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Gold and Platinum Dredging in Colombia and Bolivia, South America

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SYNOPSIS

Alluvial mining has been carried on by various methods in practically every country in South America, but the greatest output has come from Colombia, gold being the principal product, with platinum in appreciable quantities.

The paper briefly describes current dredging operations in the three main areas in Colombia, with some reference to exploration by drilling, costs and difficulties, and development drilling, including Peru and Bolivia. There is a comment on the evaluation of prospecting results.

A section on titles and concessions discusses royalty terms in Colombia and Bolivia.

The high cost of equipping a property in South America is illustrated by an example from Bolivia.

Tables give general information and operating data from four operating companies, and dredge operating costs. The operating conditions are described and recovery systems, sales and future outlook are mentioned.

Although alluvial mining has been carried on by various means in practically every country throughout South America, the major production has come from Colombia which has coastal areas on both the Caribbean and the Pacific.

There are three main areas of present-day alluvial mining in Colombia. From north to south they are the Nechi River area, in the vicinity of Zaragoza, approximately 7° 30′ north of the equator, in the Department of Antioquia. The Nechi flows into the Cauca River and it, in turn, flows into the Magdalena River, the principal artery for river transport to the interior of Colombia. Pato Consolidated Gold Dredging, Ltd., a Canadian company, operates in the Nechi River area.

The second area, southward, is in the Department of Choco in the vicinity of Istmina, Condoto and Novita, approximately 5° N latitude. Present operating areas are on a tributary of the San Juan River, a southward-flowing river that enters the Pacific just north of Buenaventura, the principal Colombian port on the Pacific Coast. One dredge operated on a tributary of the Atrato River in this area from 1932 until 1944, when it was decided to move it to the San Juan drainage

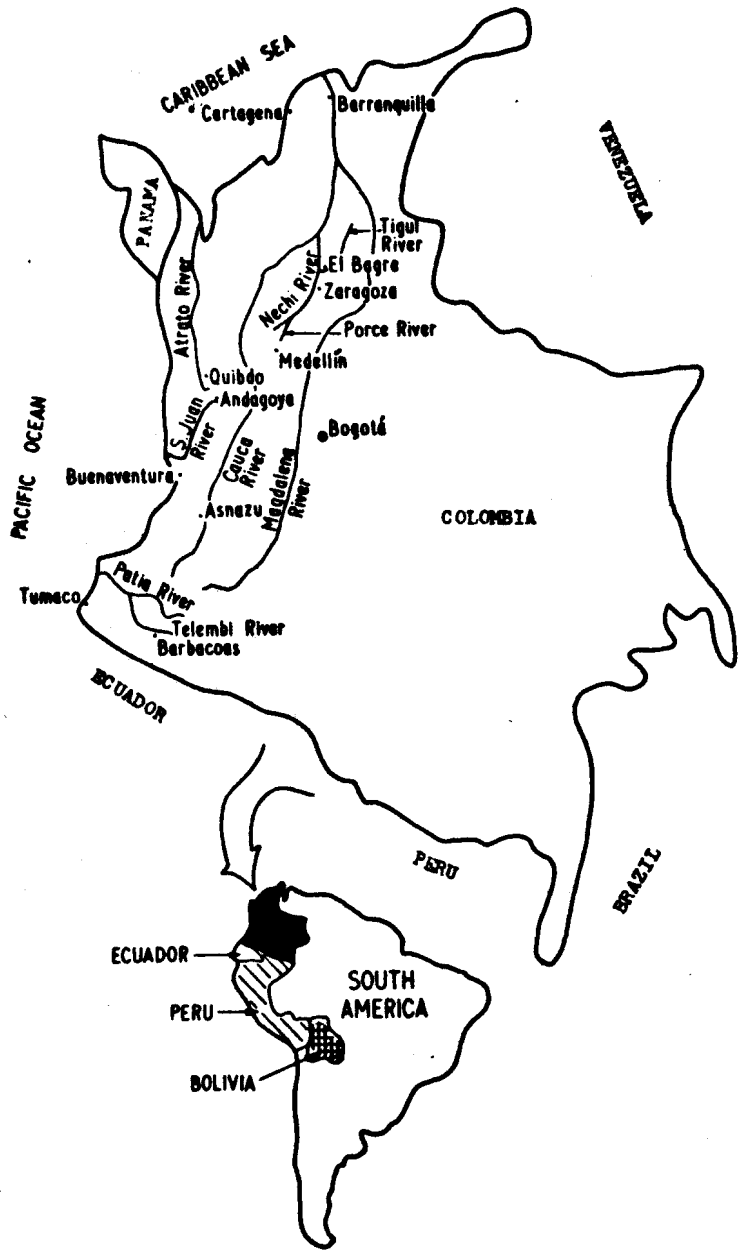

Fig. 1.—General map showing areas referred to.

area to the south. The Atrato flows northward to the Caribbean and although the dredge had only to move 40 air miles from one drainage area to the next, it was cheaper to move it 1200 miles by river and ocean through the Panama Canal after it completed dredging in the Atrato watershed. Farther south and very close to the Ecuador border at approximately 1° 45′ N latitude is the placer district near Barbacoas on the Telembi River and its tributaries in the Department of Narino.

There has been some dredging in other locations in Colombia, two of which were on widely separated tributaries of the Cauca River. Supia, just south of Medellin, and Asnazu, south of Cali. There was also one dredge working for a few years on the headwaters of the Patia River, south and west of Popayán. Asnazu, the most important of these areas operated one to two dredges from 1935 to 1956 and produced $15 531 000 in gold from 82 828 000 yd^3 of gravel.

Gold is the principal product of the alluvial deposits of Colombia, but platinum is produced in appreciable quantities in the Choco and in very minor quantities in the other areas. Russia was the largest producer of platinum until just before World War I. Colombia was the principal world producer from 1916 to 1923 and although her production of platinum has remained fairly constant since 1917, it now constitutes less than 5 per cent of world production.

Production of gold and platinum in Colombia continues to be appreciable, mainly in the three principal mining areas. This paper will be limited to the operations of the present-day dredging companies in Colombia with some reference to drilling and exploration costs in Peru and Bolivia and to costs of equipping and operating a single gold dredge operation in Bolivia.

EXPLORATION

The earlier prospecting in the Choco area was done with Empire or Union drills and in the Pato area by Empire drills and the steam-driven Keystone drills. The main drawback to the Empire drill, especially in the Choco area where all the early dredging was done in rivers, was that it could not be satisfactorily used in rivers that flooded frequently. The platform of the Empire drill screws on to the drive pipe and a hole would often be started near the river. The river would then rise as much as 10 ft or more in a few hours, forcing work to be abandoned, and often the tools and equipment would be lost.

In the early 1920s William F. Ward, an engineer who had considerable prospecting and dredging experience, developed for Compañia Minera Choco Pacifico a hand drill, known as the Ward drill, that could be used in a river on a barge or on a platform built on two large canoes. It was also easily portable and excellent for drilling on land and proved

to be much more efficient for drilling coarse gravel than the Empire drill. Greater depths could also be achieved.

The Ward drill (Fig. 2) is a simple unit that can be set up quickly. Basically, it consists of four straight poles, 5–7 in. in diameter at the large end, which are set into notches in planks to prevent their sinking

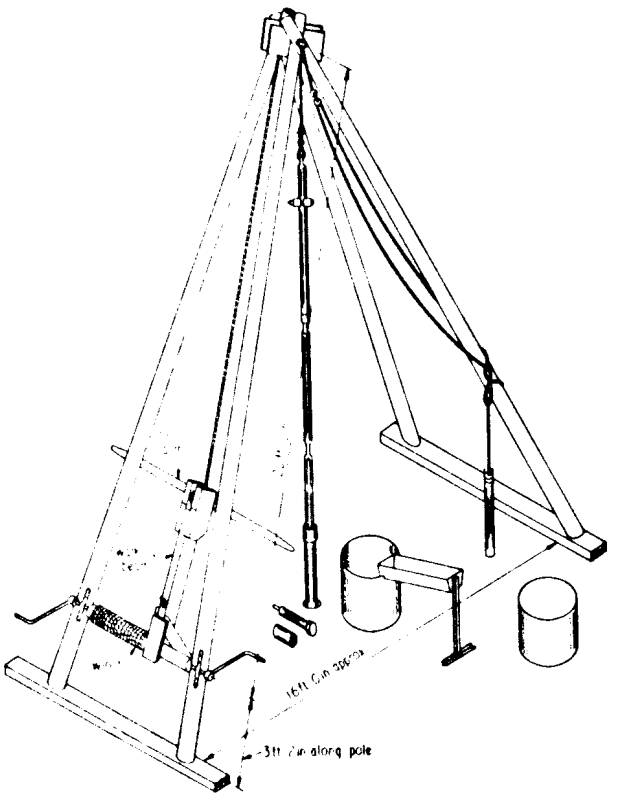

Fig. 2. Diagram of Ward drill.

into the ground. The poles are joined at the top by a shaft that holds the pulley for the drill wire or rope. The walking beam is activated by 8–10 men lining up on the cross arm. They pull down to raise the tools and vary their manner of movement depending on whether they are driving casing, drilling, or pulling casing. The Ward drill is logically most efficient in shallow ground, but can be—and frequently is—used in deeper ground, depths of 90 ft not having been uncommon in the Pato operations.

The Bucyrus and Keystone track-mounted power churn drills are

also used wherever ground conditions and drilling objectives permit. Besides being generally more economical on a cost-per-foot basis, the principal advantage of the power drills is the larger sample obtained. With power drills 6-in diameter casing is used, whereas 4- or 4½-in diameter is used with hand drills.

Cost per foot of drilling will vary widely depending on conditions encountered. The type of material to be drilled is usually the most important condition affecting the cost but location, terrain, experience of the crew, supervision, condition of the equipment, supply line and many other factors also determine the cost per foot. Tables I–IV show recent years' statistics on drilling done in the four dredging operations covered in this paper. As can be seen, cost per foot for hand drilling varies from 78 cents under exceptionally favourable circumstances near the main camp in Choco to an abnormally high figure of $20.14 per foot in an extremely isolated area that had to be supplied by plane from the Pato camp. Without previous experience in any given area it is impossible to estimate within any reasonable limits the footage or cost per foot that might be obtained per day.

A total cost per month per drill is a better figure to use, especially for exploratory work in a new area, in estimating costs of an exploration programme. When costs of an exploration programme in Peru in 1959 were estimated, figures of $5000 per month for a single-drill operation and $7000–$8000 per month for a two-drill operation were used. These cost figures are high, but the area was very remote. Initial supply lines required packing in by mules or llamas down the eastern slope of the Andes while an airstrip was built by hand.

The exploration programme along the Inambari and the Madre de Dios Rivers and several of their tributaries lasted a full three years. Six airstrips were constructed, all by hand work with homemade wheelbarrows. Equipment for five drills was purchased new and this was supplemented by additional 4½-in casing and tools to replace those lost or damaged. Some of the areas were fairly shallow – 20 to 45 ft – but the major part of the time was spent on the Inambari where depths ranged from 80 to 163 ft. From one to three Ward drills were in operation all the time.

The total cost for this entire programme averaged $7000 per month. The wages paid to labourers on this programme varied from 20 to 25 soles per day in basic pay and the total cost, including social benefits, was 35–40 soles or approximately $1.50 per day. In addition, it cost 20–25 cents per day to supply each man his usual requirements of sugar, rice, dried mutton or llama, etc. On each drill 14–16 men were employed, with additional labour when necessary for airfield construction, clearing the jungle for drill sites and packing in supplies.

Wages in Colombia for drill workers have been somewhat higher

TABLE I.—*Comparative drilling data—Compañia Minera Choco Pacifico, S. A.*

Year	Location	Type of drill	No. of holes	Depth, ft			Average ft/shift	Cost/ft U.S. $	Remarks
				Max.	Min.	Av.			
1959	Chiqui Choqui, land	BE 6″ power	24	60	36·0	50·8	18·0	1·11	Deep ground, some swampy
1959	Suruco Area „	„	17	59	16·0	37·9	21·0	1·44	Swampy ground, drill moving slow
1960	Upper Tamana, water	Ward 4″ hand pontoon	25	25	4·0	17·7	7·0	5·38	High rivers, hard drilling, canoe trans.
1960	Rio Iro Area, land	Ward 4″ hand	305	31	4·0	14·2	24·0	2·63	Canoe trans., built camp, high rivers
1960	Novita Val. „	„	121	30	6·0	11·6	39·0	1·18	Good trans., soft ground, used est. camp, swampy
1961	Novita Val. „	„	160	48	12·0	28·8	35·0	1·80	Built camp, swampy ground, easy drilling
1961	Opogodo Val. „	„	357	36	7·0	16·7	41·0	1·19	Shallow ground, easy moves, good trans.
1961	Garrapatas „	„	18	39	14·0	25·6	14·0	8·77	Built camp, high rivers, difficult trans.
1961	Raspadura „	„	35	71	19·0	47·7	24·0	1·88	Deep ground, very slow after 50 ft
1962	Raspadura „	„	76	105	10·0	60·8	21·0	1·84	—do.—
1962	La Ventura „	„	28	49	17·0	32·0	22·0	1·69	Canoe trans., much time lost travelling
1962	Bajo Opogodo „	„	50	42	12·8	22·2	38·0	2·10	Good trans., no drilling problems
1962	El Banco „	„	262	65	15·0	32·1	37·0	0·78	—do.—
1963	El Banco „	„	261	83	10·5	39·1	34·0	1·98	—do.—

TABLE IV.—*Comparative drilling data—Bolivia*

Month	Location	Type of drill	No. of holes	Depth, ft Max.	Depth, ft Min.	Depth, ft Av.	Average ft/shift	Cost ft U.S. $	Remarks
1961									
Jan.–Mar.	Challana, land	Ward 4½"	8	65·0	24·7	41·4	7·8	9·40	Boulders—hard drilling
June	Teoponte, land	BE 6"	4	84·0	32·0	57·3	8·4	4·30	,,
July	Sitahuara, land	Ward	3	51·0	26·0	39·7	8·0	9·80	,,
Aug.	Sitahuara, water	,,	6	51·0	11·0	27·9	5·7	8·70	,,
Sept.	Teoponte, land	BE	4	111·5	13·5	70·8	12·9	2·90	,,
Oct.–Dec.	Teoponte, land	,,	13	121·0	49·0	68·8	16·2	2·60	,,
1962									
Jan.–Feb.	Teoponte, land	BE	14	93·0	42·0	57·8	19·1	2·90	,,
Mar.–May	Challana, land	Ward	14	57·0	21·0	30·2	6·1	6·70	,,
June	Duran Playa, land	,,	12	58·0	15·0	26·3	12·8	2·80	,,
1963									
Jan.–Feb.	Teoponte, land	BE	7	99·0	34·0	65·5	14·4	2·40	,,
June–Sept.	Kaka River, water	Ward	34	42·6	1·7	21·2	9·1	6·30	,,
Nov.–Dec.	Asilahuara, land	BE	12	64·0	21·0	40·1	11·8	5·90	,,
1964									
Jan.–Mar.	Asilahuara, land	BE	12	89·0	24·5	51·1	14·9	4·80	Transport to other side

in the last year or so and now vary from $1.50 to $2.00 per day in basic wages plus an additional 35 per cent in social benefits.

Development drilling with Ward drills near established camps in Colombia costs an average of approximately $2000 per month. Power drills on development work cost less because fewer men are required. Two Bucyrus Erie power drills working in Narino last year averaged approximately $2600 per month for both drills. The cost for one would probably be $1700–$1800 per month. Recent costs on an exploration programme in Bolivia near transport and supply lines were running at $2000 per month for a power drill on one shift and $3000 per month with the same drill on a two-shift basis. On a two-shift basis costs per foot were averaging approximately $5.00. Costs of supervision and logistical support are principal items which, when applied to a multi-drill programme, can result in reduced unit overheads.

Evaluation of Prospecting Results

A discussion of the technical details of prospect drilling and the calculations of drilling results are beyond the scope of this paper, but the testing and evaluating of a placer deposit is not by any means an exact science and a few comments on the evaluation of prospect drilling may be of interest.

In valuing a drill-hole there are two governing factors—the gold recovered and the volume of the material from which it was derived. The gold can be weighed and therefore is definite, but the determination of the true or original volume of material from which the gold was extracted involves many variables. There is, of course, a theoretical volume of core rise that should be obtained for each foot of drive of the casing, which is a function of the outside diameter of the casing drive shoe. This theoretical volume will vary as the drive shoe wears down and cannot be obtained in actual practice as it depends on the size and looseness of the gravel, the size of the casing, the condition of the drive shoe and the length of the drive. The volume that is extracted is a deslimed volume, and even where the slimes are settled and measured the exact volume recovered cannot be determined. There is a tendency to use positive core correction factors—that is, to increase the amount of gold by the same percentage that the core rise or volume recovered is below the theoretical. This is a dangerous practice and should not be condoned in a new area, especially when there are boulders present or the gravel is very coarse. The only case where positive corrections should be used is when considerable dredging recoveries can be compared with the prospecting results. Experience has shown that even the application of proved factors to adjoining areas can be dangerous. In Choco, for example, where positive corrections up to 42 per cent were allowed based on dredging experience, these same factors applied

to deposits 10 to 15 miles away did not stand up and the resulting recoveries were very disappointing, averaging less than 50 per cent of expectancy. Negative corrections when the corrected volume recovered exceeds the theoretical should, on the other hand, always be applied.

TITLES AND CONCESSIONS

The major part of the areas that have been dredged and that are yet to be dredged in Colombia are held under mining claims issued late in the last century or in the early 1900s. One large area, the Condoto River in Choco, was dredged under a special concession that was granted to General Castillo in 1907 for his efforts during the war of One Thousand Days. There was considerable dispute over the General's title, however, because others claimed title through mines denounced prior to the time the concession was granted to General Castillo. The General's title was upheld by the Supreme Court after several years of litigation. The mining claims were generally purchased from the owners, although occasionally they were worked on a royalty basis. A law was passed in 1937 which provided that all navigable rivers and land within one kilometre thereof on either side could only be obtained for mining under concession from the government. Under the concession a sliding-scale royalty based on the tenor of the ground dredged is payable to the government. This scale is as follows:

Gold per m³ dredged mg	*Percentage of the gross proceeds exploited*
Up to 150	2
151–200	3
201–300	4
301–400	5
401–500	7
501–600	9
601–700	12
701–800	16
Over 800	20

Both when mining government concessions and privately titled mining claims certain production taxes, import duties and income taxes are payable to the government. Income taxes are at a maximum rate of 38 per cent and all taxes together total approximately 50 per cent of the pre-tax net profit.

Over the years the major problems in Colombia have been legal in nature involving title ownerships and dredging rights in navigable rivers, even where titles conferred before the passage of the new law were upheld by the courts. There have been very few problems in relation to mining under government concession. Inspectors are appointed by the Ministry of Mines to supervise the dredging, recovery, yardage measurements and reports.

The only dispute of consequence involved at one time the inclusion of transient river sand in yardage calculations for determining royalties. The rivers in Colombia rise quite often due to heavy tropical rains. These rises vary from a few feet in the large rivers in the lower Pato area to as much as 30 ft or more in the upper Narino area. Even at low stages the rivers carry considerable volumes of sand, especially at Pato, where the top part of the 90-ft dredge section is mostly sand. When the rivers rise, the volumes of sand carried into the dredge ponds require many hours to clean out. It is impossible to measure these volumes of sand accurately, but after extensive negotiations and discussions with the government mines officials acceptance of the volumes on an hourly basis as reported by the winchmen on duty was agreed. The average yardage of the dredge is then used for the calculation.

Small, narrow and swifter rivers have to be dredged on a headline digging upstream and thus suffer the full effect of transient sand or gravel in high river stages. In order to alleviate the sand digging problem in the deep ground in Pato's wide rivers the dredges dig downstream using a spud, and the only cut that is bothered with sand is the river cut where the sand washes in the side of the dredge cut.

In 1956 a contract was worked out in Bolivia on a gold placer property east of the Andes. The ground was in the government preserve and was to be worked under a concession. The government was interested in a partnership arrangement and rather than a 50 per cent split of the net profit, which would have involved accounting problems, a formula was worked out as a sliding scale based on estimated costs and production to result in the equivalent of a 50 per cent split of earnings. The contract provides for a flat 5 per cent gross royalty plus a sliding-scale sole tax on the following basis:

Gold per yd³ dredged mg	*First 5 years per cent*	*Second 5 years per cent*	*Last 15 years per cent*
300–400	4	4	6
401–500	6	8	11
501–600	10	12	15
601–700	13	15	19
701–800	16	18	22
801–1000	19	21	25
Over 1000	22	25	30

The sole tax is in lieu of all import, export and income taxes. The company is free to export the gold, and royalty and sole tax are settled quarterly in dollars or in kind at the election of the government. Shortly after the start of the operation they selected payment in kind, which is still in force.

The contract was based on many years of experience in Colombia and its location in the same country was the principal adviser in writing the Bolivian contract.

Only one major problem has arisen in regard to the Bolivian contract and that concerns the volume or yardage used in the calculations to arrive at the tenor. In view of the previous problem with transient sand in Colombia, care was taken to cover this point clearly in the Bolivian contract. There has never been any problem in Colombia with tailings that have had to be re-dredged and the Bolivian contract clearly states that *all* yardage dredged is used in calculating the tenor. Nevertheless, the inclusion of tailings in royalty calculations has been contested by the head of the gold department of the Bolivian Mines Ministry.

When a dredge digs parallel courses there has to be a certain amount of re-dredging of its own tailings due to the arc the buckets make as they dig from top to bottom and to the fact that the tailings have a lower angle of repose than virgin ground. The amount of tailings to re-dig is small in percentage and varies with the conditions in any particular area. Sometimes it is possible to spread tailings away from the virgin ground; on other occasions it is necessary to stack them along virgin ground for water-level control.

The dredging of tailings has never yet affected the volume sufficiently to alter the sole tax scale, but the government agency has yet to approve officially any of the liquidations and the matter is of increasing concern.

A sliding-scale royalty and or sole tax is a fair system for both the government and the operator of a property. If the ground is rich, the government gets a large percentage, but if it is low-grade the operator pays only a small percentage to the government so there is enough margin left to operate profitably.

As a result of the problem on tailings, the Ministry of Mines has refused lately to negotiate another contract with a sliding-scale sole tax based on tenor and has insisted on an increasing-scale basis. The new scale is not published yet, but it is understood that royalty plus sole tax starts at a combined 14 per cent of gross production and increases gradually to 30 per cent in 25 years.

DREDGE INSTALLATION

The cost of equipping a property in South America can be very high in an isolated location such as in Bolivia where it was necessary to construct airfields, buy aircraft of special type and fly everything in. Only $151 000 was spent in exploring the property in Bolivia before sufficient reserves were developed to justify the equipping of the property, which then cost almost four million dollars.

A second-hand dredge in Bulolo, New Guinea, which was originally

designed for airlift, was purchased at the site, as it was, for $175 000. It cost $135 000 to dismantle, $40 000 to truck it to Lae, $70 000 to ship it from Lae to Arica, Chile, $57 000 to haul it from Arica to La Paz by rail, $25 000 to haul from La Paz to Caranavi by truck and $128 000 to fly it from Caranavi to Teoponte, the construction site. The last figure does not include the cost of two Northrop aircraft which amounted to $350 000.

The foregoing figures, except for the aircraft cost, are included in the dredge cost of $2 090 426, shown in Table V, which is a general breakdown of the costs of equipping the property in Bolivia with one 11-ft³ dredge capable of digging 65 ft below water.

TABLE V

Dredge	$2 090 426
Diesel power plant	202 157
Transmission line	48 232
Buildings	385 227
Aircraft	385 455*
Airports	73 546
Transportation equipment	56 997
Office machines	6 126
Furniture and fixtures	18 979
Sundry equipment	29 282
Exploration equipment	29 091
Construction equipment	85 475
Mechanical shop equipment	89 554
Electrical equipment	7 800
Carpenter shop equipment	5 767
Hospital equipment	10 986
Materials and supplies	262 509
Exploration and development	151 083
	$3 938 692
*Two Northrop Airplanes	$349 079
One Helio Courier	36 376
	$385 455

More recently, a second-hand dredge was purchased by Pato for $50 000. Extensive modifications were done on this dredge to extend its digging depth from 65 to 90 ft. The hull was lengthened 24 ft, which required major modifications to the superstructure. The total cost of this dredge installed and in operation on the property in Colombia will approximate $1 807 654.

DREDGING

Tables VI–VIII provide operating data and general information on fifteen dredges used by the International Mining Corporation's associated companies in South America, while Tables IX–XI provide cost data on the twelve units which have been operating in recent years.

Owing to an extensive strike at Pato in 1963 cost figures for 1962 are used for that company as they are more representative of normal operation. Pato's dredge 6 has been shut down for several years because of a lack of reserves for this small specially designed dredge. Pato's dredge 8 started operation in August 1964, and Choco's dredge 2 was shut down the same month. Narino's dredge 1 has been shut down since early 1962 for lack of reserves. A study of these Tables readily indicates the difference in the character of the ground being dredged and the conditions under which the dredges are operating.

The Bolivian dredge—a single unit, supplied by air, operating in a remote area under the most difficult dredging conditions—is by far the poorest performer in capacity in relation to its size and has the highest monthly and unit costs. It was expected that performance would be poor and costs correspondingly high when the area was entered, but both have been worse than expected. The ground is very tight with many large boulders, most of them close to bedrock which makes it very difficult to clean bottom, and the wear on the bucket lips is hard to imagine. A 6-in welded lip segment will last only a few months as compared to a year and a half in the Pato and Choco operations in Colombia. As many as four lips have been worn off in a single year in Bolivia. The wear on all other parts of the dredge is also excessive in comparison to other dredges operating under less severe conditions. The ladder on the Bolivian dredge has been broken twice; the stacker has dropped three times; and the hull has been punctured twice. Screen plates and stacker belts have a very short life. The main dump hopper requires constant rebuilding, as does the ladder and practically every other operating part of the dredge.

Power costs of 6·1 cents/yd^3 in Bolivia and 2·3 cents/yd^3 in the Narino operation are a reflection not only of low yardage but also of the higher cost of diesel-generated power. At Choco, where some diesel power is used in conjuction with hydroelectric power, costs range from 0·5 to 1·0 cents/yd^3, which compares to costs of 0·2 to 0·3 cents at Pato where an efficient hydroelectric plant produces very low-cost power. In terms of cents/kWh, generating costs vary from 0·25 cents at Pato to 3·7 cents in Bolivia, with average costs of 0·62 cents/kWh for hydro and 2·1 cents/kWh for diesel at Choco and 2·6 cents/kWh for diesel at Narino.

Diesel fuel for the Bolivian operation is trucked down a precipitous road on the eastern slope of the Andes to the end of road transport. From there it is then floated in 1000-gal* rubber tanks approximately 40 miles down a swift river to the operating site. This results in diesel fuel costs of 33 cents per gallon landed at the operating site. In Narino

* U.S. gallon.

TABLE VI.—*General information and operating data on all dredges—Pato Consolidated Gold Dredging, Ltd.*

Dredge number and name:	1-A, Pato	2, Nechi	3, Jobo	4, San Fco.	5, Boyaca	6, Guayabal	7-A, Sta. Margerita	8, Antioquia
Date of construction	1936	1915	1937	1938	1938	1950	1941	1936 (dwg.)
Last reconstruction	1947	1957	1953	1950	1958	—	1949	1964
Depth of hull, ft	7·75	9	10	11	11	7·5	9·1	11
Width of hull, ft	45	60	80·2	74	74	44	70	70·5
Length of hull, ft	105·3	125	157·4	170	165·3	92·5	166·05	173·25
Width of ladder well, ft	5·6	5·6	8·7	8·7	8·7	5	8	8·25
Flotation depth, ft	5	6·75	7·2	7·2	7·2	5·5	7·79	9
Digging face to end of stacker, ft	207·25	282	345·25	349·25	359·2	161·67	405·96	395
Top stern gantry to waterline, ft	58·25	69	77·67	77·67	77·67	44·21	93·5	72·5 Deck
Lower tumbler to end of tail sluices, ft	157·25	200·5	256·50	263·75	265·75	134·75	250·44	278·83
Length of digging ladder, ft	83·3	101	144	158	156	77·5	160·25	171·25
Max. digging depth, ft	45	48	81	91	87	39	87	90
Spuds	1	1	2	2	2	1	1	2
Size of buckets, ft^3	6	8·5	13·75	13·75	13·75	2·2	13·75	13·75
Pitch of buckets, in.	30	33⅓	38	38	38	21	38	38
Number of buckets, average	71–75	71–75	87–100	105–109	105–109	92	105–109	117
Buckets per min	30	26	28	28·0	32	35	28·5	28
Size of revolving screen, ft	5·4 × 34·5	6 × 34·5	8 × 48	8 × 48	8 × 48	4 × 24	9·1 × 54	9·25 × 53·31 o.d.
Screen rev/min	10·50	10·7	8·25	8·25	8·25	13·4	7	6
Screen slope, in.	1–1½	1–1½	1–1½	1–1½	1–1½	1–1½	1–1½	1–1¾
Jigs	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Theoretical maximum capacity, yd^3/month	288 000	353 520	615 600	604 800	703 641	122 400	615 600	615 600
Actual capacity, yd^3/month—recent years	145 000	224 000	400 000	477 000	491 000	51 000	329 000	Not known

TABLE X.—*1963 dredge statistics—Choco group and Narino (contd.)*

	CHOCO GROUP								NARINO	
	Dredge 2		Dredge 3		Dredge 4		Dredge 6		Dredge 5	
Bucket capacity, ft³	7		12		8		11		12·7	
Yardage dug, average per month	340 214		480 981		259 577		525 102		277 970	
Costs, average per month	Total	cents/yd³	Total	cents/yd³	Total	cents/yd³	Total	cents/yd³	Total	cents/yd³
*	$		$		$		$		$	
Indirect:										
Labour	5 319	1·6	7 447	1·5	6 852	2·6	7 648	1·5	11 559	4·2
Materials	1 915	0·6	2 681	0·6	2 710	1·0	2 681	0·5	6 523	2·3
Royalties	873	0·3	—		4 798	1·9	828	0·2	2 597	0·9
Depreciation	806	0·2	1 128	0·2	967	0·4	1 128	0·2	1 272	0·5
Miscellaneous	2 132	0·6	2 985	0·6	3 784	1·5	3 300	0·6	5 505	2·0
	$11 045	3·3	$14 241	2·9	$19 111	7·4	$15 584	3·0	$27 456	9·9
Total costs	$27 451	8·1	$35 265	7·3	$35 898	13·8	$41 131	7·8	$51 457	18·5

* Amortization of deferred heavy spare parts. † Amortization of deferred dredge reconstruction.

TABLE XI. *1963 dredge statistics—South American Placers, Inc.*

	Dredge 7	
Bucket capacity, ft³	11	
Yardage dug, average per month	145 892	
Costs, average per month	*Total*	*cents/yd³*
Direct:	$	
Labour	4 153	2·8
Materials	8 545	5·9
Power	8 887	6·1
Shop work	2 303	1·6
Laboratory and refining expenses	1 114	0·8
Insurance	1 169	0·8
Miscellaneous	2 064	1·4
	$28 235	19·4
Indirect:		
Labour, materials and miscellaneous	27 585	18·9
Royalties	8 279	5·7
Depreciation	26 864	18·4
	$62 728	43·0
Total costs	$90 963	62·4

and Choco the diesel fuel is transported up-river in company-owned barges and is landed at the operating sites at approximately 17 cents/gal.

Supplies for the Bolivian operation are flown from the end of road transport in company-owned tri-motored Northrop aircraft. These planes, which are not licensed in the U.S.A., were designed especially for short-field heavy-lift work in the Korean War, but were not completed before the end of that conflict. Two of these aircraft were purchased to haul the dredge to the operating site and they did the job well, hauling loads up to 5 tons and more from a short field built by the company at the road terminus. It now appears likely that a road will be constructed with U.S. AID (Agency for International Development) funds to mining and agricultural areas in the vicinity of our operation, and it is estimated that overall costs will thereby be lowered at least $80 000 per year with the elimination of the airlift and river transport of diesel fuel.

The Narino operation is in a narrow river valley with fairly hard digging in coarse material. The river fluctuates rapidly as much as 30 ft in twenty-four hours from the tropical rainfall which exceeds 300 in. per year. It has been a single-dredge operation except for 2 or 3 years when dredge 1 from Choco was moved down to dig some shallow areas.

Dredge 1 performed satisfactorily in the Choco, but poorly in the more compacted coarser alluvials of Narino. Direct costs are not too much higher than those at Choco, but the new dredge has to absorb all the indirect costs of supervision, shops, warehouses, commissary, hospital, schools, transport, housing, and all the other things that are essential to isolated operations.

The Choco operation has a variety of digging conditions. Dredge 4 is in a small swift river with coarse material and many boulders, although the digging is still easier than in Bolivia. Dredges 3 and 6 have been in a large inland area with relatively easy digging. For several years dredge 2 has been in an inland area where it has been able to handle large yardage for its size. All of the Choco dredges have had changes in bucket capacities, bucket-line speeds, and by other means operating performance has been generally improved.* The yardage has been increased as much as 286 per cent from the original performance of some of the dredges.

The Pato operation has the best overall digging conditions with easy digging and very few rocks larger than a man's head. The supply line from Barranquilla on the coast is relatively long, but river transport is available by private companies at reasonable rates. All of the dredges operate out of one main camp as compared to three camps in Choco and two in Narino. All transport to the dredges at Pato is by river launches. Power costs are low, as mentioned earlier. Indirect costs are distributed equally over six dredges and from July 1964 a seventh unit will help carry the overhead. The company has very modern and efficient shops, hospital, and other facilities. Pato also has extensive reserves, whereas Choco and Narino have very limited reserves.

Recovery Systems

Jigs are used as the primary recovery system on all the Pato dredges, on Choco's dredge 6, and on the Bolivian dredge. The other dredges have tables with standard riffles. The gold is so fine-grained at Pato that recoveries would be very poor without jigs. Choco's dredge 6 had jigs installed a few years ago and platinum recovery has definitely improved so jigs are soon to be installed on Choco's dredge 3.

Sales

The platinum produced by Choco is sold in the U.S.A. to refiners, generally through brokers. The gold produced in Bolivia is sold in the London market. Gold produced in Colombia is sold to the Bank of the Republic at 835 per oz with 25 per cent paid in dollars and 75 per cent in pesos at the average free rate of exchange during the previous week. Since August 1964 the Bank of the Republic has also been paying a bonus of 15 pesos per oz of gold to the large mining companies. A large bonus has been paid to small mines for several years and still continues.

* Romanowitz, C. M., High-speed bucket-lines. *Min. Wld, San Francisco*, **22**, July 1960, 39–43.

Future Outlook

Colombia has been experiencing an inflationary period during recent years, as have most other countries. In the past 11 or 12 years the peso has depreciated from 2.50 pesos per dollar to 13 pesos per dollar, which has been helpful to the mining industry because the currency was depreciating at a faster rate than costs were rising. However, costs continue to rise at an ever-increasing rate and the pressure for higher wages to offset increasing living costs is constant. Owing to an unfavourable balance of payments the importation of necessary equipment and spare parts is a very serious problem. Local manufacture of many items is increasing, but often, as with many new industries, the quality is not as good as it should be and the cost is generally considerably higher than that of the same imported item.

With a fixed-price product in an inflationary economy it has been necessary to steadily improve operating efficiencies and recoveries. Bucket-line speeds have been increased and jigs have been installed to improve recoveries that suffered with increased volumes. These improvements, plus some help from a depreciating currency and, more lately, the bonus in Colombia, have made it possible for the mining companies to continue on a profitable basis.