GUYANA

Ministry of Agriculture and Natural Resources

REPORT ON THE GEOLOGICAL SURVEY DEPARTMENT FOR THE YEAR 1966

Geological Survey Department

P.O. Box 789

Georgetown, Guyana

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ANNUAL REPORT FOR 1966

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I. INTRODUCTION

The Geological Survey Department has its headquarters in Georgetown. There is a district office in Bartica, which is situated at the confluence of the Essequibo and Mazaruni Rivers.

At headquarters are housed the administrative and geologists' offices, petrological, colourimetric, spectrographic, fire assay, lapidary and sample preparation laboratories, a wireless and geophysical workshop; a museum, library and drawing office. Other facilities include a rock store, mechanical workshop and stores. The district office at Bartica functions mainly as an intransit centre for stores and personnel between headquarters and operations in the north central sector of the country.

The function of the Geological Survey is to establish the nature and extent of the country's geology and mineral resources as far as possible and necessary for Government purposes and to undertake, or advise Government on any other projects in the public interest which have geological implications.

During the year the Department fell within the responsibility of the Ministry of Forests, Lands and Mines.

II. GENERAL REVIEW OF THE YEAR

Independence

Several significant events took place during the year. The country became Independent on May 26th and assumed the new name Guyana.

Professional Staff

The Director of the Survey, Dr. P.H.A. Martin-Kaye opted to retire under the terms of the Overseas Service Aid Scheme and left the country on May 18th after 4 years as Director, and 16 years altogether with the Survey. Mr. P.B.H. Bailey, Deputy Director left in similar circumstances on May 24th after 13 years with the Survey. Dr. Sobharam Singh took over responsibility as Director as from 18th May and was appointed to this post with effect from 23rd June. For the first time in the history of the Survey a Guyanese occupied the chair as Director. Mr. C.N. Barron, Senior Geologist, was appointed to act as Deputy Director.

The shortage of Senior Professional staff was substantially aleviated with the arrival, during the second half of the year, of 4 more Swiss geologist recruits and the return of the Guyanese Geophysicist, Dr. M.A. Lee.

The availability of senior professional staff during the year is given in Appendix I.

Other Staff

Mr. S. Singh, Acting Chief Clerk was appointed Personnel Officer, Ministry of Health. He left the Department on 10th June, 1966 to take up his new appointment. Since 12th June, 1966 Mr. J.O.P. Adams has been acting in the post of Chief Clerk.

Training

Mr. M.D. Hope, Assayer, spent 3 months at the Mineral Resources Division of the Institute of Geological Sciences in London undergoing training in fire assaying and general analytical techniques. He returned to the Survey in February.

Mr. M.A. Lee, Commonwealth Scholar, successfully completed his studies for the Ph.D. degree in Geophysics at Imperial College, London and returned to the Survey towards the end of the year.

Mr. M. Persaud, Technical Assistant Grade I, spent 6 weeks at Denver Laboratories of the U.S. Geological Surveys in Colorado training in techniques of Atomic Absorption and general colourimetric analysis.

Integration of Mines with the Geological Survey.

During the second half of the year the Mines Department moved into the premises of the Geological Survey, the first positive step towards integration. By year end, however, modification of the laws to achieve complete integration had not yet been effected.

III. SUMMARY OF FIELD WORK 1966.

Shortage of professional staff severely curtailed field operations during 1966. All available staff were thrown into the Department's intensified mineral exploration programme. No regional mapping was specifically undertaken during the year.

The north of Guyana has been selected for the mineral exploration programme both on its relative accessibility and on its greater geological and mineral promise. It is, however, completely forested, with a population of only some 2,000 persons spread over some 12,000 square miles, and served by only 200 miles of poor road and 30 miles of mine railway. Geologically, it consists of greenstones of probably Archaean age with numerous granitic intrusions, and normally weathered to a depth of 100 feet or more.

The current mineral exploration programme is designed to examine the more accessible mineralised areas in the north of Guyana. In view of the absence of surface shows, evidence of mineralisation is based on the presence of old goldfields, of electromagnetic and magnetic anomalies detected by the UNTAB airborne geophysical surveys, and of favourable geological structures or environment. The regional geological background is derived from work carried out mainly by Government geologists, during the last 100 years. This culminated in the 1:1 million Provisional Geological Map of British Guiana, published in 1962 and the 1:200,000 geological atlas from which it was constructed.

During 1966 exploration activities were centred in the North West District (Barama), and the Aremu and Puruni goldfields. The results are summarised below.

Waini NW - Tassawini

In the Barama, geochemical reconnaissance along the southern margin of the Teki Granite had been initiated in the Tassawini during 1965 by Field Assistant, Mr. V.A. Agrippa under the supervision of Dr. S. Singh. During 1966 a further area of some 21 sq. miles was covered to the west of the earlier grid by Mr. J.D.N. Punwassee and Dr. W.G. Muller. Owing to the low swampy nature of the country and the resultant complicated drainage, soil sampling on grids of 100 x 400 and 200 x 1320 feet was employed instead of stream sampling. The samples were analysed for arsenic and zinc colourimetrically and for 10 other elements on the spectrograph. Work on them was not complete at year end, but the only elements showing notable anomalies are arsenic and molybdenum. The chromium background is generally high. Stream sediments were collected in Chinese Creek and for about 8 miles up the main Potaikashuru Creek. These have only been analysed for arsenic so far: a small anomaly is shown in the upper reaches of Chinese Creek.

Since stream sediment sampling in the vicinity of Tassawini Mine in 1965 had indicated a correlation between gold and arsenic or chromium, a small geochemical soil programme on

100 x 50 foot centres was mounted north of the mine in 1966 by Mr. M.W. Carter, Geochemist. This showed several areas with arsenic anomalies. In order to determine the relation of these to gold distribution and to the soil residual clay profile, 15 trenches (20' x 6' deep) and 63 pits (10 feet deep) were sunk and sampled in detail. The results are being analysed statistically, but there is no doubt of the close correlation of gold and arsenic. Mercury assays along one line here also show a marked correlation with the other two elements. The old open-cuts of Tassawini Mine were geologically surveyed in detail and all quartz veins, shear zones, and adjoining country rock were sampled and assayed to determine the distribution of gold and arsenic. The correlation here was not good, possibly owing to leaching of the sides of the open-cuts. Finally, 4 diamond drill holes were sunk in order to determine the continuity of structures and (as far as possible) values at depth, and the nature of the gold-arsenic association. The first two holes were started in Open-cut 2, the other two holes in the principal anomalous areas found by pitting north of the mine.

A complementary geological survey was carried out in the Barama River section of the area and in those area geochemically investigated.

Puruni NW Sheet

In the middle Puruni area two conducting zones detected by airborne surveys were investigated for base metals using geochemistry and ground geophysics, and three old alluvial goldfields

were examined in an attempt to find the source of the gold. A considerable part of the area was also examined by stream sediment sampling. The work was carried out by Mr. C.N. Barron, Mr. F. Guardia and Dr. H. Schielly.

Considering these surveys in turn, the Whanamparu area (Project 81) lies around First Priority Conducting Zone 11, some 2 miles W. of Peter's Mine. It carries no old gold workings, and samples from a 400 x 500 soil grid have yet to be analysed. Stream sediments in the area showed no marked clumping of high heavy metal values. Geophysical work showed a moderately weak conductor consistent with that envisaged from the airborne "Input" results. A Vertical Force magnetometer survey showed E-W trending isograms uncorrelated with the Turam anomalies. No significant self-potential zones were picked up. The Arno Creek area (Project 46) lies across conducting Zone 12, some 3 miles east-southeast of Peter's Mine. The airborne survey showed only first channel response, but the area was examined on account of the nearly coincident magnetic dipole and the local alluvial gold workings of Arno Creek. Results of stream sediment sampling programme await completion of analyses. The ground geophysical survey was sited rather too far to the north, but encountered the northern part of the magnetic anomaly as an intensive asymmetric dipole in the southeast corner. A very weak, extensive Turam anomaly in the southwest coincides with conducting Zone 12, but is attributed to the thick laterite capping of the hills there.

The first of the gold prospects investigated was that at Million Mount, where extensive soil sampling was followed by drilling of 7 diamond drill holes. Million Mount consists of two east-west ridges of granite porphyry, bounded on the north by an unconformity, the Million Mount Break. This is overlain by polymict conglomerates including fragments of the porphyry, followed by phyllites and sandstones. The eastern end of the ridges carries abundant gold in the soil, and rather less in the residual clay beneath. The underlying porphyry is intensely silicified and altered for the most part, but despite the evidence of soil and pit samples, assays of the porphyry and quartz veins (replacement and small late veinlets) gave poor gold values, both in the northeast where large replacement veins are common and in the southeast where small late veinlets are predominant. Further west an extensive plexus of veins runs westsouthwest along the top of the southernmost ridge. These had been extensively pitted, but resampling showed little or no gold. One of the two drill holes here met the quartz at depth but assay results are not yet to hand. The country rock here shows less sign of alteration. A hole was drilled under an outcrop of mineralised, very altered rock at Mara-Mara mouth (Project 81) but the core was disappointing.

East of the Puruni River, between Mara-Mara and Jubilee Creeks, there is a massive ridge of amphibolite. Stream draining this ridge have produced a notable amount of alluvial gold, and attempts, were made to trace the source of this gold in the Jubilee

field in the south, in Arno and Charles Creeks further north and in the lower Mara-Mara itself. The amphibolite is massive, and intruded by granite near Jubilee Creek. It appears to represent basic rocks in the north-south striking Peter's Mine Formation. Its metamorphism, and probably the granite intrusion, is older than the Million Mount Break, but it is affected by the east-west or east-southeast faults such as that followed by lower Jubilee Creek. These faults and the associated sub-parallel foliation may be related to the east-west foliation of the Cuyuni Formation which overlies the Million Mount Break. There is evidence at Peter's Mine and in the Jubilee Creek field, and probably elsewhere in the amphibolite belt. In the Jubilee field a 100° shear carries a plexus of quartz veins. Samples of vein quartz collected from exposures in the old open pit here gave poor gold assays, though fragments from the old dump gave up to 9 ozs. per ton, with occasional visible gold. Very extensive old gold workings occur nearby, and small tributaries of Jubilee Creek upstream of the workings still carry good values of coarse gold at their heads.

The Aremu field lies in the same band of metasediments and volcanics of the Cuyuni Formation overlies the Million Mount Break, but some 15 miles along it to the east, where the metasediments and volcanics lie along the south of the Aremu Granite batholith. This area lies in Sheet 2 of the Puruni SE Quarter Degree Square, and during the 1st field season 1966, ground follow-up in areas yielding airborne EM responses was extended in two

parts of it. Most of the work was done in the headwaters of the Oko River, while a brief exercise was carried out by Dr. H.O. Bruggmann in the region of Aremu Mine. In addition, some detailed geochemistry was done by Dr. P.M. Bradshaw (Geochemical Research Centre, Imperial College of Technology) around the Aremu vein and the copper occurrence found during 1965 near conducting Zone 11 together with a Turam (EM) Survey of the locality, this has defined a small drilling target.

The Oko headwaters are underlain mainly by purple and red phyllites schists and (?) metatuffs interdigitating (as intensely sheared horizons) with predominantly massive amphibolites. Hornblende schists and gneisses appear in the Kairuni Creek area in close proximity to granodiorite (Younger Granite). Further positive evidence was recognised in support of the postulated Aremu-Oko shear zone, probably major structure in the Aremu-Oko Goldfield.

Geochemical sampling shows anomalous copper values in active sediments in two areas in the Oko region and further work is required to ascertain the possible significance of these stream sediment anomalies.

During the second field season, the reconnaissance follow-up in the Aremu region was completed by two parties working westwards to the Mara-Mara headwaters and north-westwards from Aremu Mine into the headwaters of the Big Aremu River. A tie-up was affected with similar work being carried out in the Puruni River.

The most important result emerging was the location of the belt of country which gave airborne EM zones Nos. 5-9 as the Puruni SE 2 sheet. This belt is underlain by bed-rock conductors in the form of highly carbonaceous metasediments, rather similar to the rocks found in Area 33 Puruni River. Drainage reconnaissance yielded no anomalous values for copper, zinc and lead. The area stretching from the headwaters of the Big Aremu through the Upper Mara-Mara and further South into the Puriary headwaters, is underlain almost entirely by metasediments forming a large-scale synclinal structure; the presumed axial region of the syncline has been intruded by basic porphyrite. Predominantly arenaceous meta-sediments appear structurally below schists, phyllites, of the Aremu-Mara-Mara watershed. On the northern limb of the syncline (in the Big Aremu Area) the meta-arenites appear to overlie a unique sequence of coarse conglomerates, greywackes tuffs rather typical of the Central Cuyuni Formation. Reconnaissance mapping suggests that the sandstones and conglomerates strike roughly north-south, parallel to the nearly western margin of the Aremu Granite. The reason for this discordance with the regional roughly east-west strike is unknown.

During the latter part of the year a 50 mile dry weather road was cleared to the drilling target mentioned above, and a diamond drill was moved in just before year end.

Waini SW sheet -Ianna.

A programme of 4 drill holes was planned for Ianna during the first field season of 1966 under the supervision of Dr. S. Singh. The Ianna Granite is a mineralising granite stock as was evident from old gold workings along its northern margin. A hole was drilled to intersect the Stonehill gold-quartz workings and another nearer the margin which bottomed in granite. Assays are not yet available. Due to exceptionally dry conditions during that season, further drilling was impossible.

In view of the identification of molybdenite in the Yakishuru Granite stock 4 miles N.E. of Ianna, a geochemical soil sampling grid was laid over the Ianna Granite. Several anomalous pockets of molybdenum were indicated.

Waini N.E. & Mabaruma S.E. Baramanni and Luri Creek.

In order to investigate the nature and thickness of the superficial deposits between Baramanni and the sea, three holes to hard rock were put down between 13th December, 1966 and 18th January, 1967.

These holes were selected by Dr. Singh from ten readily accessible sites chosen by the writer and Dr. Lee during a visit from 8-10 November.

All three holes were vertical, and drilling was straight forward despite general inundation of the area to a depth of 2-4 feet. The cost of the operation excluding officers' salaries and

amortisation of equipment was $3,750, i.e. @ $4.40 per foot.

Hole 1 (Site 2, Baramanni Lake) 145-8 ft. to top of hard rock (granitised schist).

T.D. 171.6 feet

Hole 2 (Site 4, Luri Mouth) 274.2 feet to top of hard rock (biotite schist). T.D. 301.4 feet

Hole 3 (600' upstream from site 7,150' south of Luri Creek) 332.8' to top of hard rock (banded low grade metasediment).

T.D. 380'

(The Drill and Drill Supervisor were kindly made available by United Nations Technical Assistance Board).

Despite reports from time to time of the oil and gas seepages in the district no petroleum indications were encountered. Sludge samples were taken at every ten feet and will be retained for possible polynological study. A representative collection of cores has been made.

IV. RESEARCH PROJECTS

1. Palynological Programme

This year saw the completion of the Pollen Research Programme which started in 1962 under the direction of Professor van der Hammen and Mr. T.A. Wijmstra of the University of Leiden. This project was eventually supported by the principal bauxite companies as well as the Government Geological Surveys of the three Guianas. The Guyana Geological Survey was liason in this project. In addition to the Coastal belt, work was also carried out by Mr. Wijmstra on the upper part of the Takutu Formation (which fills the North Savanna Graben) and Mr. Wijmstra made a further visit there later in the year.

In addition to a number of interim reports, the following papers have now been published as a result of this programme.

van der Hammen, T., 1963. "A Palynological Study of the Quaternary of British Guiana". Leidse Geologische Mededelingen, 29 pp. 125-180.

Wijmstra, T.A. 1966. Palynology and Stratigraphy of the Guiana Coastal Basin. Presented at VIIth Inter-Guiana Geological Conference, Paramaribo.

Wijmstra, T.A. and van der Hammen, T. Late Glacial and Holocene climatic and vegetational history of the Rupununi Savannas (Guyana). VIIth Inter-Guiana Geological Conference, Paramaribo.

The picture presented, in brief, is of thick marine sedimentation in the Cretaceous (the date of commencement varies from place to place) followed by brackish water conditions in the present coastal areas until mid-Eocene. The Middle and Upper Eocene appear to have been an important period of denuation, related to the Kopinang Surface in the Pakaraima Mountains, and the coastal bauxite appears to have been formed at the beginning of this period. After further sedimentation another gap occurs in the late Miocene. In van der Hammen's Quarternary paper, correlation of transgressions with three interglacials has been demonstrated.

In the North Savannas, a palynological study of drill cores to 300 feet depth has shown the presence of Jurassic and lower Cretaceous pollen and spares. The depth of the basin from preliminary geophysical reconnaissance is of the order of 11,000 feet.

2. Radiometric Age Determination Programme.

The preliminary programme of stratigraphic age determinations undertaken by Dr. Snelling in 1961 was almost completed by the end of 1965, and only a few specimens remained to be dated. These included specimens of charnockitic rock from the Kanuku Group, and of volcanic rocks from the Iwokrama and Kuyuwini Groups and from the Apoteri Andesite Formation. The results of these are expected early in 1967. Future work will consist firstly, of determinations tied into a 4 year reconnaissance survey of the south of Guyana under

Dr. J.P. Berrangé of the Institute of Geological Sciences, and based on preliminary photogeological interpretation. Secondly, a programme of age determination in the north of Guyana is planned: this will endeavour to date the principal periods of intrusion and mineralisation.

At the end of August the Survey was fortunate to receive a visit from Dr. Ian McDougall, of the Australian National University. Dr. McDougall and his associates have done a considerable amount of work on the radiometric dating of the Younger Basic sills which intrude the Roraima Formation. His results and their interpretation differ in several respects from those of Dr. Snellings and Dr. McDougall's visit provided an opportunity to discuss the stratigraphic significance of these different interpretations.

3. Palaeomagnetic Research

Following radiometric age determinations on basic sills intruding the Roraima Formation by McDougall et al and Snelling (Nature 1963), a palaeomagnetic programme on the same intrusives was undertaken by Prof. Hargraves of Princeton University. The intention of this programme was to take advantage of the dating in making a palaeomagnetic comparison with South Africa and Canada.

Following a visit to the Gran Sabana in Venezuala, where the same intrusives are well exposed, Prof. Hargraves, spent a week in the Paruima-Kako area during January 1966. After laboratory work on his samples he was to return in November for a further week

spent collecting from basic dykes and sills up the Potaro River between Tumatumari and Kaieteur, on Eagle Mountain, and from the Kopinang sill near Velgraad.

Preliminary results from Prof. Hargraves' first expedition provide quite strong magnetic evidence of two (or more) distinct polarity groups in the Roraima intrusives. The two groups are roughly 180° opposite in azimuth, but both have positive inclinations of 25 to 30 degrees. Results from Prof. Hargraves second expedition are awaited with great interest.

V. UNITED NATIONS-GUYANA MINERAL SURVEY PHASE II.

The United Nations-British Guiana Aerial Geophysical Survey Project which operated between 1962 and 1965, placed accent on airborne geophysics. Approximately 16,000 square miles of the country were covered by airborne magnetics at line spacings of $\frac{1}{2}$ mile. Approximately 3,850 square miles of territory were covered by airborne electromagnetics flown at $\frac{1}{4}$ mile spacings. The contractors, Aero Service Corporation, listed over 50 priority targets amongst the conductors identified for further ground follow-up.

With its limited financial and personnel resources, the progress of ground investigation by the Geological Survey was very slow. In 1965 a request was made to United Nations Special

Fund for assistance to accelerate ground investigation of the recommended target areas with the view to early development of the country's mineral resources. In June 1966 the Governing Council of the United Nations Development Programme informed Government of its approval of the application and the Plan of Operation was formally signed on 19th October, 1966.

The project has been designated United Nations-Guyana Mineral Survey Phase II. Contributions for financing the project are as follows:

U.N. Special Fund Contribution	U.S.	$ 966,600
Guyana Govt. Contribution towards local operating costs.		69,600
Guyana Govt. Counterpart Contribution in kind.		1,077,000
	U.S.	$2,113,200

Under the project U.N. will provide the following specialist personnel:

	Total Man-months
1 Project Manager	39
1 Geophysicist	24
1 Chemist	12
2 Geologists	60
3 drilling supervisors	72
Consultants	9

Several fellowships have been provided for and equipment including 3 diamond drills, telecommunications equipment and transport vehicles will be provided by United Nations. The Guyana Government will provide counterpart personnel and logistic field support.

The first step towards implementation of the project was taken with the arrival of the U.N. Project Manager, Mr. G.A. Moorhead, in November. Mr. Moorhead has been associated with Guyana as Commissioner of Lands and Mines and later as Mining Legislation Advisor. His appointment and return were most welcome.

Mr. Dave Miller, whose services were made available through United Nations as drilling supervisor under the 1962-65 project, continued under an extended arrangement by United Nations and provided valuable supervision and training of Guyanese drillers.

VI. TECHNICAL ASSISTANCE - U.S. A.I.D

The Department was very fortunate to have visits during the year from several specialists attached to the U.S.G.S. through U.S. A.I.D. in Georgetown as part of a long term programme of technical assistance from the American Government.

Dr. W. Griffiths, Geologist-Geochemist came to the Department early in the year accompanied by Dr. F.N. Ward, Chemist with U.S.G.S. and spent 3 months reviewing geochemical procedures in the field and laboratory and provided valuable advice.

In March, Mr. A.E. Weissenborne, Economic Geologist with the U.S.G.S., visited the Survey and spent a period of 3 months. Mr. Weissenborne provided valuable guidance to the Survey in its mineral exploration programme and he made an re-appraisal of data on Peter's Mine. Dr. F. Myers, Spectrographer spent a week in the Survey.

Dr. Charles Milton, Research Professor at George Washington University paid a 3 week visit during September and carried out field studies of the merumite occurrence in the Merume River. Dr. Milton had been carrying out research on this mineral for many years and during this visit collected specimens for further laboratory studies.

Mr. Francis C. Lopez, Cartography Advisor to the U.S.G.S. visited the Department in May and held valuable discussions with the Drawing Office staff. He also made recommendations for improvement of the existing services.

VII. MINERAL DEVELOPMENT

Bauxite

Demerara Bauxite Company

During 1966 Demba produced 1,650,096 long tons of Kiln dried metallurgical grade bauxite. Of this 993,954 long tons was shipped together with 497,179 long tons of calcined bauxite and 296,956 long tons of alumina. Work stoppages significantly affected production. The alumina production failed to meet the forecast figure by a small margin, due to strikes and process problems, but the quality was improved. Some 70% of the alumina plant intake consisted of dried concentrates from the tailings recovery plant, the balance being made up of laterite and lump bauxite.

The exploration programme for 1966 consisted of seismic surveying together with drilling. A total of 109 holes were drilled in active E.P. areas (445 and 500) and along the proposed route of the Atkinson-Mackenzie road. A proportion of the drill holes now sample bedrock, and a research project at Leicester University is

examining these samples and their possible correlation with the composition and mode of occurrence of the associated bauxite.

Reynolds Metals

Total shipment of bauxite for the year 1966 were 516,948 L.D.T. This compares with 376,389 tons in 1965 and 305,665 in 1964. Production was detrimentally affected by work stoppages amounting to 10% of the working year.

Additional expansion, including new dryer and calcining facilities was initiated in 1966. Additional river facilities for handling greater tonnages have also been partially provided for. Other facilities such as Power Plant, Docks, Warehouse, and Office in support of the proposed additional production will cost approximately $8,000,000. The total cost of expansion plans for Reynolds at both Everton and Kwakwani are in the neighbourhood of $15,000,000.

Manganese

Manganese Mines Management Ltd., a subsidiary of Union Carbide, is the only Company at present engaged in mining Manganese at Matthews Ridge in the North West District.

During 1966 the company produced 180,000 tons of ore of average grade 37.4% Mn. This compares with 166,194 tons for the previous year.

Exploration activities continued around the Mining Lease at the Ridge and at the Company's Concession at Pipiani on the Barama River, 25 miles southeast of their present mine.

Development again figured prominently in the work done during the year. Decisions were taken to increase jigging and crushing capacity and planning for these installations commenced.

Gold and Diamonds

Diamond production fell by about 19% to 98,888.79 carats in 1966. This was partly due to exhaustion of the richest pools in the upper Mazaruni and on the plateaux west of Kaieteur Falls (Potaro area) and around the upper Kurupung (Mazaruni area). In addition, the the activities of itinerant buyers has made the established shops reluctant to stake miners to the previous extent.

Gold production increased by nearly 50% however, reaching 3045 ounces in 1966. This is partly due to increased efforts to recover the gold present in the diamond gravels, but the production in the Northwest, outside the diamond areas, has also increased by some 600 ounces.

The production from the districts, taken from the records of the Mines Section, is as follows:

District	Diamonds (metric carats)		Gold (ounces)	
	1965	1966	1965	1966
Berbice	891.19	1,446.53	-	2
Potaro	16,571.57	10,337.34	335	458½
Mazaruni	80,429.91	71,017.63	470	679
Cuyuni	10,800.92	8,887.98	338	603
Northwest	-	-	776	1,284½
Rupununi	4,674.02	6,347.31	158	18
TOTAL	112,873.61	98,888.79	2,077	3,045

Oil

The two major oil companies holding concessions over the coastal and offshore belt continued activities through the year. During the year Continental Oil Company was granted an oil exploration lease over an additional 2,225 square miles offshore extending northwestwards from their previous concession to the international boundary with Venezuela, bringing their total offshore concession to 16,025 square miles. Towards the end of the year the company had applied for a further exploration lease over 4,750 square miles onshore.

Continental carried out a further seismic programme of 500 miles over their offshore concessions under contract to Western Geophysical.

Seismic data for Shell's offshore concession was still being processed at year end. The Company, however, commenced drilling of the first of 6 planned stratigraphic holes. By the end of the year, three holes, totalling 7,000 feet were completed. There were no significant shows of oil and gas.

Government had, early in the year announced its intention to grant an Oil Exploration Lease to Phoenix Canada Oil over 2600 square miles of the inland Takutu Basin, but at year end that Company had not yet taken up the licence.

VIII. HEADQUARTERS WORK

Laboratory

The increasing demands on laboratory facilities arising from the Department's intensified mineral exploration programme, indicated that modification in the layout of the analytical and sample preparation sections of the laboratory was urgently required. It was also apparent that changes in the organisation of personnel were necessary. New methods were needed for labelling specimens and filing data. At the beginning of the year a considerable back-log of unanalysed samples had accumulated. In order to prevent a recurrence of this situation, it was necessary to estimate the laboratory capacity. Establishment of a sample preparation section was undertaken and existing arrangements altered.

To bring about the required improvements the analytical section of the laboratory was sub-divided into three sub-sections:
The spectrographic laboratory: headed by Mr. M.A.A. Shariff;
The assay laboratory: headed by Mr. M.D. Hope; and
The colorimetric/atomic absorption laboratory: headed by Mr. M. Persaud.

The spectrographic and colorimetric/atomic absorption laboratories were engaged in trace-element analysis for the geochemical field surveys. The assay laboratory carried out macro-analysis for gold and silver on rocks and cores for preliminary assessment of prospects. In the spectrographic laboratory a semi-quantitative 6-step procedure was intruduced to process a substantially larger

number of samples. As the methods used in the colorimetric laboratory were field methods, modern equipment was needed to speed up and improve on the quality of the analyses. In order to achieve these aims new equipment and reagents were necessary. New instruments, in their turn, necessitated further training for the staff. In conjunction with members of the U.S.A.I.D. mission, Drs. F.N. Ward and F. Myers, improvements of existing techniques were made and suggestions for training courses were drawn up. Training courses for M.A.A. Shariff and Mr. M. Persaud were arranged.

Mr. M.D. Hope, head of the assay laboratory returned in February from the U.K. where he undertook a training course, in fire-assaying, spectrographic and chemical analysis. On Mr. Hope's return he was appointed Assayer. Arrangements were immediately begun for setting up a regular programme of analysis for gold and silver. Owing to the great work load of the fire-assay laboratory, the need for re-organisation of the chemical laboratory, and the lack of great demand, wet-assaying for base metals was not carried out. Instead the samples submitted were sent overseas for analysis. Re-equipment of the analytical laboratory for such work was, however, planned and carried out. It was considered that such analysis should be under the direct supervision of the Geochemist.

Reorganisation of the analytical laboratory consisted of rewiring, resiting of equipment, installation of new laboratory furniture and air-conditioners and general refurbishing. This was essential for trace-element analysis and the speeding-up of the analyses.

In the sample preparation section of the analytical laboratory, the first requirement was the appointment of a sectional head. Mr. E. Johnson, Lapidary, acted in this capacity for the year. Two officers were appointed to prepare soil and stream sediment samples for trace-element analysis, and two others for the preparation of rock and drill-core samples for fire-assay. A room was set aside for this work and ancillary equipment ordered and installed. Re-equipment and re-organisation were planned but work was not completed by the end of the year. To speed-up processing of samples high wet strength Kraft paper envelopes were introduced for all geochemical samples.

New methods were introduced and existing ones modified, to achieve satisfactory numbering and storage of samples and for facilitating the filing and retrieval of data. Those improvements were necessary for efficient processing of samples. All these achievements were directly attributed to the experience and enthusiasm of the acting Geochemist, Mr. Maurice Carter.

With full staff and completion of the re-organisation of the analytical and sample preparation sections, it is estimated that the trace-element laboratory capacity is 3,000 samples per month. The fie-assay capacity is estimated at 150 samples per month.

Number of trace-element determination 1966 - 69,180

Number of gold and silver determinations 1966 591

Drawing Office

During the year the normal work of the Drawing Office continued in preparing maps for geological, geophysical and geochemical expedition reports.

Publications for which maps were parepared were Bulletins 37 and 38. A mineral compilation map was prepared and published in colour on a topographic base map of scale 1:1,000,000. A topographic map on the scale 1:1,000,000 was also published.

The demands on the services of the Drawing Office by other Government Departments and industrial and other exhibits, continue to increase. The Drawing Office coped admirably with the increased volume of diagrams and maps for mining concessions and leases.

A working map for the United Nations-Guyana Mineral Survey Phase II was prepared on a scale of 1:200,000. This comprised a geological base map on which was superimposed airborne geophysical data. At year end there were 5 vacancies in the Drawing Office.

Library and Publications

The books on the Accession in the library amount to 11766.

The Library received 78 different periodicals of which 45 were obtained by subscription and 33 free or on an exchange basis. Seventy (70) were of a scientific or technical nature and 8 of administrative, commercial or general interest.

Table I shows the total number of publications loaned, catalogued and received:-

Table I

	Publications loaned	Publications catalogued	New Publications accessioned
January-March	169	54	20
April-June	104	79	87
July-September	277	73	76
October-December	319	105	183
	868	311	366

The Library maintained a wide distribution of the Survey's publication to 213 Universities, Libraries, Geological Surveys and other institutions and individuals. The publications of many of these institutions were received in exchange.

Table 2 shows publications printed and cyclostyled for sale and free distribution:-

Table 2

1) Bulletin No. 37.

Geology and petrology of part of the Guyana Shield on the South Savanna-Rewa area of British Guiana, by S. Singh — 500 copies

2) Geochemical breakthrough in mineral prospection in British Guiana, by J.H. Bateson. Canad. Min. J., 1965, v. 86, p. 71-73, 78. — 370 "

3) Cordierite in the Pre-Cambrian rocks of the South Savannas, British Guiana, by S. Singh. Geol. Mag., 1966, v. 103 p. 36-43. — 25 "

4)	Orthopyroxene-bearing rocks of charnockitic affinities in the South Savanna-Kanuku complex of British Guiana, by S. Singh. J. Petrol., 1966, v. 7, p. 171-192.	100	copies
5)	The Paleocene and Lower Eocene pollen flora of Guyana, by P. Leidelmeyer. Leid. geol. Meded., 1966, v. 38, p. 49-70.	300	"
6)	Interpretation of airborne magnetometer survey in British Guiana for the Geological Survey of British Guiana under the United Nations Special Fund by Aero Service Corporation, 1964.	196	"
7)	Interpretation of airborne input survey in British Guiana for Geological Survey of British Guiana under the United Nations Special Fund by Canadian Aero Mineral Surveys Limited, Project No. 5007, by A.R. Rattew, 1966.	198	"
8)	Mineral exploration map of Guyana, Scale 1:1,000,000, 1966.	3,000	"
9)	Map of Guyana, Scale 1:1,000,000, 1966	1,000	"
10)	Mineral Resources Phamphlet No. 5: Merumite, by C.G. Dixon, 1957.	200	"
11)	Mineral Resources Pamphlet No. 6: Monazite in the Rupununi District, British Guiana, by R.A. Dujardin. 1955.	200	"
12)	Mineral Resources Pamphlet No. 9: Kyanite deposits on the Supernaam River, British Guiana, by C.G. Dixon and O. St. John. 1959.	200	"
13)	Geophysical surveys in British Guiana, March-April 1963, issued by Great Britain. Overseas Geological Surveys.	68	"

Table 3 shows the distribution of publications:

Table 3

	Sold	Free	Total
Annual Reports	26	343	369
Bulletins	199	273	472
Mineral Resources Pamphlets	24	41	65
Proceedings of the Fifth-Inter Guiana Geological Conference	8	6	14
Records, Vols. 1, 2 & 3	11	348	359
Miscellaneous Reports	16	13	29
Free Publications	-	394	394
Maps	786	3,443	4,229
	1,070	4,861	5,931

Volumes bound amounted to 8

Wireless and Geophysical Workshop

The wireless and geophysical workshop of the Geological Survey Department, maintains communications and geophysical equipment which are used for geophysical surveys and maintaining communication between headquarters and mobile field parties.

In the communication section there is a total of 16 transmitters including 4 R.C.A. SSB-A transceiver units, 4 Hallicrafter transceiver units, and 2 Heathkit transmitters which are the DX 40 and DX 60 types. There are in addition 12 transistor radio receivers for use by field parties. Breaks in transmission during the field seasons were mostly due to power failure.

The geophysical section, which was headed and supervised by Mr. G.N. Rodwell, Geophysicist, during 1966 maintained a variety of geophysical equipment. These include 4 Sharpe Magnetometers,

3 Askania Magnetometers, 2 Sharpe E.M. Units, 2 Turam E.M. Units, 1 Pye potentiometer, 1 Sharpe resistivity unit, 1 Sharpe S.P. unit, and 1 Tellolmeter.

Mr. Richard Belletty, technician in charge of this section coped admirably with the task of maintenance and repairs.

Mechanical Workshop

There was a staff of five Driver Mechanics under the charge of the Foreman Mechanic, Mr. Cyril Narain. Major and minor overhauling repairs were done to the Department's vehicle, engines, and drills including Land Rovers, vans, outboard engines, lighting plants, charging plants, tractors, water pumps, and power saws.

The workshop is equipped with a lathe, an oxyacetylene welding plant, an arc welding plant, an electric drill, an electric grinder, a spraying machine, a vulcanizer and other workshop accessories.

During the year the workshop overhauled twenty five outboard Archimedes engines, three Sea Gulls, two Jap charging plants, three Briggs and Stratton lighting plants, three Land Rovers, one tractor, and a number of small power motors, in addition to routine maintenance of all other Departmental vehicles and machinery.

IX. CONFERENCES AND VISITS

Conferences: The Director, Dr. S. Singh lead the Department's delegation to the VIIth Guiana Geological Conference held in Paramaribo in November. He was accompanied by Dr. M.A. Lee. Altogether 15 papers, covering various aspects of Guyana geology were presented.

Visits

Dr. P.M. Bradshaw and Dr. J.S. Tooms of the Applied Geochemistry Section at Imperial College visited Guyana to carry out an on-the-spot appraisal of a suitable project for a Post-Graduate Bursary for Research in Geochemistry. At year end Dr. Bradshaw had signified interest in launching geochemical research at Eagle Mountain and the programme should get underway to 1967.

Dr. Ian MacDougall of the Research School of Physical Sciences at the Austrailian National University spent a week in Guyana during August. Dr. MacDougall has been actively interested in the Roraima dolerites. Dr. MacDougall was accompanied by Dr. Singh and Mr. Barron on a traverse of the Potaro River to observe the field occurrences of some of these dolerites exposed in this river section.

Dr. R.B. McConnell, a former Director of the Survey was a most welcome visitor when he spent a few days with the Survey in December. Dr. McConnell stopped off on his return journey to

Britain from attending the VIIth Guiana Geological Conference in Paramaribo.

Dr. David Bleackley, another past member of the Survey, but now with the Institute of Geological Sciences in London visited the Survey in November while en route to Chile.

In addition, the Survey saw a great influx of mining companies officials and oil companies personnel during the year.

APPENDIX I

Staff Availability

Senior Professional

Establishment	Name	Availability
1 Director	P.H.A. Martin-Kaye, B.Sc., Ph,D., A.R.C.S., F.G.S., M.I.M.M.	Retired w.e.f. 21st June, 1966.
	S. Singh, B.Sc., Ph.D., F.G.S., F.R.G.S., A.M.I.M.M.	1st Jan.-31st Dec., 1966. Appointed Director as from 23rd June, 1966.
1 Deputy Director	P.B.H. Bailey, M.A., A.M.I.M.M., F.G.S.	Retired w.e.f. 18th September, 1966.
	Vacant	
1 Geochemist	M.W. Carter, M.Sc., (Acting)	1st Jan.-31st December.
2 Geophysicists	G.N. Rodwell, B.Sc., D.I.C.	1st Jan.-31st December.
	M.A. Lec, B.Sc., Ph.D., A.R.S.M., D.I.C.	26th Oct.-31st December.
1 Petrologist/ Mineralogist	Vacant	
4 Snr. Geologists	C.N. Barron, B.A., F.G.S.	1st Jan.-31st December. Acting Deputy Director 24th May, 1966.
	3 Vacancies	
11 Geologists	J.D.N. Punwassee, B.Sc., F.G.S.	1st Jan.-31st December.
	G.A. Sampson, B.Sc., F.G.S.	1st Jan.-31st December. Acting Senior Geologist.
	H.O. Bruggmann, D.Phil.	1st Jan.-31st December.

APPENDIX I (Contd.).

	W. Muller, D.Phil.	9th July-31st December. New Appointment.
	H. Schielly, D.Sc., Nat.Dip.Ing. Geol.	13th August-31st December. New Appointment.
	R. Steiger, D.Sc., Nat. Ing. Geol.	25th August-31st December. New Appointment.
	T. Gyr., D.Sc., Nat. Dip. Ing. Geol.	30th November-31st December. New Appointment.
	F.J.L. Guardia, B.Sc.	5th March-31st December. New Appointment.
	3 Vacancies.	
2 Scientific Assistants	M.A.A. Shariff (Spectrograph)	1st January-31st December.
	A.O. Edwards (Field)	1st January-31st December.

APPENDIX II

Summary of Expenditure 1966

a) Recurrent Expenditure
Head 29
Ministry of Forests, Lands and Mines
Geological Survey and Mines.

Sub-head	1.	Personal Emoluments	G $199,283.10
	2.	Transport and Travelling	9,979.67
	3.	Miscellaneous	3,392.63
	4.	Land and Water Transport	3,715.32
	5.	Labour and Rations	33,120.06
	6.	Uniforms	940.89
	7.	Library and Publications	2,789.92
	8.	Revenue protection	- -
	9.	Rental of Quarters	- -
	10.	Sanitary and Fuel	311.47
	11.	Study Courses	- -
	12.	Materials for Survey	3,521.35
	13.	Drawing Instruments and Materials	5,815.60
	14.	Repairs and Maintenance of Scientific Equipment.	1,496.98
	15.	Printing of Maps and Reports	18,930.70
	16.	Special Scientific Research	56.63
	17.	Geophysical Surveys	13,514.95
		Total Recurrent	G $296,869.33

b) Development (Capital) Expenditure
Division XI
Ministry of Forests, Lands and Mines

Sub-Head 6.	Geological Surveys	416,459.32
7.	Purchase of Equipment	64,368.41
	Total Development (Capital)	480,827.73

Total Recurrent and Development (Capital) - G$777,697.06

(G$1 is equal to 4s. 2d).