.

Around camp, ordinary precautions must be taken to guard against ants, scorpions, tarantulas and other insects. The most destructive creature here is the "wee-wee" ant--some large, some small, all red, and all organized into fighters and workers. They can move into a field of bananas and destroy it in a short time. They have not, however, caused me any difficulty in two years of maintaining camps. Another ant to avoid is the "congo", about 5/8 inch in length, with a strut like a black stallion and a bite producing intense pain and often fever. Ticks, gnats and other nuisances are to be found, and the pests vary widely with locality. If the area around a camp is kept cleared of weeds and grass, the crawling things keep away, though in new camps ordinary vigilance must be maintained.

The mean temperature is about 80 degrees Fahrenheit, and it is nearly always comfortable in the shade. Around the middle of a cloudless day, with a temperature in the nineties, it gets uncomfortably warm in the sun. Nights are cool, and one always needs a blanket for sleeping.

Except for the prevalence of malaria, the climate is healthful. The malaria is not fatal, and the atabrine treatment now used "knocks it out" in a few days. Some foreigners avoid malaria for years. The natives, of course, get it in their blood as babies and uncomplainingly carry it through life. It must be borne in mind that only the female of the anofeles mosquito, a minority species, carries malaria.

She must bring it direct from an infected person, and her life span is only a few days. The hours from 5:00 p.m. to 9:00 p.m. are said to be the time she is out. Houses can be screened to reduce malaria risk, and everyone sleeps under a mosquito net.

FORMER REPORTS OR ENGINEERS' DATA

If any report on the district is available, I have failed to find it, nor have I located any other engineers' data.

TITLE AND OTHER GENERAL INFORMATION

Mineral rights in the Republic of Colombia are nationalized. Surface rights are acquired by clearing and cultivating land, but if the land is abandoned by its cultivator or one of his chain of assignees, it reverts to the government. By making permanent improvements, such as growing an orchard, title to surface rights in perpetuity may be acquired.

An owner of a placer or alluvial mine does not own the quartz or lode rights; the latter may be filed on and acquired by any eligible discoverer. The owner of a lode mine, however, is also the owner of an alluvial mine under its boundaries.

A mine owner may extend his operations over land to which others have acquired surface rights. In this case, he must pay for surface damages, the fee being fixed either by mutual agreement or by the courts. He owns the timber rights for such timber as he may need, if it is found within the limits of his mine. In general, mines may make use of idle water by taking material possession of it. The first mine filed on has preferred rights; any surplus water may be taken by other mines, and permanent use made thereof.

The Colombian constitution says the foreginer will enjoy the same rights as nationals. In the Intendencia of Choco, however, the foreigner may not own mines, though he may operate them as a lessee. Foreigners as individuals may operate in Colombia without special permit, but foreign companies or societies must have a legal permit to do business. This permit costs about 600 pesos. A duly-appointed agent must represent the foreign corporation by power of attorney.

Title to such mines as the Balboa comes direct from the Colobbian government. There are four steps to acquiring such title:

(1) The AVISO, or notice, in which the discoverer files in the office of the district alcalde or mayor (in this case at Acandi) a notice stating that he has discovered and claims a mine, describing its boundaries. This aviso is posted, and anyone with an adverse claim is supposed to assert it.

(2) The DENUNCIO, which is a claim of discovery filed in the office of an official at the capital of the state or territory (in this case at Quipdo).

(3) The POSESION, which is formal possession tendered by the Alcalde at the orders of the Intendente, or territorial governor. In a sense, the locater may have been in possession ever since his aviso, as he can mine and exploit the property during the entire period of perfecting title, provided no adverse claim is asserted.

(4) TITULO, which is a certificate of title conferred by the proper official of the national government, and must be registered or filed.

The total cost of securing title, including attorney's fee, is usually about 200 pesos per claim, and the time required is about two years. La Balboa and La Balboa No. 1 have been fully titled. La Balboa No. 2 and No. 3 are in the third stage, Posesion. Each claim must go through all the above-described steps individually, not as a group of claims.

Commencing the third year after titling, an annual investment of 600 pesos for an isolated claim or 1,800 pesos for a contiguous group, is required to be spent. In the event the expenditure is not made, the normal tax of 20 pesos per claim per year is doubled to 40 pesos. This expenditure for development work may be made on any one or on any number of the group where claims are contiguous and being developed as a group by a single ownership. There is no time limitation for completing the exploitation of a mine.

The mining industry is especially favored by the Colombian government. No direct royalty is exacted, but all gold must be sold to a specified agency, and the government thereby exacts a tax. Eighty-five per cent of the value of the gold is paid for in Colombian pesos at U.S. mint values at the current rate of exchange (now approximately 1.75 pesos per U.S. dollar), and 15 per cent at the arbitrary rate of exchange of 1.13 pesos per U.S. dollar. Thus, it is a sliding tax, varying with rate of exchange. At the present time, it figures 5.67 per cent of the value of the gold produced.

A foreign or foreign-owned organization, when selling its gold, may secure 40 per cent of the value thereof in foreign exchange, there being no additional deduction or tax therefor. Any other

exportation of money is subject to a small tax.

Operators and operating companies are required to pay Colombian income tax on net profits, graduated from 1 per cent to 5 per cent on net incomes of less than 13,000 pesos up to 17 per cent on net income in excess of 600,000 pesos per annum.

The duty on mining machinery is approximately 1 centavo per kilo, or $5.20 at present rate of exchange per short ton, plus some consular fees.

TRANSPORTATION AND SUPPLIES

There are two or more motor ships of about 100 tons each, which carry bananas weekly from Acandi to Cristobal, a distance of some 200 miles. Many native sailing boats (canoas) of 40 to 80 tons ply the coast, mostly back and forth to Cartegena, and are available for freight. Freight must be landed by means of lighters, many of which are available, unless brought in the smaller canoas, as the motor ships cannot enter the shallow river.

Heavy machinery, weighing in excess of about 3,000 pounds in one piece, would have to be shipped from Cristobal or Cartegena either in a barge or in a shallow-draft, well-ballasted vessel capable of entering the Rio Acandi to discharge.

Freight rates from U.S. gulf ports to Cristobal, Canal Zone, are $10.00 per ton or 25 cents per cubic foot, ship's option, plus dock charges. Freight rates by the Hamilton Banana Line from Cristobal, Canal Zone, or Colon, Republic of Panama, to Acandi are $7.50 per ton, plus loading charges, and lighterage at Acandi. The canoa

rate would be less. From Cartegena to Acandi, it is 6 pesos per long ton, exclusive of lighterage.

From Acandi to the main Balboa camp, 12 miles, there is a gradual climb of approximately 450 feet over a fair mule trail. To carry heavy machinery, this trail would have to be widened and changed in places to eliminate grades, which are small in extent but steep. The widening should be done for 50 pesos per kilometer, plus cost of bridges. It is estimated that 2,000 pesos should be sufficient to put the trail in proper condition.

The cost of transporting mule-pack loads from Acandi to the Balboa camp is approximately two centavos per pound, the centave being the one-hundredth part of a peso. A caterpillar tractor would be required to draw heavy machinery. The present trail crosses the bed of the Rio Acandi Seco fifteen times, but a few of these crossings could be eliminated. Heavy machinery should be taken in during the dry season, at times when the river crossings carry only a foot or so of water.

Native food staples, such as rice, plantains, sugar, coffee, coconuts, lard, salt, and some other articles are obtainable in Acandi. Other foods will have to be shipped in from Cartegena or Colon, Colon shipments being subject to duty.

Machine-shop work can be secured in Cartegena or in some cases in the shops of the Canal Zone in Cristobal. Cartegena, a city 80,000 and an important port, affords a wide assortment of machinery and supplies. Lumber, at a cost of six centavos per foot, can be secured from a sawmill located at Acandi.

LABOR

Native labor, mostly Negro but some Colombianos of mixed extraction, is available. The standard rate of common laborers' pay in the district is 1.20 pesos per 8-hour day. Better-than-average laborers draw up to 1.50 pesos per day, and native straw bosses are satisfied with 1.75 to 2.00 pesos per day. Figuring the peso at 1.75 per U.S. dollar, common labor runs roughly 70 cents to 86 cents per day. The labor is fairly efficient--comparable to the southern U.S. negro.

Carpenters draw from 1.50 to 3.00 pesos per day, depending on demand and skill. Blacksmiths and mechanics, some of whom are competent, draw about the same amount. Many have worked for foreigners in other parts of Colombia or in the Canal Zone. A salary of 100 pesos per month will hire the best native mechanics. Some of the native labor has had small-scale placer mining experience with pan, sluice box and ground sluice. The common labor supply is ample. Mechanics and other artisans would have to be brought in from other mining districts, of which Colombia has many.

A concern whose monthly payroll exceeds 1,000 pesos is required to furnish for its employees: (1) medical attention when needed, (2) hospitalization when necessary, and (3) compensation insurance. Rate on compensation insurance is about 6 per cent of the payroll.

Those employed on a monthly basis are entitled to a two weeks' vacation with pay each year. In the event of the discharge of a monthly employee, he is entitled to a bonus of one month's pay for each year of his service.

Colombia specifies a minimum wage of 1.20 pesos per 8-hour day, and a day of rest each week (Sunday or other regular rest day), without pay, for men paid by the day.

GEOLOGY

The Rio Acandi Seco empties into the Rio Guati, which in turn flows into the Rio Acandi. The headwaters of the Rio Acandi Seco are in the Cordilleras of the Andes, where the continental divide is only some 15 miles from the east coast of Colombia, which is there the Gulf of Uraba. The peaks of the Cordilleras in the vicinity are about 4,500 feet in elevation. The course of the river is about north 70 degrees east, being roughly perpendicular to the local axis of the Cordilleras.

The average rate of stream gradient across the easternmost claim, La Balboa No. 2, is 55 feet per mile. Progressing upstream westward across La Balboa No. 1, it increases to 65 feet per mile; across La Balboa, 180 feet per mile; and across La Balboa No. 3, the gradient becomes much steeper.

It is a young stream, with canon walls in places in the upper reaches. Beginning in the eastern part of La Balboa and continuing downstream eastward through La Balboa No. 1 and No. 2, there are good benches, widening downstream. Except where interrupted by a couple of narrow gorges, they vary in width from a hundred yards to a quarter of a mile or more. The soil overburden averages about three feet, and the gravel about nine feet, making about twelve feet to be handled in washing the bench gravels. The values for the most part lie in channels and crevices in the bedrock. Where there is a clay content

the gold is distributed more or less through the gravel. But where little or no clay occurs with the gravel, which is generally the case, the gold has settled to bedrock and is found mostly in the crevices. Both gravels and soil overburden invariably show fine gold, sometimes also coarse. Values are not uniformly distributed, but are spotted. There are areas of thin values and channels of rich values. These rich channels result from traps rather than from reconcentration.

The exposed rocks are predominantly hard crystalline granites, with some decomposed granites, hard basalts and hard schists. No sedimentary rocks were observed. Bedrock in the crystalline granites, basalts and schists is very uneven, characterized by deep crevices and high, hard, miniature ridges and knolls. This feature offers a clean-up problem, which will be discussed later.

The gold recovered is very coarse, and many nuggets weigh more than a gram. Occasionally, a nugget of an ounce or more is found, and one weighed over 1½ ounces. Most of the gold is rough, indicating little wear and movement since being freed from its source rocks. Some is worn smooth from greater movement. Occasional pieces of white quartz showing free gold are found. The gold is of high grade, assaying 868 to 870 fine, and is easily recoverable in a standard type of sluice box. A large amount of black sand occurs, together with magnetite pebbles. I found no platinum or tin.

The source of the gold is unknown. It is too coarse to postulate its source as disseminated in the country rock. The greater part has its source upstream from the portion tested, that is, above the possibly workable placer area, while some is carried in by tributary

creeks within the limits of the Balboa claims. It apparently comes from stringers, veins or lodes occurring over a wide area in the upper drainage area of the river. If it is a series of stringers, veins or lodes, then all appear to derive their enrichment from the same general source, since the gold is all of the same fineness. The vegetation is so dense that it is practical to prospect only where canon walls occur. Therefore, locating the source appears to offer a most difficult problem.

Along the Cordilleras to the southward some 50 miles, there appears to have been a hiatus in continental uplift and a period of intense erosion of Silurian shales, slates and schists, giving thick alluvial deposits along the eastern slope of the range, followed by uplift and the development of the present river system, with recent erosion leaving gravel hills sometimes 100 feet above the present river beds. If the same hiatus occurred here, its only effect was to retard erosion of the harder igneous rocks comprising the core and flank of the range.

There is now going on a reconcentration of the liberated placer gold and its deposit as richer gravel in the present stream. The thickness of the stream bed deposits averages approximately 1 yard. The gravel falls into two classes: (1) bench deposits, one to four feet above the river bed, and (2) river bed deposits, in river.

The boulder content, of plus 12 inches diameter, varies greatly, from about 20 per cent of the deposits in the eastern end of the claims to nearly 40 per cent at the center of the claims, with the large-boulder percentage continuing to increase upstream. The

handling of these boulders presents the major problem in the exploitation of the Balboa mine. Many are quite large--of four-foot diameters and greater.

The Rio Acandi Seco carries enough water for any practicable placer operation, flowing some 2,000 cubic feet per minute even in the dry season. In the rainy season, sudden floods multiply that flow many times. The drainage area is small, the rises come quickly and the river becomes a torrent with the water rising two or three feet after ordinary rains. During the protracted rains of the rainy season, the flood stage is much higher, even up to 10 feet or more in the narrower places. When the rains stop, the flood subsides in a few hours, and the flow returns quickly to almost its normal seasonal level.

VALUE OF SECTIONS

The testing was done over a period of six months, and a total of 154 samples were tested. These 154 tests all went to bedrock; those not reaching bedrock were ignored.

The gold recovered in each test was weighed and the volume of sample was estimated in the small-scale testing, and measured in the case of the larger volumes. In pits and small cuts the testing method varied. In some cases all the material was washed, in others a complete cross section was cut, while in other cases samples of only the gravel or lower gravel were taken. In the latter cases, the volume of all material above the actual sample was calculated in determining values, but was assumed to be valueless. Where samples exceeded 1/2 cubic yard they were generally put through a sluice box,

or sometimes ground-sluiced in river bed sampling.

In the early testing, the values obtained were so spotted that an effort was made to test the benches by sluicing blocks of 50 cubic yards or more. Even then results continued spotted, and throughout the testing both benches and stream bed have shown extremely spotted values. So far as the benches are concerned, no additional information is to be gained from the natives, their work being confined to the river bed.

In view of the small amount of bench testing, the spotted character of the results, and the lack of confirmatory information from the work of the natives, it is patently impossible to evaluate the benches. Therefore, no such attempt is made here.

With the river bed, we have a somewhat different situation. There we have, in addition to my own sampling, much confirmatory information from the work of 50 or 60 natives. In many cases, I could get complete results on their operations by advancing them food supplies and buying their gold. Although spotted values are prevalent, and while further testing of large volumes may reduce the valuations thus far indicated, it is apparent that the river bed carries good values. These values, though mined by the crudest methods, are sufficient to afford the natives a living, and most of them will not work more than four or five hours a day unless driven by a boss. The advisability of further testing of larger volumes will be discussed later.

The river bed gravels increase in value from an average of 32 cents per cubic yard at the easternmost mile tested to $3.006 per

cubic yard at the western limits of Mile 4 East. I expect further testing to reduce the latter average. On the basis of the results, the entire stream bed tested shows an average of $1.06 per cubic yard.

If the entire stream bed from Mile 9.3 East to Mile 4.0 East could be washed, there would be a total yardage of some 447,800 cubic yards and a recovery of $478,221.00.

Averaging the various sections of bench samples, including bank at river and benches back from river, we get an average of 19 cents per cubic yard, too low for profitable exploitation. However, there are benches upstream from the eastern limits of Mile 5 East containing values well in excess of the average shown.

Further testing will be required to determine bench values. In fact, a thorough testing program will be necessary to provide proper data with which to compute the value of the bench sections.

CONSIDERATION OF OPERATING METHODS

The operating problem is dual, comprising the bedrock problem and the boulder problem.

(1) Bedrock. The predominating bedrock being a hard, crystalline granite, it cannot be dug satisfactorily by dragline or shovel. It must be well cleaned in order to recover the values, which are found chiefly on the bedrock and in the crevices. Cleaning the bedrock, then, for all practical purposes, entails a hydraulic or hand operation throughout, or a combination of dragline or shovel to handle as much as practical, and hydraulic or hand operations for cleaning the bedrock and crevices. As previously stated, the bedrock is extremely uneven.

(2) Boulder. With such a content of large boulders, grading from about 20 per cent at the eastern limits to 40 per cent or more of plus 12-inch diameters at the center of the claims, and continuing to increase upstream, monitors are hardly practical. The boulders could be screened out, of course, by grizzlies. But the time lost removing boulders from the grizzlies would slow down the operation so much that the method would be economically unsound with the values and distribution of gravels indicated. The monitors would be held up most of the time by the boulder-removing part of the operation. The boulder problem would prove increasingly difficult progressing upstream, and more difficult in the river bed gravels than in the bench gravels, since the river bed carries a much greater percentage of large boulders. Therefore, in spite of certain favorable factors (steep stream gradient, fair water supply available relatively close to the operation and at an elevation sufficient to provide the required pressure, and control of all areas useful to the operation) hydraulicking is in my opinion eliminated by the boulder problem. In considering dragline or power shovel, the boulder problem again offers difficulties. There are too many large boulders to be thus handled at reasonable costs, say not exceeding 25 cents per cubic yard of bench gravels, including depreciation. This is in addition to the bedrock problem discussed in paragraph above, and flood danger.

If costs per cubic yard were no object, the material downstream from Mile 4.0 East could be handled in volume by a combination of dragline (with auxiliary power shovel equipped with rock grab, or winches for stacking boulders) and monitors or hand operation for

cleaning bedrock. This would involve a separate sluice or washing plant for the bedrock gravels. In the Balboa property, the recoverable values appear too low to justify such expensive installations and operations. Also, the flood danger is ever present, and expensive installations could suffer great damage through floods. Furthermore, the character of the stream is such that it would be impractical and doubly dangerous from a flood standpoint to take a dragline upstream from Mile 5.5 East.

If further testing is decided upon, and if such further testing shows sufficiently better values than the preliminary testing has shown, then it may be possible to operate the property profitably on a small scale by a hand operation, or a series of hand operations, utilizing the cheap labor available. In test sluicing even difficult benches, my costs have been kept under 30 cents per cubic yard where 80 cubic yards or more were sluiced. That work utilized no machinery but moved boulders, large and small, by hand, and naturally embraced an abnormal amount of boulder stacking and installation time.

PROPOSED METHOD OF HAND OPERATION

This material under conditions maintaining in this locality can be moved more safely and more cheaply by hand and small machinery than by the usual placer installations. Volume can be secured by installing multiple units along the streams at proper intervals. Efficient methods should handle the bench gravels at a cost not to exceed 25 cents per cubic yard, bank measurement, excluding depreciation, and may with proper organization be reduced. Some experimenting would have to be done to determine the cost of handling the river

bed material in volume, though it is safe to say it will be much greater than the cost of handling bench gravels.

To handle river-bed material efficiently, the stream bed would have to be dried up, which means that parallel channels would have to be dug and the stream waters diverted thereto. The material removed in digging such channels would, of course, be washed. If the recovery proved too low to defray the cost, the deficit would be chargeable to the stream bed operation.

Standard 50-foot sluices would be needed, with riffles made of angle iron of the usual dredge-type construction, with undercurrent for catching fine gold, giving a fall of 8 inches per 12 feet of sluice section.

To work a bench and the river bed simultaneously in one sluice, two double-drum winches with each sluice and pumps for dewatering holes would be installed. Track and mine cars of, say, 30-cubic-foot capacity would be placed on the bench. (The car trucks can be shipped in and the bodies made on the ground.) The cars, loaded by hand and trammed to the base of the hopper, would be pulled by one winch from there to hopper level, dumped, and the contents fed to the sluice.

It is only with some difficulty that the river bed, carrying its normal water, is workable during low water. For proper results, the stream should be diverted and the channel dewatered. Then it could be worked essentially in the same manner as the benches. For working it in low water, gravel boats made on the ground of bolted hardwood, 30 cubic feet in capacity, pulled back and forth by the

same winch as the one handling cars, could be loaded by hand, the loaders stacking their boulders behind them in the cleaned river bed and using the winch to stack larger boulders requiring moving. The gravel boat, made on hardwood skids, would be pulled up a ramp, dumped into a hopper, and the gravel fed to the sluice.

One winch can be used to stack tailings and large boulders in bench or stream bed. The winch moving gravels to hopper may also be used in stacking river boulders. It may in some places prove necessary to use winches and pit men during noon hours and after the crew's quitting time for boulder and tailings stacking. Using only two winches, there will be much changing of cables from one operation to another and back again, but the labor for such work is cheap and the real element is winch time lost. If the winches are overworked, the cars can be pulled up a low incline and dumped by two men using a hand-powered winch. Resourcefulness in many ways will be required in such an operation.

Bench gravels can be fed from one side and river bed gravels from the river side of the same sluice. The daily capacity of each sluice would be limited by capacity of flume and the amount of trackage which could be laid advantageously. The uneven bedrock will make it difficult, no doubt sometimes impossible, to carry trackage as low as desired and in the places desired.

The river gravels, the river bed being narrow, are limited to a fraction of the bench deposits. In working an entire bench to a width of 100 yards and the river bed simultaneously, the bench would furnish about 400 cubic yards to some 30 cubic yards of river gravels per lineal yard of river, taking the average width of the river bed

as 30 yards. Manifestly, as much or as little of the bench as desired could be taken.

On both benches and dried-up river bed, holes will require dewatering and will necessitate pumping. Some holes will, during operations, require more or less continuous pumping of seepage waters. Two self-priming pumps, one 2-inch and one 4-inch, should be provided for such dewatering.

In Appendix 1 is shown the approximate cost of equipment and installation for such an operation as above described, with capacity of 100 to 200 cubic yards per 8-hour day.

An installation for handling only river-bed material could eliminate one winch, and possibly cars and trackage. Also, a smaller flume and sluice box could be used, since a river-bed operation cannot provide efficiently the same volume as a bench operation. A volume of 75 cubic yards, bank measurement, per day would be good yardage for such a river-bed operation as described.

To aid in stream diversion, cutting through from old channel to new channel and damming old channel, a small power shovel with digging bucket of even 1/4 or 3/8-cubic-yard capacity and 30-foot boom would be desirable but not essential. In the absence of such a power shovel, a 1/2-cubic-yard, Sauerman-type digging scraper, used as a dragline with a winch, could be substituted.

Flood risks can be reduced by installing winches on high ground, moving portable pumps to safe ground at the end of each working day, and keeping other equipment, when not in use, safe from flood waters. During the rainy season, sluices can be "loaded" before quitting work or as the river shows signs of unusual rise during working hours;

ramps and inclines can be anchored and flumes kept weighted down. Thus sluice and flume installations may come through ordinary high waters without great damage. And such damage as occurs may be repaired without great cost.

All the native miners are accustomed to working in water. Some have had experience working in streams where they would have to dive under the water to fill their bateas.

The jungle growth offers no serious problem. The trees can be felled, and the vegetation and brush cut by machete men. After drying a few weeks, all can be burned. The cost is about 20 pesos per acre. Naturally, the clearing is done weeks ahead of the installation of equipment. Roots are stacked as uncovered in mining operations.

All possible piece work should be contracted. Schedules exist for road clearing and ground clearing. A schedule for car loading (one for bench gravels, and another for river bed) would have to be worked out.

RESUME AND CONCLUSIONS

The testing thus far would indicate the river bed itself to contain an average of $1.06 per cubic yard, or a total of $478,241.00 for the possibly workable portion between Mile 9.3 E and Mile 4.0 E. Further sampling in large blocks may revise this figure.

Upstream from Mile 4.0 E, the stream becomes merely a mountain creek with many canon walls, too difficult of operation to consider exploiting on any scale worthy of mention here. Further testing to confirm the values thus far indicated appears justifiable, especially

the washing of larger blocks of stream bed deposits.

The results thus far obtained in bench sampling are too spotted to warrant a judgment as to the bench values. It is noteworthy, however, that the section wherein most testing has been done, Mile 4.0 E to Mile 5.0 E, shows the highest average of any mile section. From 33 bench tests, an average value of 35½ cents per cubic yard is obtained, and from 12 river bed tests, an average of $3.005. If further consideration is to be given the property, a comprehensive bench-testing program should be carried out. Drilling is not recommended because of three considerations: (1) the boulder content, (2) the absence of clay, letting the heavier gold settle to the bottom of the hole, with the consequent difficulty of its recovery from bedrock of the character prevalent, and (3) the fact that cheap-labor pitting is not expensive, ground waters in the dry season not interfering greatly.

The cost of pitting should average about 15 pesos per pit and 7.50 pesos for cuts, these figures including cost of washing samples. A total of 32 cuts (16 on each river bank per mile, spaced at 330-foot intervals) and 32 pits (a row of 16 on each side, spaced 330 feet back from the cuts) should provide sufficient data for the valuation of the benches for the immediate purpose of determining the aggregate recovery from the river bed and such bench deposits as must be handled for stream diversion, provided the bench values alone prove too low for profitable exploitation.

The cost of the uniformly-spaced, pit-and-cut sampling outlined per lineal mile can be figured at 720 pesos, $426.67 U.S. currency, for labor costs. Testing of old stream channels and sluicing of

blocks will involve additional expense.

It is safe to say that if recoverable bench values exceed an average of 30 cents per cubic yard, at least for such deposits as must be moved for stream diversion, then the mine can be profitably worked. If such bench values average 25 cents per cubic yard, it can possibly be worked at a profit.

If the values in pitting continue spotted, as they no doubt will, then test blocks of bench gravels should be sluiced.

In any further testing program, old river channels in the area tested should be searched out, sampled thoroughly, and mapped, since such channels have undergone reconcentration and consequent enrichment, and also offer possible channels for stream diversion.

It is, of course, impossible to predict profits until the value of the sections is definitely determined. The question is not bench values alone, nor stream bed alone; it is the aggregate recoverable values from workable sections of stream bed and such portions of benches as will pay or which must be moved for stream diversion. These factors are balanced against equipment and operating costs.

As to volume, the amount of profitably workable bench deposits is entirely problematical. On the basis of results thus far, the volume of possibly profitable river-bed deposits, supposing the river bed from Mile 8.0 East westward to Mile 4.0 East to be profitably exploitable, would be some 299,800 cubic yards. This would provide 200 cubic yards per day for 1499 days (probably six working years, deducting Sundays, holy weeks, fiesta days when the natives will not work, and shut-down periods). On the basis of the preliminary testing,

this 299,800 cubic yards shows total recoverable values of $438,841.00 or $1.46 per cubic yard.

In any consideration of hydraulic or dragline operations, any economy resulting from cheap labor is more than offset by difficulties and expense of transport, and isolation from large supply bases. More important is the consideration that the bedrock and boulder problems render hydraulicking and draglining unduly difficult. To put such machinery as a dragline into the Rio Acandi Seco is to invite flood damage. Therefore, small units (as few as or as many as conditions and available capital warrant), relatively inexpensive, adaptable to flood protection, and utilizing cheap labor, appear to offer the only possible practical operating method. The alternative appears to be to let the proposition alone.

RECOMMENDATIONS

I believe the results thus far justify further testing of large blocks, 500 cubic yards and upwards, of the river bed itself, the blocks to be located more with reference to favorable conditions for working the wet river bed and economical handling then to regular spacing. Four such tests at intervals of approximately 1/4 of a mile, the first in the vicinity of Mile 4.75 East, with one upstream and two downstream therefrom, might be sufficient to justify the small installation outlined in Appendix 1, providing the necessary bench testing shows the net cost of diversion channels to be not too great.

The two small, single-drum winches now on the property, together with other equipment available there, should be practically sufficient

for the purpose. Some repairs and additional tools, flumes, and sluices will be required at a total expense of about $800.00.

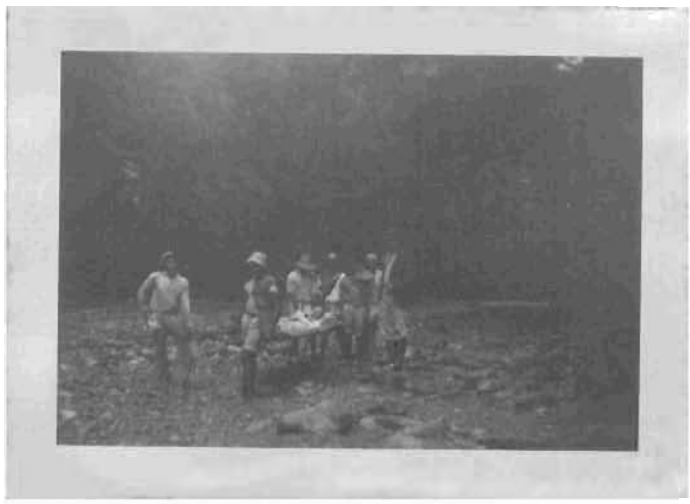
The cost of such river-bed testing should be largely or wholly reimbursed by gold recovered. A fund of $2,000.00 in addition to the $800.00 for repairs, etc., should finance the river-bed work. Such a testing operation should furnish also the information required as to handling costs of river-bed material in volume by hand methods.

If the four tests recommended show sufficient values, some 41,000 cubic yards (ample yardage for the small operation outlined) will be blocked out. And if the parallel bench values tested simultaneously justify it, the operation can thereupon be undertaken.

If these results are not favorable, then further testing upstream to Mile 4.0 East and downstream as far as results warrant can be undertaken if desired at that time, the corresponding benches again being tested simultaneously.

If and when an operating unit is installed it should first make a diversion channel; then with the waters diverted, it can be moved to successive locations for washing the deposits from the dried-up river bed, along with such bench deposits as the values thereof justify. With the first unit in operation, the expansion of operations will be dictated by results.

Main Camp at La Balboa, with Jungle Background



Bed of Rio Acandi Seco at Trail Crossing at Mile 7.4 East

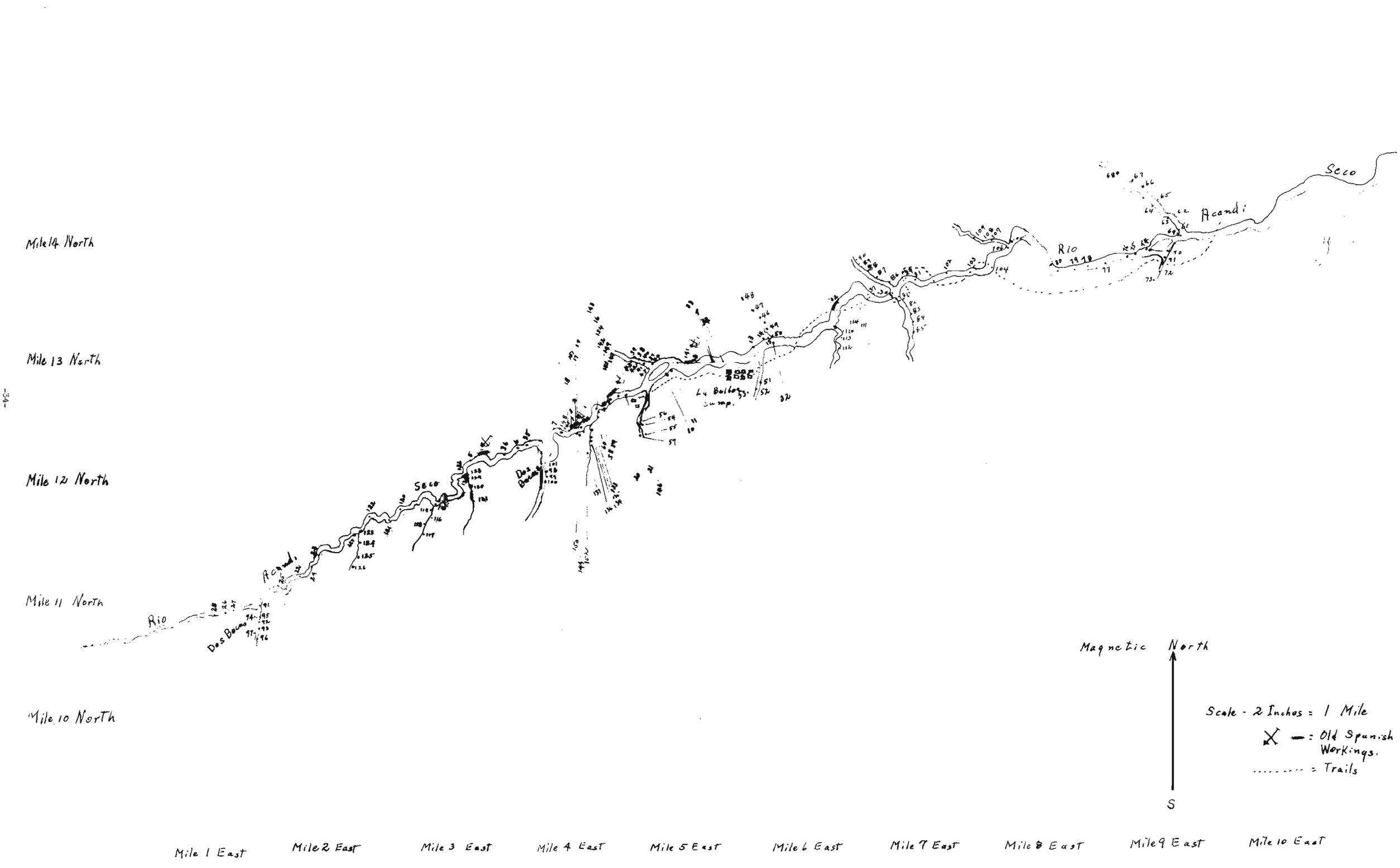
(Note river boulders in stream bed and jungle wall at stream bank.)

Cholo Hunter, 18 Years Old

At Balboa Camp

Banana Boats at Their Anchorage at Acandi

Cuna Indians at Acandi


Mile 14 North
Mile 13 North
Mile 12 North
Mile 11 North
Mile 10 North
Mile 1 East
Mile 2 East
Mile 3 East
Mile 4 East
Mile 5 East
Mile 6 East
Mile 7 East
Mile 8 East
Mile 9 East
Mile 10 East
Rio
Dos Bocas
Seco
Acandi
La Balsa
Swamp.
Magnetic North
S
Scale - 2 Inches = 1 Mile
= Old Spanish Workings.
= Trails

APPENDIX 1

Approximate Cost of Equipment and Installation of Plant Provisionally Recommended

Necessary for each unit:

2 winches, double-drum, with Ford V-8 motors	$ 2,100.00
2,000 feet cable (9/16-inch)	120.00
20 sets car trucks (available here)	400.00
1,000 feet rails, splice plates, spikes, two switches (available here)	375.00
1 4-inch Jaeger self-priming pump and 1 2-inch Jaeger self-priming pump, with accessories, discharge hoses, suctions, etc.	1,150.00
2 1/2-cubic-yard Sauerman scrapers	320.00
Picks, shovels, small tools, nails, bolts, misc.	500.00
Crating above equipment	300.00
Freight & transportation, U.S. gulf port to Acandi	600.00
Transportation Acandi to La Balboa	600.00
Duties	200.00
Installation of equipment	1,500.00
30,000 feet lumber and transportation thereof	1,500.00
	$10,265.00

APPENDIX 1

(cont.)

Further Outlay for Initial Unit - Not Necessarily Duplicated on Additional Units

2 months' payroll, 50 days at $75.00 per day	$ 3,750.00
Gas, oil, greases, 50 days	715.00
Camp equipment	400.00
Native quarters	500.00
Road, Acandi to La Balboa, 12 miles	1,150.00
	$ 6,515.00
Necessary for each unit, as shown on page 35	10,265.00
Total	$16,780.00

Trucking or freight of equipment to U.S. shipping point; power shovel, its cost, freight and transportation (if furnished), will involve additional cost.