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AN APPRAISAL OF THE MINERAL POTENTIAL OF THE PETER'S MINE AREA, NORTHWEST DISTRICT, GUYANA

By

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U. S. Geological Survey

This report is preliminary and has not been edited for conformity with Geological Survey format.

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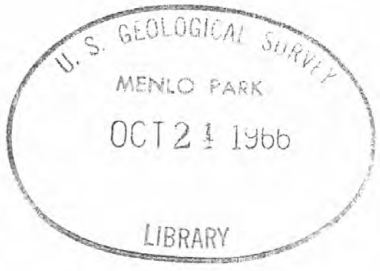

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INTRODUCTION

Purpose and scope of this report

This brief appraisal of the mineral potential of the Peter's Mine area in the Northwest District on the Puruni River, Guyana, was made by the writer in company with Mr. C. N. Barron, Staff Geologist, Guyana Geological Survey, over a five-day period in April, 1966. This study constitutes a part of the U. S. Geological Survey's advisory services to the Government of Guyana's central geological service, under the auspices of the Agency for International Development, U. S. Department of State.

About 1½ days were spent southwest of the Peter's Mine area in trying to find on the ground evidence of an electromagnetic (EM) anomaly that was indicated by an airborne geophysical survey conducted under the auspices of the United Nations Special Fund. The rest of the time was spent in the Peter's Mine area itself. The geology of the open pit at the mine was mapped, two of the old adits were inspected, and a general reconnaissance was made of the area. On returning to Georgetown, the records of the 1964-1965 drilling project were reviewed and the data correlated with the pit mapping. The following interim report appraising the potential of the Peter's Mine area is based on this information.

In writing this report, I have drawn heavily on Mr. C. N. Barron's extensive knowledge of the geology of this part of Guyana and of the Peter's Mine area. Many of his ideas are included.

Location

Peter's Mine, one of the most productive lode mines in Guyana, is on the Puruni River, approximately 30 miles above its confluence with the Mazaruni River. The only present means of access is by boat from Issano on the Mazaruni River. A cleared area near the mine would permit access by helicopter. A cart road formerly ran from the mine to Kartabu Point near Bartica on the Mazaruni River 65 miles distant. This road has not been used for many years and is now impassable.

History of mining and investigation

Peter's Mine was in operation from 1904 until December 1909. According to old records, production during this interval was approximately 39,800 ounces of gold recovered from 49,600 tons of ore milled, or a recovery of 0.79 ounce per ton. In 1915 and 1916 the mine was reopened, additional development work was done, and 1,103 ounces of gold were recovered. The mine has been closed since then except for an abortive attempt in 1948 to recover gold from the old tailings by cyanidation. The history of the mine has been described in a publication of the Guyana Geological Survey Department (Bishop, 1937).

In 1964 and 1965 the Geological Survey Department re-examined the Peter's Mine area. Shallow holes were dug by Banka drill and the spoil panned for gold to outline the gold-bearing area. Following this seven diamond drill holes were put down. Data were carefully recorded, but a formal report on the results of the drilling has not yet been completed.

GENERAL GEOLOGY AND MINE DEVELOPMENT

The general geologic setting of the Peter's Mine area is shown in figure 1, a map prepared by C. N. Barron. The gold deposits are in Precambrian psammitic and pelitic schist which is part of the Cuyuni Formation of the Mazaruni Group. The Peter's Mine area is near the western edge of a body of granitic rock and lies within an area of gold mineralization that extends from Million Mount and Mara Mara Creek southward at least to the southern edge of figure 1. A substantial production of alluvial gold has been obtained from this area in the past, but little or no mining is being done at present.

Figure 2 depicts the geology in the vicinity of Peter's Mine. Figure 3 is a composite plan of the principal underground workings showing the outlines of the various ore bodies. These workings are inaccessible; the information on figure 3 comes from old company maps and from the files of the Geological Survey Department.

The main workings of Peter's Mine consist of a 300-foot shaft with levels at 100, 200, and 300 feet below the collar, and an open pit whose floor is approximately at the 100 level. The 100 level was also once connected to the surface through No. 1 and No. 2 Tunnels (figures 2 and 3). No. 1 Tunnel has been partly destroyed by the open pit and its location is hidden under the debris that masks the wall of the pit. The portal of No. 2 Tunnel has not yet been found. Several other short adits explored veins to the north and south of the main workings. Most of those workings are no longer accessible and only a few are shown on figure 2. Approximately 700 feet south of the open

pit is an inclined shaft and a series of pits and trenches on a north-trending vein. Still further south, near the Puruni River, are several shafts and many trenches and pits. This area has not been examined in detail but reconnaissance by C. N. Barron indicates that several veins are present. According to Barron a $2\frac{1}{2}$ foot vein exposed in the inclined(?) shaft shows visible free gold and other veins in a nearby adit showed considerable free gold on panning.

Production from Peter's Mine came mostly from the 100 and 200 levels and from the open pit. Comparatively little seems to have been mined from the 300 level.

DETAILED GEOLOGY

At Peter's Mine at least 4 principal veins were mined; the North-South Vein, the West Branch Vein, the Sutherland Vein, and the Karnes and Peter's Veins; these last two appear to be the same (figs. 2 and 3). Other veins are mentioned in the old mine reports but are not readily identifiable. Mapping of the Peter's Mine open pit indicates numerous interlacing and branching veins. The general trend of the mineralized structure north of the open pit is slightly east of north with a dip of 70° W. In the immediate mine area the strike swings sharply to the southwest, and south of the mine area the strike is again northerly. C. N. Barron has postulated a fault immediately south of the Peter's Mine open pit to account for this bend in the structure. Although no direct evidence of a fault exists at the surface, ground magnetic surveys are reported to show a disturbance south of the mine and thus lend some support to this hypothesis. Barron's map of a tunnel south of the mine also shows a number of small faults striking in roughly east-west directions.

The country rock exposed in the open pit is a much weathered chloritic schist. Drill-hole sections show that extreme weathering extends to a depth of from 100 to 200 feet. In general the foliation of the schist strikes a little east of north and dips steeply west or vertically. Locally, especially near some of the faults, the foliation is much distorted. C. N. Barron collected samples of residual soils along several lines across the mineralized zone. From a count of quartz grains he concluded that to the east the schist is derived from arenaceous sediments, whereas to the west it is derived from argillaceous sediments; some alternation of argillaceous and arenaceous layers was recognized near the contact. He concluded further that the mine is in the arenaceous schist near the arenite-argillite contact. Drilling has confirmed a belt of arenaceous schist to the east and argillaceous schist to the west, but in the immediate mine area, this simple relationship does not seem to hold rigidly.

Old mine reports mention that a "white quartz porphyry" was found in the mine working. None was noted on the surface nor in any of the drill holes.

Andesite was cut in drill hole 7 southwest of the mine, but none was found in drill holes closer to the mine area. Magnetometer surveys indicate that andesite forms a band west of the mineralized zone which can be traced parallel to the regional strike for many miles to the north.

Innumerable carbonate or quartz-carbonate seams are striking features of the country rock in the mineralized area. In the open pit

most of these have been removed by weathering, but others are very conspicuous in the drill cores. These veins are all low in gold; apparently they antedate the period of gold mineralization.

Sloughing of the walls of the open pit has obscured much detail, but nevertheless the complex vein structure can still be seen in places. The principal veins trend northeast and dip 60° to 70° N.W., intersecting the foliation of the enclosing schist at a slight angle. Some veins, however, dip as low as 15°, a few dip steeply southeast, and a few strike northwest. Many veins have well-defined gouges. In some places fragments of vein material are found in the gouges or in the adjacent brecciated wall rock, indicating post-mineralization or intra-mineralization movement on the veins.

Veins in the open pit range from a fraction of an inch to as much as 15 feet wide but commonly are 4 to 5 feet wide. Some are composed of nearly solid quartz, but many are composite zones made up of numerous quartz stringers. Free gold can be panned from nearly all the veins exposed in the open pit, but iron-stained quartz, limonite, and included wall rock are usually all that can be seen in hand specimens. Old mine reports indicate that pyrite was abundant on the 200 and 300 level; small amounts of chalcopyrite and galena are also mentioned. Molybdenite was observed in cores from drill hole 4. Production records indicate that the ore probably averaged about 1 ounce of gold per short ton, but assays as high as 6 ounces per ton over widths of 9 feet are reported. Samples of veins in the open pit taken by C. N. Barron in 1964 substantiate this range; they contain from 0.19 ounce of gold per short ton to 6.77 ounces. These samples, which

were assayed only recently, are plotted on figure 2.

Study of the mine maps suggests that the principal ore sheets may have raked to the southwest.

EXPLORATION BY THE GEOLOGICAL SURVEY DEPARTMENT

During the Geological Survey Department project at Peter's Mine, numerous Banka drill holes were put down and the samples panned to outline the gold-rich zone. Following this, diamond-drill holes were put down, all in or near the main mine area. Results of the drilling were not entirely satisfactory because of the difficulty of correlating the veins cut in the drill holes. Furthermore, the low gold content of most of the samples assayed was disappointing. Nevertheless, quartz veins or vein zones were cut in all but one of the drill holes, and many of these had substantial widths. Native gold was noted in the drill cores in at least three places. One hole yielded an assay of 1.1 ounces of gold per ton over a width of almost 6 feet. Another assayed 11.403 ounces over 1.3 feet, or 5.403 ounces over 3.7 feet, and this interval was underlain by about 11 feet of possible gold-bearing rock from which no core was recovered. These results, together with the encouraging samples from the open pit, provide some reason for optimism even though the diamond drilling did not yield the results that had been hoped for. Some further study of the Peter's Mine area therefore seems justifiable.

Description of drill holes

Veins mapped in the open pit can be matched very closely with those recorded on the old mine maps. Using both surface and underground

data, it was possible to draw cross sections along the drill holes and, with some confidence, correlate on these sections the veins cut in the drill holes with those that had been mined in the old workings.

Section A-A' (Holes 3 and 4)

Holes 3 and 4 were drilled to provide a cross section through the ore zone just north of the open pit (fig. 4). The two holes dip toward one another, and it was planned that both would transect the entire ore zone. The section was well chosen because most of the important veins mined in the old workings should have been intersected. Unfortunately, Hole 3 hit an open space at a depth of 396.6 feet, probably the crosscut to the shaft on the 300 level, and caved so badly that it had to be stopped at a depth of 432.5 feet before penetrating the main part of the Peter's Mine mineralized zone. Above the cave the hold penetrated a series of quartz stringers. Free gold was noted in the core immediately above the cave, but no assay was made of this part of the core. Below the cave the hole cut additional quartz veins. Assays of this part of the hole are very low in gold, but core recovery was poor. The zone of veins cut in Hole 3 appears to be one that crops out in the northwest corner of the open pit.

Hole 4 was drilled in a northwesterly direction to a depth of 700 feet. Three quartz vein zones were cut, one of which contained visible free gold; the core sample from this averaged 5.403 ounces of gold per ton over 3.7 feet. The deepest two of these veins seem to correlate with the North-South and Karns veins, although these correlations are not certain. The third vein, which contains free gold,

cannot be correlated with any known vein, except possibly the Karns vein; this correlation is unlikely, however, as it would require a reversal of the dip of the Karns vein. Hole 4 was not entirely satisfactory because it cut the veins at an unfavorably low angle and did not test any of the ground west of the North-South vein; thus there is an unexplored gap between Holes 3 and 4. Nevertheless, these holes show that the veins contain gold and that they extend at least 500 feet below the surface.

Section C-C' (Holes 1 and 2)

Holes 1 and 2 are in a northwest-trending section southwest of the open pit (fig. 5). Like Holes 3 and 4, they were drilled in a "V" pointing toward one another.

Hole 2 intersected the Peter's Mine structures at a high angle and traversed the entire known mineralized area. It passed through the probable extensions of both the West Branch and Peter's veins, which in this area appear to be close together. There was no indication of the North-South vein in the core, but mapping in the open pit suggests that toward the south the North-South vein bends toward the southwest and becomes the West Branch vein. Some quartz vein zones cut in Hole 2 southeast of the Peter's vein cannot be correlated with any structures in the pit or in the underground workings.

Assays from hole 2 were in general disappointing. However, an extensive zone of quartz veins cut between 539 and 591 feet, correlating with the downward projection of the West Branch vein (fig. 5), shows some encouraging assays. Most assays of this part of the core

were low, but samples from 539.0 to 544.0 feet, and from 544.0 to 549.0 feet assayed 6.95 and 4.36 ounces per short ton respectively, or an average of 5.66 ounces over a 10-foot length.

Hole 1, which at the collar had an inclination of 51°, steepened and cut through the mineralized zone at a very low angle and as a consequence, intersected only two of the productive structures and explored only a small part of the mineralized zone. For most of its length it seems to have followed down the dip of the Peter's vein, but apparently penetrated through the West Branch vein in the interval between 610 and 683 feet. Assays were disappointing except in the interval between 450.4 and 456.0 feet, which yielded an assay of 1.1 ounces of gold per ton. Because the inclination of the hole was so close to the dip of the vein, the samples probably are not very meaningful.

Section D-D' (Holes 5 and 6)

This section was designed to test the extension of the Peter's vein to the north of the mine workings. Holes 5 and 6 were both inclined southeasterly at 45° and 49° respectively (fig. 6). From 416 to 436 feet, Hole 5 passed through the probable extension of the Peter's-Karnes vein. At 251 feet it passed through a few feet of pyritized and weakly silicified rock that may be the extension of the North-South vein. Hole 6 penetrated a narrow quartz zone from 724.5 to 726.5 feet that probably is the extension of the North-South vein. Visible gold was reported in weathered rock at a depth of 139 feet in a small quartz stringer that does not correlate with any particular vein. No assays of Hole 6 are available. Assays of Hole 5 are very low, but

show slight rise at its presumed intersection with the North-South and Peter's-Karnes veins.

Holes 5 and 6 indicate that the veins are weaker and less numerous north of the Peter's Mine and are probably north of the area most intense mineralization.

Hole 7

Hole 7 is about 600 feet southeast of Section C-C' (Holes 1 and 2). It bears S. 45° E., has an inclination at the collar of 45°, and was drilled to a depth of 814 feet. It was designed to test a magnetic high southwest of the Peter's Mine open pit. No geologic section at the hole is included in this report because no surface geologic information is available to correlate with what was found in the drill core. The hole cut no quartz veins of any consequence and evidently is west of the mineralized area. Assays showed little more than traces of gold (up to 0.03 ounce /short ton) but these showed a clearcut maximum in the psammitic schist, along the strike of the ore horizon further north. It did penetrate some 600 feet of andesite flows, the probable cause of the magnetic anomaly, and thus yielded valuable geologic information.

Discussion of the drilling results

Of the seven holes drilled in the Peter's Mine project, six cut quartz veins of appreciable width. Sections through the drill holes show that most of these veins can be correlated with veins that were mined on the 100 and 200 levels or that can be seen in the open pit. Sections A-A' and C-C' (figs. 4 and 5) show that these veins extend to at least the 600 level, far below the level at which mining ceased

in the old workings. In drill holes 1 and 2 (Section C-C'), well south of the known mineralized area, veins are still strong and persistent. Section D-D' (fig. 6) indicates that the veins continue north of the old workings, but are weaker and less numerous. The drilling, therefore, has been successful in demonstrating that the mineralized structures continue in depth, and that, although they weaken to the north, the southern limit of the mineralized area has not been reached.

Conversely, the low gold assays from the drill cores are disappointing. In comparison with the high values reported from veins in the mine workings and confirmed by sampling of the open pit, they are also somewhat puzzling. Neither secondary enrichment nor impoverishment of gold content with depth appear to be the answer. Some near-surface enrichment in gold is probable, but should be relatively slight. Furthermore, gold veins at Peter's Mine are not the epithermal type which commonly become impoverished at shallow depth. On the contrary, they are in Precambrian rocks and presumably were emplaced under conditions of relatively high pressure and temperature. There is no geologic reason why both veins and gold should not extend to considerable depth.

The fact that the drill cores yielded a few extremely high assays and many extremely low ones probably provides a clue to the discrepancy. In high-grade deposits, particularly some gold deposits, the valuable minerals commonly are distributed erratically through the ore. In such deposits, it is not unusual for a drill hole to pass through a

rich portion of the deposits without drilling samples giving any indication of valuable ore. Many examples of this could be cited. The fact that a few drill core samples yielded gold assays of from 0.2 to as much as 11.4 ounces per ton and that free gold was noted in the cores in three places, indicates that the veins cut in the drill holes do contain gold 1/. One must conclude, therefore, that

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1/ Since writing the above, additional assays have been obtained from Hole 2. They show a 10-foot length at the intersection of the Hole with the West Branch Vein which averages 5.66 ounces of gold per short ton, strongly supporting this statement.

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the low assays of drill cores do not necessarily mean that the Peter's Mine veins are barren.

APPRAISAL OF THE POTENTIAL OF THE PETER'S MINE AREA

The records of the Peter's Mine operation contain both favorable and unfavorable features which must be considered in any attempt to appraise the potential of the mine. On the one hand the mine produced nearly 40,000 ounces of gold, valued at present prices at near $1.4 million U. S. currency. This production came from an area less than 300 feet long by 200 feet wide. All of it came from shallow workings, most of it from above the 200 level and none of it from below the 300 level. The average recovery of nearly 0.8 ounce of gold per ton of ore milled is sufficient to be of considerable interest, especially since it is probable that the recovery of gold was not good.

On the unfavorable side is the hard fact that the mine obviously was not profitable. It closed after operating for 5 years, and an attempt to reopen it some years later was unsuccessful. Analysis of the old data indicated that four factors contributed to the failure of the enterprise:

(1) The high cost of transportation.

(2) The great expense of building and maintaining a road from the mine to Kartubu Point, in an attempt to solve the transportation problem.

(3) Failure to anticipate a change in the mineral character of the ore, resulting in poor recovery in the mill.

(4) Exhaustion of the developed ore.

Evaluation of the potential of the Peter's Mine area must not only include an appraisal of the potential amount of gold-bearing material remaining to be discovered but must also include an inquiry into whether there has been a change in the other factors that would permit operations under present-day conditions.

Transportation is still a problem and will remain so unless a road is built. It is unlikely that enough ore could be found at Peter's Mine alone to warrant the cost of constructing and maintaining a road. However, in recent years small gold mines have been able to operate successfully in isolated areas by use of air transport. It would be entirely feasible to construct an airstrip at Peter's Mine that could accommodate light planes. Supplies could than be brought in and gold bullion shipped out by air.

The mill at Peter's Mine was designed to treat a free-milling gold ore. Old reports indicate that on the 200 level an appreciable proportion of the gold was contained in pyrite, and this gold could not be recovered. Although the total gold content of the ore may have been nearly the same, the lower recovery would have had the same effect as a decrease of gold content. Undoubtedly, more gold was locked up in pyrite on the 300 level. According to an unpublished report by Sir John Harrison, written in 1924, an attempt to recover gold in the pyrite by installing vanners produced a concentrate assaying 35 dwt. per ton (1.75 ounces per ton worth U. S. $36 in 1924), obviously insufficient to pay the cost of shipping to a smelter at that time. Installation of a concentrating and cyanide plant would probably solve this problem.

Drill-hole results may not tell much about the gold content of the veins, nor can much definite information on gold content be obtained from the old mine records. Some reports state that the veins were as rich on the 300 level as above; others state that the veins were breaking up into stringers and that the grade was decreasing. In any event, the old mine maps indicate that the ore shoots found on the 100 and 200 levels were incompletely developed on the 300 level, owing to either impoverishment of the veins in gold, or more likely, the increase in pyrite and the decrease in the amount of gold recoverable by the methods then in use.

The drilling done by the Geological Survey Department has shown that the gold-bearing structures extend at least to the 600 level undiminished in size. They appear to weaken to the north, but continue

to the southwest at least to Holes 1 and 2. A series of shallow open cuts suggests that gold-bearing veins are present still farther south near the inclined shaft shown on figure 2. The ore zone therefore may extend considerably father both vertically and to the south.

Assuming that the veins continue to the 600 level and extend as far south as Section C-C', the block of mineralized ground would be roughly four times the volume of that already mined. If the gold content should be similar to that already mined, this block of ground would have a potential production of about 160,000 ounces of gold. Whether Peter's Mine could actually produce this amount can only be determined by detailed explorations and development. Nevertheless, the size of the target is sufficient to be of real interest. This estimate does not include any extension of the ore bodies beyond Section C-C', neither does it make allowance for any production from the area of the inclined shaft, immediately south of the mine area, or from the old workings further south near the Puruni River, mentioned in the introduction to this report. Several other nearby areas of placer production such as at Jubilee Creek and on the left bank of the Puruni River south of Peter's Mine (fig. 1) may also have some potential for production, although they have not yet been studied by the Geological Survey Department.

SUGGESTIONS FOR FURTHER EXPLORATION

The most direct way of determining the grade of ore at Peter's Mine would be to rehabilitate the shaft, pump out the mine, and sample the underground workings. This, however, is clearly beyond the scope of the Geological Survey Department's present exploration program. Past

experience has shown that diamond drilling does not give reliable assay results, but it has yielded valuable information on the continuity of the mineralized structures. Some additional drilling seems justifiable to confirm information already obtained and to attempt to extend the mineralized zone.

Recommendation 1.--Drill hole Collar location: Approximately 235 feet N. 70° W. from Peter's Mine Shaft. (fig. 2)

Bearing: S. 50° E. (Magnetic)

Inclination: 40°

Inclined depth: 700 feet

Purpose: To crosscut the principal veins of the Peter's Mine deposit directly under the area where their attitude, thickness, and grade are best known from mine workings and from the mapping and sampling of the open pit. This will permit a better correlation of the veins intersected in the hole with these exposed on the surface and will give a better understanding of the structure. Figure 7 shows the veins that are expected to be cut by the hole. Hopefully, positive information on the gold content of the veins will be obtained. The proposed hole should provide the information that Holes 3 and 4 failed to obtain.

Recommendation 2.--Drill hole Collar Location: West of the Peter's Mine road approximately 360 feet southwest of the portal of No. 3 Tunnel (fig. 2).

Bearing: S. 75° E. (Magnetic)

Inclination: 45°

Length: 675 feet

Purpose: To test the extension of the Peter's Mine ore zone southwest of Holes 1 and 2. These holes demonstrate that the Peter's Mine veins continue strong southwest of the point where mining ceased on the 200 level. An inclined shaft and a series of surface workings 700 feet to the south suggest that the mineralized zone may continue south of Holes 1 and 2 (fig. 2). Hole 7 failed to cut any vein of note. The proposed hole will determine whether the mineralized zone has terminated or whether it has swung to a more nearby north-south strike.

Before drilling the hole the shallow surface workings north and south of the inclined shaft should be cleared out, the veins sampled, and their strike and dip plotted on figure 2. The location of the proposed hole should be shifted depending on what information is obtained from this work.

Recommendation 3.--Drill hole location: Area of old workings south of Peter's Mine area and near the Puruni River. Purpose: An area near Peter's Mine landing has a large number of prospect pits, trenches, shafts, and adits which expose several veins in coarse sandy metasediments. Most of these strike approximately north. The area has not yet been examined in detail, but panning of samples from veins and from the old dumps yielded interesting amounts of gold. These excavations should be mapped and sampled, and the strike and dip of the veins plotted. If the samples give favorable results at least one shallow hole should be drilled to test the most promising part of the area.

Recommendation 4.--The walls of the open cut at Peter's Mine were partly cleaned during the Geological Survey project; but in many places they are still covered by debris. Some additional cleaning of the walls of the pit would permit the face to be mapped in greater detail. Figure 2 indicates that in two places the old workings of the 100 level intersect the north face of the pit and are covered by a relatively thin layer of slide rock. It is possible that with a relatively small amount of labor those workings might be uncovered. If they are in a reasonably good condition, they might yield a great deal of information about the Peter's Mine veins.

The objective of the program outlined above is to enhance the attractiveness of the Peter's Mine area by demonstrating that the potential tonnage of ore is sufficient to justify the expense of detailed exploration and development. It does not appear that exploration by a Government organization should go much beyond this program.

REFERENCE CITED

Bishop, D. W., 1938: Report on an area between Quartzstone Head, Aremu mine, and the Puruni River: British Guiana Geological Survey, Bull. 9, 20 p.