GUYANA

MINISTRY OF AGRICULTURE AND NATURAL RESOURCES

REPORT ON THE GEOLOGICAL SURVEY DEPARTMENT FOR THE YEAR 1968

Geological Survey Department

P.O. Box 789

Georgetown, Guyana

1969

Printed at the Government Printery, Georgetown

GEOLOGICAL SURVEY DEPARTMENT

Ministry of Forests, Lands and Mines

ANNUAL REPORT 1968

P.O. Box 789,
Georgetown, Demerara,
GUYANA.

GEOLOGICAL SURVEY DEPARTMENT

ANNUAL REPORT FOR 1968

CONTENTS

CONTENTS (Continued)

CONTENTS (Continued)

I. INTRODUCTION

The Geological Survey Department has its Headquarters in Georgetown. A district office is also maintained at Bartica, which is situated at the confluence of the Essequibo and Mazaruni Rivers, a focal point for access to the interior and about 50 miles from Georgetown.

At the Headquarters in Georgetown are housed the Administrative and Geologists' offices, Petrological, Geophysics, Spectrographic, Colorimetric, Atomic Absorption, Fire Assay, Sample Preparation and Lapidary Laboratories; a Wireless and Geophysical Workshop; a Cartographic Office, Library and Museum. Other facilities include a Rock Store, Mechanical Workshop and Stores. The District Office at Bartica continued to function as an intransit centre for stores and personnel between Headquarters and field operations. The Department's boat house is located at Bartica and this housed the Department's fleet of 25 bateaux during the off field season periods of the year.

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 Agriculture and Natural Resources.

II. GENERAL REVIEW OF THE YEAR

Professional Staffing:

A 70% professional staffing level was maintained during the first field season of the year but this fell to 50% during the second season with the resignations, on termination of their contracts, of geologists Dr. R. Steiger, Dr. W.G. Muller and Mr. F.J.L. Guardia, and the departure of Mr. G.A. Sampson, Senior Geologist on post-graduate training in Canada. Year end saw the resignations of two more geologists Dr. T. Gyr and Dr. H.O. Bruggman and of the temporary Geochemist Mr. M.W. Carter. Dr. A.N. Choudhuri was appointed Petrologist/Mineralogist on 28th December. With the departure of seven professionals during the year and the recruitment of only one, professional staffing level at year end reached an all time low of 40% and this will certainly affect adversely the mineral exploration programme for 1970.

At year end there were only 5 Guyanese geologists out of a total establishment of 20. The Department continued to rely heavily on expatriate recruits, with the consequent rapid turn over of professional staff, since expatriate geologists seldom return after one tour of 2 or 3 years duration.

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

Other Staff:

Miss R.E. Harry, Supervisor of Library and Records was seconded to the Commonwealth Caribbean Secretariat with effect from 28th May, 1968. Mrs. J. Subryan, Temporary Clerk assumed duties in the Library on 8th October, 1968.

Mrs. V. Wharton assumed duties as Secretary (Ag.) on 31st August vice Miss S. Baynes, Secretary proceeding on vacation leave.

Miss I.V. Lowe was appointed Chief Draughtsman with effect from 1st November, 1967 vice Mr. T.M. Rahaman.

Training:

Mr. G.A. Sampson, Snr. Geologist, left Guyana in September to pursue a 2 year course of training leading to the M.Sc. degree in Petrology and Mineralogy at the University of Toronto under the Commonwealth Fellowship Plan.

Mr. R. Henry, Field Observer proceeded on a one year course in Geochemical Prospecting in West Germany as from 3rd December, 1968.

Mr. C. Rodrigues, Field Assistant Trainee left Guyana in September, 1968 to take up a Canadian Government award at the University of British Columbia, Vancouver, Canada, for a 4-year course of training leading to the B.Sc. (Hons.) Degree in Geology.

Five other candidates continued their Geology Scholarships in Universities in Canada, Britain and U.S.A. one of these, Mr. J.C. Inasi, is expected to return in 1969.

III. SUMMARY OF FIELD WORK 1968

A. GEOCHEMICAL-GEOLOGICAL EXPLORATION

1. Geochemical pathfinder studies in the abandoned Aurora Goldfield, Cuyuni River (Puruni NW Sheet 2) by T. Gyr.

Soil Samples taken over the three principal lode deposits and their surroundings were analysed for Cu, Cr, Mn, Ni, Au, As, Sb, Ag, Co, Pb, Mo. Only copper and chromium showed significant correlation with the gold workings, while arsenic and molybdenum were below detection threshold. Copper values from the Aleck Hill open cuts were anomalous relative to the local background, (70-150 on 30 ppm) but were within the background of samples collected a few hundred yards to the north. Chromium showed anomalous values of 400-500 ppm on background of 70 ppm in the immediate vicinity of the open cut, but both copper and chromium anomalies appear to be too limited in area and in the case of copper, too indistinct for them to be useful as pathfinder elements for reconnaissance work.

2. Geochemical-geological investigation of molybdenum soil anomalies within the Ianna Granite Stock, Barama River. (Waini S.W. Quarter Degree (by A.R. Westerman.

Dr. S. Singh had noted sections of mineralised country rock averaging 0.1% MoS_2 in drilling the margin of Yakishuru Stock in 1966. At the same time soil samples showing anomalous Mo values were found over Ianna Stock 3 1/2 miles to the WSW. Both areas have been important gold producers especially from gold quartz veins.

Ianna Stock is a composite intrusion into chloritous carbonated green schist country rock of the Cuyuni Formation. The molybdenum soil anomalies which were investigated by 100' square soil sampling grids and in auger holes,

in some cases centre on old gold/quartz stringers with the same trend.

Structural control of the mineralisation by roof joints and cupolas of the Yakishuru Type Instrusion [Albite 50%; Quartz 48%; biotite 2%] is indicated. The Yakishuru Type is probably the last intrusive phase in the area. Mineralised shear zones at the old Sweetheart Gold Mine, Ianna, and Yakishuru, may be related to this last intrusion.

At present analyses of the soil samples in the laboratory are incomplete but definite anomalous areas are showing up.

During the Second Field Season all efforts were directed to the study of Ianna and a detailed topographic map is expected to aid the delineation of fairly complex geological boundaries.

Time was found to investigate Airborne EM anomaly 11, Sheet E1 which was found to centre in granite topography 4 3/4 miles south-southwest of Ianna. This granite intrudes and hornfelses country rock of Barama Group type, being massively bedded quartzites and quartzose schist with 6"horizons showing carious weathering. In a stream draining this granite area an average of 10 naked eye grains of gold per battel was panned. The area is too remote in relation to Ianna and Yakishuru to have come to the attention of the pork-knockers.

During the first field season the reconnaissance nature of work at Ianna and low water conditions allowed extensive mapping of the Middle Barama River. It appears however that the unmapped area around Kokerit which is known to have current bedded conglomerates may provide the key to the structure of the area and to the relationship between Barama Group and Cuyuni Formation.

In the centre of the Middle Barama basin is the late tectonic affected hornblendic Teki Batholith, about which position, a 65° genufliction in the trend of the early F_1/F_2 tectonics occurs. Between Towakaima and Mazawinni in the West of the basin, a batholith with significant biotite content intrudes the junction between gneisse and parallel trending mica schists. Lithological elements similar to both these batholiths are found as members of the Ianna Stock. Both batholiths have attendant and probably earlier dyke suites.

South of Towakaima in the South West of the Map area a differentiated basic or ultrabasic intrusion was found. It is composed of alternate bands of anorthosite and hornblendite. The only quartzose facies were found in the North and the South of the hill and has not been visited.

3. Geochemical-geological investigation of airborne EM anomalies in the Puruni (Puruni SE Quarter SE Quarter Degree Sheet) by G. Vallance.

Airborne EM Conductor 4. Puruni SE Sheet 3 (Powis Creek)

This is a three channel anomaly on one flight line only. Geological and geochemical surveying was carried out within a grid of one and a half square miles sampled at 500' x 200' centres. Rocks occurring are a conglomerate containing mostly volcanic material, silified sediments, intermediate intrusives, a quartz feldspar porphyry and several thick quartz reefs. Quartz-tourmaline pebbles were found within the outcrop of the porphyry. Geochemical results, do not appear to bear economic significance, except for nickel values which are 5 times the general background over the intermediate intrusion. Some coarse gold was found in the smaller creeks but none was found in the quartz reefs.

Airborne EM Conductor 6, Puruni SE Sheet 1 (Usgus Creek area).

A grid 3000 feet square around previously encountered copper values of 50 and 160 ppm on a background of 30 ppm was sampled. 20 foot long trenches were dug adjacent to these high values, in one of which the E-W trending, northerly dipping boundary between two residual clay types was found. Rocks seen in the area are volcanics and sediments. Geochemical results do not appear to be economically significant.

Stream sediment molybdenum anomalies

Anomalies found by Guardia were resampled. Results indicate that most molybdenum values are less than 3 ppm. But new samples from the Million Mount area gave significantly anomalous molybdenum values (up to 18 ppm on a background of zero).

Airborne EM Conductor 3: Puruni SE Sheet.

The grid previously sampled by C.N. Barron was extended to the west. Zinc values do not appear to be economically significant. Analyses for copper are awaited.

4. Geochemical-geological investigation of nickel-chrome soil anomalies in the Blue Mts. - Wanamu region, Barama River (Waini SW Quarter Degree Sheet) by G. Vallance.

Nickel anomalies found by Kilpatrick in 1967 were open in the southeast. These anomalies overly serpentinite dykes and were mapped to the southeast using a minimag and geochemical sampling. Magnetic anomalies of >1000 and soil geochemical anomalies >1000 ppm in nickel were found. In a small area of laterite cap the serpentinites gave rise to magnetic and chromium anomalies, but the nickel values were not high in soil samples. Anomalous areas were further sampled by pitting and augering. The overburden appears to contain workable nickel laterite in places.

The serpentinites are derived from periodotites, and fresh clinopyroxenes and olivines can be found in places. There is abundant magnetite and some chromite, serpentine and magnetite appear to have been remobilised by hydrothermal activity.

The country rocks are sediments, mainly pelites, and metamorphosed basic intrusives. The Wanamu granite contact lies about 1 1/2 miles southwest of the serpenites.

The Wanamu River was traversed to a point about twenty miles southwest of the Wanamu mouth. Rocks occurring are mainly coarse grained igneous rocks with some amphibolites and metasediments.

5. Geochemical-geological investigation of airborne EM anomalies in the Kartuni River (Puruni SW/NW Quarter Degree Sheet), by H. Schielly

An expedition was undertaken into the Puruni-Kartuni area from February to May 1968. The aim was to cover by geological mapping and geochemical soil sampling, airborne EM anomalies which were recommended for ground follow-up in area E13.

Only the western part of area E13 was covered. This region, which was only partially known geologically, appears to be characterised by complex folding of rocks regarded as Cuyuni Formation and Barama Group. Rocks of the latter group seem to coincide with strong airborne EM conductors. Outcrops of Older Basic Intrusives are mainly associated with the Barama Group. The Younger Granite Group is represented by a small granite stock at Bembaru Rapids (Bembaru Granite) in the Puruni River. The stock is slightly differentiated, and parts of its margins seem to be fault-controlled. The Younger Basic Group shows up in dolerite dykes as well as in large dolerite (cone?) sheets.

Structural evidence were mainly gained from aerial photographs. A regional foliation has a northwesterly trend in general, but secondary folding has locally produced swings of foliation. Faulting along the Bembaru Granite was observed in river outcrops, but faulting along the eastern margin of the large batholith west of the Kartuni (out of this area) is assumed by aeromagnetic interpretation. This latter fault is part of a Kartuni graben complex which seems to form the present lower Kartuni valley striking generally N-S. There is indication that the Younger Basic Dykes have been intruded into old fault or shear systems, which had a major trend to northeast and a minor one to northwest.

Gold was, in the past, widely worked south of the Puruni, apparently derived from amphibolite-like rocks. North of this river, as far as about 16 miles up the Kartuni River and within an area about 2-5 miles wide along this river, the alluvials are extremely poor in minerals. There were, however, gold and doubtful diamond findings reported in the past from middle and upper Kartuni and its tributaries.

Five grids were cut over the most promising airborne EM anomalies. Soil and stream sediment samples were collected on each sub-area, and analysed in the laboratories in Georgetown. No ground geophysical work was carried out. It seems now that the economic potential of the investigated area is very poor. Indications of primary economic mineralisation have not been found, and only a soil arsenic anomaly coinciding with Airborne EM Anomaly 34 seems to justify further follow up.

EM Anomalies 156, 90 and 32 are possibly carbonaceous, formational conductors. Under Anomaly 94, a body of older basic intrusives caused a significant but weak chromium anomaly which is associated with increased nickel and cobalt values. The peculiar arsenic peak on Anomaly 34, which corresponds very accurately with the strongest airborne EM conductor, seems to indicate formational trends but cannot be explained. Arsenic is often a pathfinder element for gold, silver and tungsten.

All the other analysed elements did not give any significant results. These include copper, zinc, cobalt, vanadium, nickel, molybdenum, lead, tin.

It appears that Anomalies 152, 153, 154, 155 and 157 are formational and possibly due to carbonaceous material. Of possible further interest are high airborne radiometric responses corresponding closely with EM Anomaly 155, since uranium can be enriched in black shales.

EM Anomaly 89 seems to be similar to anomaly 90 and appears to be formational, possibly due to carbonaceous material. Again there is a high radioactive response in the vicinity of these two anomalies.

On EM Anomaly 35 a heavily pyritised amphibolite outcrops.

Radioactive impulses were also detected near EM Anomalies 32 and 34, where the former suggests carbonaceous material.

An attempt was made to cover EM Anomaly 41 by geochemical stream sediment sampling, but the expedition had to retreat due to heavy rains and floods in the Kartuni valley.

The following recommendations are made for further work. Ground geophysical surveys for radioactive impulses should cover particularly the arsenic anomaly which is coincident with EM conductor 34. This should be done in conjunction with detailed geological studies. The remaining part of area E 13 should be covered by geochemical soil sampling. For academic interest ground geophysics should check anomalies 90, 94 and 32.

6. Geochemical-geological investigations at Mariwa Mountain-Cuyuni River (Georgetown NW Quarter Degree Sheet) by C.N. Barron

Five weeks were spent in the latter part of 1968 running stream and soil geochemical surveys on Mariwa Mountain, some 20 miles up the Cuyuni River from Bartica. This was the site of a small copper mine worked by Thomas Hildebrandt, a Dutchman, in 1740-42.

The interesting area lies on the western flanks of the mountain, overlooking the Cuyuni River. The laterite cap originally covering the mountain has been removed on the west by erosion, and creeks show good exposures of amphibolite, minor sediments with north-south bedding and near the river, an intrusive dioritic rock. The latter may be related to the granite seen in the Cuyuni River. The principal penetrative foliation is also north-south running. Cross structures run mainly northeast-southwest, and may be related to local fracturing. The only mineralisation seen was of pyrite, both yellow and silvery varieties, generally on fractures in amphibolite.

The soil grid lay north-south. It was about 1 mile long by a half mile wide with sampling on 300' x 100' centres. Two north-south trending, locally interrupted soil copper anomalies were encountered. That on the east corresponds roughly with the eastern amphibolite ridge: that on the west appears to be partly outside the grid. Both are open at the southern end. Soil copper values reach 560 ppm on a background of about 80 ppm. Six sample sites were augered to 8 feet and showed increased values (up to 600 ppm against 480 on the surface) under the anomaly.

Further work is planned.

7. Geochemical-geological investigations at Anaturi East, Lower Barama (Waini NW Quarter Degree Sheet) by R. Steiger

Detailed geological and geochemical surveys in the surroundings of a drill target were carried out on the recommendation of Dr. Muller and Dr. Saha because of promising geochemical geophysical results obtained during reconnaissance work in the 2nd season 1967. The area consists mainly of mica schists (with staurolite and kyanite), gondites (with associated carbonaceous shales), slightly mineralised lenses of fine-grained granodiorite (pyrrhotite and some chalcopyrite), and tourmaline-quartz veins. Within the sampling grid no anomalous values were found, and since this confirmed the findings in three drill holes (Dr. Muller), where only uneconomic sulphide mineralisation was encountered, the area was abandoned.

Mineralisation inside of the granite is not of economic interest. A genetical connection between granite and mineralisation of the countryrock, however, is likely.

8. Geochemical-geological investigations of airborne EM Conductor 4, Port Kaituma (Waini NW Quarter Degree Sheet) by R. Steiger

In this area detailed geological and geochemical work was done, following up interesting Pb and Cu values in soil samples found during reconnaissance work in the second field season of 1967. At the same time Dr. Saha carried out a ground geophysical survey, trying to locate an airborne EM conductor which was thought not to be related to carbonaceous material. The area consists of a slightly differentiated body of syenite, adjoining rocks of granodioritic composition. Abundant veins of syenite pegmatite occur within the syenite and in part of the granodiorite. Most of these veins are mineralised. Magnetite, galena, fluorite and pyrite have been identified. Small amounts of cassiterite were found within the syenite. Since no geochemical results were available at year end, it was not yet established whether the mineralisation was of interest or whether it only represents background mineralisation to be expected in such environment.

9. Geochemical-geological investigation of part of airborne EM Conductor 5, around mile 19 on Matthews' Ridge Railway (Waini NW Quarter Degree Sheet) by R. Steiger

A brief geological and geochemical survey was carried out in order to follow up a few high Cr and Ni values in soil samples encountered during the 2nd Season 1967, and to establish whether they represent only background fluctuations over basic rocks or whether they are really anomalous. The area consists of chlorite schists (representing basic intrusives or extrusives), phyllites, carbonaceous shales and quartzites. Also in this area Dr. Saha conducted a brief ground geophysical survey. No geochemical results were available at year end.

10. Reconnaissance Geochemical Survey - Stream Sediments Sampling in the Eeribisi - Blue Mountain Area, Cuyuni River (Georgetown SW/NW Quarter Degree Sheet) by J.D. N. Punwasee

The area surveyed is easily accessible and is situated on the left bank of the Cuyuni River, about six and half miles upstream from Upper Kamaria.

The primary aim of the survey was to investigate a possible copper soil geochemical anomaly depicted on the map compiled by Sherritt Gordon Mines Limited in 1966. A reconnaissance geochemical stream sediment sampling was carried out as a preliminary stage of the investigation. CXHM determinations were carried on the spot to ascertain the further piloting of stream sediment sampling. Creek lines were cut and sample stations were sited at 1000 foot intervals.

In the survey area outcrops and boulders of meta-sediments, igneous rocks (ranging from intermediate to basic in composition), vein quartz, laterite cemented sandstone and laterite occurred. Approximately east-west striking foliation, dipping to the north, was observed.

With strings of CXHM 20 + highs, the area seem very promising, but these highs must be viewed with caution as most of the streams have incised deeply into areas covered with laterite duricrust, laterite soil and laterite boulders. The highs may be due to laterite of silt size particles which are enriched with

the ions of the elements Cu, Pb, Zn, Ni, etc. The probability of laterite being responsible for the highs was debatable as hydroxylamine hydrochloride added to the buffer solution, should prevent iron from interfering in the test.

In the CXHM method the metal determined is chiefly Zn. The method should be tested in both laterite and non-laterite areas to test its applicability in tropical terrains. A spectrographic scan was carried out Cr, Co, Ni, Cu, Mo and Pb. Analyses for Cu, Ni and Zn were done with the Atomic Absorption Spectrophotometer. For the element Cr, the high values ranged from 225-300 ppm. The values of Co were low and were not considered significant. The spectrographic values of Cu are lower than the A.A. Spectrophotometer values, the latter of which ranged from 240-510 ppm. High values of Zn from A.A. Spectrophotometer determination ranged from 170-400 ppm.

The Spectrographic values of Ni were higher than those from the A.A. Spectrophotometer. The values for Ni were low and were not considered significant.

It is recommended that further survey in the area should continue.

11. Report on geoligical and geochemical investigations in the Omai Mine Area (Omai SW/NW Quarter Degree Sheet) by F.J.L. Guardia

Several pronounced EM anomalies were detected by airborne survey in the Omai Mine Area, which had had a long history of gold extraction.

Rocks of the Mazaruni Group, mainly coarse sediments and intermediate to acid volcanics, are folded into a broad anticline and syncline with WNW-ESE and NW-SE axial trends respectively. Folding culminated in local zones of shearing. The rock types, sequence and style of folding are apparently continued north-westwards into the Eldorado and Honey Camp-Issano areas. Granites have been intruded into the Mazaruni Group rocks. One small granitic body at Omai Mine is intensely mineralised and is host for much of the gold. Two, possibly three, sets of dolerite dykes are found in the area and are generally later than the granites. Extensive Berbice Formation deposits, including sands and transported laterites, mantle much of the area mapped.

Ground studies have not revealed bodies that can be considered the cause of any of the electromagnetic anomalies, but the alignment to strike of the Mazaruni Group and the occurrence of carbonaceous sediments in similar sequence elsewhere suggest that most of the anomalies are uneconomic bedrock conductors.

Values for Cu, Ni, and Cr, in stream sediments have revealed anomalous areas, three of which warrant further study. Reconnaissance soil sampling over one of these areas in the immediate mine area has been carried out. No close correlation between geochemical and electromagnetic anomalies has been observed, except in the case of one small but strong conductor that appears to coincide with a well defined hydromorphic copper anomaly.

12. Pedogeochemical Survey at Morne Charles (Deux Branches) Prague River, Dominica, in the West Indies, by M.W. Carter

Work continued in Dominica during the year as Technical Assistance from Guyana.

A defined but incompletely delimited geochemical copper anomaly 2400 feet long by 100 feet wide or average exists in the Morne Charles (Deux Branches)

area, Prague River, related to pyritic mineralisation in hydrothermally altered andesites. The anomaly is defined by the 200 ppm copper isograd and is still open on its north and south limits. Within this anomaly smaller areas occur where the copper content rises to seven times the background count. These areas occur at points north of the grid origin.

A undefined geochemical zinc anomaly occurs in the Morne Charles (Deux Branches) area, Pagua River, related to mineralization in hydrothermally altered andesites. Further analytical results are required to define and delimit this anomaly, but the anomalous values so far obtained are south and southwest of the grid origin. Isolated high values occur northwest of the grid origin.

These anomalies are significant superjacent geochemical anomalies.

13. **Summary of work in Upper Demerara, Project No. 270, A.K. Banerjee - U.N. Geologist**

An area of about 8 square miles covering EM Anomalies 161 and 175 in Area E-15 was covered by detailed geological mapping, geochemical stream and soil sampling and ground geophysical surveys during the second field season of 1968.

The south-eastern section of the area is covered by coarse grained, often porphyritic granodiorite which has intruded the amphibolites and hornblende schist of the Mazaruni Group; these are exposed in the central and western parts of the mapped area. A number of younger dolerite dykes trending NE-SW, NW-SE and N-S occur in the granodiorite and in the Mazaruni Group. A large portion of the northern half of the area is covered by laterite which gradually tapers out to the west. The foliation in the granodiorite and in the amphibolites trends E-W to ENE-WSW with a vertical or steep northerly dip. Several cross faults have been postulated. Five sets of joints or shear planes are present, often filled with quartz and epidote. Pyrite is the only visible sulphide in the area.

A stream sediment survey delineated two areas with anomalous copper values, one centred around airborne EM conductor 175 and the other 6000 ft to the north-west and outside the area covered by airborne geophysical surveys.

The central zone was covered by a soil survey with cross lines 500 ft. apart, subsequently reduced to 250 ft. over anomalous copper values. Samples were collected at 100 ft. intervals on the cross lines. The survey outlined a copper geochemical anomaly of plus 200 ppm Cu against a background of 30 ppm. Values within the 200 ppm contour go up to 500 ppm. The strike length of the anomaly is 3400 ft with a width varying from 200 ft to 1000 ft. Trenches excavated across the anomaly exposed heavily oxidised rocks with copper values increasing to almost double within 8 ft from the surface. The maximum copper value obtained was 1300 ppm. Selected samples were tested for Ni, Cr, Au and Ag. Nickel appeared to be sympathetic towards the copper and the highest value went up to 400 ppm. Zinc, though erratic, was also high (400 ppm) in the trench samples. No relationship between copper and chromium values was established.

The second copper anomalous zone to the north-west appears to be along an extension of the strike of the central zone but the intervening area is mostly covered by laterite and showed no geochemical values of interest. A soil grid with cross lines 500 ft. apart and samples every 100 ft. gave values from 200 ppm to 600 ppm copper over a width of 3000 ft., extending 2500 ft.

and still open to the west. Further work in this area is essential.

Ground geophysical surveys using the EM Gun, Turam, S.P., Magnetometer and Gravimeter were carried out in the area. Owing to the low order of geochemical values found coupled with the results of the geological mapping, only a limited amount of work was done over the airborne EM Anomaly 161. It was noted that the six channel response on one flight line falls close to a traverse fault. A number of strong ground conductors were coincident with N-S trending basic dykes but geochemical surveying over these failed to show any minerals of interest.

A series of conductive zones which were delineated were found to be coincident with or adjacent to, the geochemical copper anomaly which falls within airborne EM Anomaly 175. The conductive zones which appear to have a steep northerly dip were traced to the west until they passed under the laterite. Gravity surveys over the EM-geochemical anomaly indicate small gravity highs; also the gravity values increase to the SW indicating a fault; a change in rock types; or a contact coincident with the geochemical anomaly. The magnetic surveying confirms this and has also indicated the presence of several fault zones.

A test drilling programme has been drawn up for this area during the first field season of 1969.

14. Colorado School of Mines - US AID Geochemical Research at Omai Mine

Mr. Steve Collings graduate student of the Colorado School of Mines undertook geological-geochemical research work in the old Omai Mine block with a view to ascertaining the control of gold mineralisation there. Laboratory work was still in progress in the Denver Laboratories of the U.S.G.S. and in Golden Colorado at year end.

15. Eagle Mountain - British AID/Imperial College Project

Mr. R. Montgomery was assigned to the Geochemical Research Project at Eagle Mountain by the Applied Geochemistry Group at Imperial College. He was accompanied by his supervisor designate Dr. Peter Bradshaw. The purpose of this research project is to determine the control of molybdenite mineralisation and whether workable deposits exist.

A number of bore holes were sunk and the geochemical grid extended. Laboratory work on the samples in proceeding in the laboratories of Imperial College in London.

B. GEOPHYSICAL INVESTIGATIONS

Geophysical Investigations by S.N. Saha (U.N. Geophysicist)

During the year, ground geophysical work was conducted over four principal areas. They are

1) Anaturi Creek area, Lower Barama River

2) Around mile posts 2 1/2 and 19, on Kaituma - Matthews Ridge railway.

3) Baramali Creek area, near Aremu, Puruni SE Sheet 2.

4) Upper Demerara River, above the Great Falls, somewhere north of Empresa Hills and West of Wamara Mountain, Potaro SW Sheet 2.

Short summaries of the work done and results obtained are given below.

1) **Anaturi Creek Area**

The area is located around Anomalies 11 and 12 of area E14, of the airborne EM survey of 1967, and the ground work comprised detailed survey by E.M., S.P. and magnetic methods and to establish drill hole points based on the geophysical and geochemical data. A zone characterised by strong conductivity with coincident magnetic and S.P. anomalies and weak soil copper anomaly, was drilled, and the result indicated the cause of the anomaly as due to thin parallel bands of pyrrhotite with traces of copper. The depth and dip prediction from the geophysical data was reasonably correct. The area was abandoned after three test drill holes were put through as the deposit was not of any economic significance.

2) **Kaituma-Matthews Ridge Railway (2 1/2 and 19 mile posts**

This area was first located as an airborne EM conductor during the aerial EM survey of 1964-65. Geological and geochemical work, was subsequently carried out by Dr. R. Steiger and some good soil copper and lead anomalies had been reported. On his recommendation ground geophysical work was undertaken to investigate the possibility of massive sulphide deposit. E.M., S.P. and Magnetic methods were used. The survey showed no indication of any anomaly which can be attributed to sulphide mineralisation. The ground EM anomaly indicated a weakly conductive zone which faithfully followed the high earth embankment of the railway which runs for more than a mile. The magnetic picture showed the structural grain of the country rocks.

A quick E.M. and magnetic survey over a few lines was carried out around the mile post 19 of the same railway (from Kaituma) to test some of the soil geochemical anomalies found by Dr. R. Steiger. A strong conductor was delineated and the cause of this anomaly is probably the exposed carbonaceous sediments in the place which has no correlation with the geochemical anomaly.

3) **Baramali Creek area, Aremu, Puruni SE Sheet 2**

Airborne EM Anomaly 11 of the 1964-65 airborne EM survey around Baramali Creek was further investigated by ground EM, Magnetic and S.P., methods. The object of this survey was to locate drill sites on the basis of geophysical and geochemical data. Three smaller areas were chosen (zones A, B and C) for detailed investigation. Drill hole No. 20 Azimuth 205°, dip 45°) was located to investigate the cause of a coincident E.M., Magnetic, S.P., and soil copper anomaly. The drill hole did not meet any appreciable mineralisation. The cause of the anomaly was assumed to be superficial and ascribed to the course of the Baramali Creek and its flood plain. The magnetic anomaly could not be explained as the drill hole was not extended long enough to make any conclusion. Zone B, situated further to the N-W, was characterised by a zone of high soil copper value and strong electrical conductivity. Two holes, DDH 21 and 22 (22, 107 ft. South of 21) were put in the azimuth 180° and dips 35° and 45° respectively. None of these met the bedrock even at a depth of 300 ft. and the holes were then abandoned. The existence of a fault zone, having weathered and waterfilled rocks has been attributed to the cause of the conductive anomaly.

The third area, Zone C, was characterised by a coincident weak geochemical, EM, Magnetic (slightly shifted) and S.P. anomalies. A drill hole was suggested in this region, but the Project Manager did not consider it justified in view of low geochemical values (maximum 130 ppm. of Cu).

4) Upper Demerara River Project

This area is located on the western side (left bank) of the Demerara river, above the Great falls, somewhere west of the Wamara Mountains. The area was characterised by airborne EM Anomalies 175 and 161 of area E15 of the 1967 survey, together with a coincident magnetic 'low' in the area. Ground geological, geophysical and geochemical surveys were undertaken to cover an area of about 8 square miles around a point 2 miles West of the river. At first, a reconnaissance survey was conducted which covered both of the anomalies. Ground E.M., Magnetic, S.P., and Gravity methods were used. Around Anomaly 175, the ground EM anomalies, particularly those observed by the Turam method, delineated a 1 1/2 miles long, WNW-ESE trending, wide conductive zone, which partly coincided with a 3000 ft. long trend of high soil copper value, of the order of 200+ ppm, the back ground value being around 32 ppm. The Turam anomalies continued under the laterites, where geochemical copper anomalies are absent. The magnetic and the gravity data indicated a zone of contact or fault following the Turam anomaly trend, with the exposed amphibolites to the South, and the down thrown side towards NNE. The Turam anomalies, situated to the north of the fault or contact trace, are probably caused by thin parallel mineralised bands or stringers injected within a wide sheared or breciated zone dipping towards NE in conformity with the fault plane. Test drilling will be undertaken in the next field season to find the cause of the anomalies.

The airborne EM Anomaly 161 situated within the granodiorite country rock was not picked up by any ground EM methods nor did the soil geochemistry show anything significant. Turam survey - affording better depth penetration was not carried out in the area. No further action was taken to investigate this area as the camp was closed.

C. DIAMOND DRILLING OPERATIONS

1. Exploratory Diamond Drilling in Anaturi East Area, Lower Barama River, North West District, by Werner G. Muller

During 1967 the Anaturi East area had been checked by reconnaissance geological, geochemical and detailed ground geophysical surveying. Coincident E-M, Magnetic and SP anomalous zones were detected, as well as weak soil copper anomalies. The area coincides with aero EM Anomalies 11 and 12, in area E14 of the second U.N. airborne geophysical survey.

In spite of the weakness of surface indications of mineralization, exploratory drilling was recommended in order to investigate a strong conductor occurring beside a small belt of intrusive rocks of granodioritic composition.

The conductive zone intersected was found to be caused by slight sulphide mineralization of sedimentary origin, in a series which also contains carbonaceous (probably graphitic) components.

The intersection mineralized zone was considered to be of no economic significance.

2. Exploratory Diamond Drilling at Aranka, Cuyuni River by H.O. Druggman

Previous drilling (1965) in the once famous Aranka Goldfield indicated weak copper mineralisation (chalcopyrite). Operations, therefore, were resumed during the first field season 1968 and four diamond drill holes were sunk in order to establish grade and extent of the (disseminated) ore. As the mineralisation, outlined by a geochemical anomaly, appears to be restricted to the vicinity of the Aranka granite batholith the drill holes were laid out accordingly: three holes 650-900' in length and 500' apart were located within and adjacent to the geochemical anomaly, alongside and close to the granite contact so as to intersect it. Another hole was sunk farther away from the contact in order to check on a possible extension of the ore in this direction. As the mineralised country rock (predominantly acid to intermediate lavas with subordinate tuffs and sediments) is characterised by an approximate NW-SE trend of the foliation (which seems to control the mineralisation) the four holes were drilled towards NE at a dip of 45°.

Five mineralised zones may be discerned; three of them are tentatively correlated as persistent horizons over at least 1000'. The best intersections show the following values:

In DDH 5 (near the western margin of the geochemical anomaly): .46% Cu over 60' (true width) within which enriched zones occur: .64% Cu over 28', 1% Cu over 12', 2.13% Cu over 5'.

In DDH 6(SW of DDH 5): .67% Cu over 15' within which 1.69% Cu over 5'.

In DDH 7 (SE of DDH 5): .4% Cu over 60' within which 6% Cu over 20' and .51% Cu over 35'.

In DDH 8(E of DDH 7): .46% Cu over 75' within which .68% Cu over 30', .88% over 20'; and .64% Cu over 15'.

During the second field season four more holes, totalling 3,949 feet were drilled. Altogether it was estimated that the mineralised horizon contained 2.4 million tons with an average grade of 0.45% Cu. Owing to incomplete assaying it is not yet possible to estimate the gold content of this horizon.

3. Exploratory Diamond Drilling in the Groete Creek Gold-Copper Prospect by M.C. Hamilton

During the first field season of 1968, operations in the Groete Creek Area were extended to include drilling of the 1800 ft. of strike west of the major copper-anomaly. Geochemical sampling of the weathered overburden down to unaltered bedrock was continued on two N-S profiles across the higher contours of the anomaly.

At the end of the season a total footage of 6,575 ft was drilled; 6,144 ft. in 6 inclined holes aimed at intersecting the mineralised body and 431 ft. in 8 vertical overburden holes. This brought to overall footage, since commencement of operations in 1967, to 18,241 ft. in 42 drill holes.

Drilling of the anomaly to date revealed a WNW-ESE striking mineralised zone, with an indicated tonnage of approximately 112,500,000 tons of 0.2% Cu enclosing a richer zone of approximately 17,000,000 tons of 0.6% Cu associated

with gold values of 0.05 oz. per ton.

The ore consists of chalcopyrite, pyrite and pyrrhotite occurring in definite predictable zones. The controlling factor appears to be a shear zone lying sub-parallel to the foliation along the metavolcanic/metagraywacke contact. There is moreover ample evidence of post ore metamorphism and subsequent movement of the orebody along a series of north-south wrench faults as well as a change in trend towards the south-west.

On the basis of this evidence a reconnaissance geochemical survey was undertaken in the SW adjacent area by Mr. A.O. Edwards. Analyses showed anomalous values (200-500 ppm. Cu) over the surveyed area, thereby suggesting the strike continuity of the mineralised zone.

Further operations in the area were suspended during the second field season pending a thorough evaluation and assessment of the drill hole and geochemical data and petrological and ore-mineralogical investigations in the laboratory.

4. **Exploration Drilling at Aremu (Purune NE Sheet 2) by M.N. Fargher (U.N. Geologist)**

Exploration in the area included a detailed examination of airborne EM Anomalies 1 and 11 by ground geophysics, geochemical surveys and diamond drilling.

The examination of airborne EM Anomaly 1 extended over a period of one year. Its location was established on the ground and the zone defined by ground geophysics, Turam and EM Gun, by Dr. S. Saha who also covered the zone by S.P. and Magnetometer surveys. The geochemical survey was carried out along the strike for 12,000 ft. and cross lines which were 2,000 ft. long, were at 500 ft. intervals: follow-up sampling on intermediate lines 250 ft. apart was carried out where warranted by copper values obtained in the initial sampling.

Disseminated pyrite and chalcopyrite were found in outcrops of microdiorite in Sampson's Creek.

A total of 11,382 ft. in 20 holes were drilled across the zone; of these, two holes with an average depth of 800 ft. were drilled in the period under review. The drilling revealed a series of acid and intermediate volcanics, with interbedded tuffs and black carbonaceous sediments all dipping to the south at about 65° and intruded by two microdiorite bodies. Low grade chalcopyrite mineralisation was present in the volcanics and the microdiorite: the most persistent section was exposed in the cores of diamond drill holes 2, 5, 6, 7, 8 and 9, where the mineralisation occurred mainly in the volcanics beneath the upper microdiorite and averaged 0.67% Cu over 64" for a strike length of 500 ft. Trace values of gold, silver, molybdenum and nickel were associated with the chalcopyrite. The remaining holes showed low to trace copper values with the exception of DDH-14 which gave a section averaging 0.67% Cu over 64" and DDH-18 which gave 0.29% Cu over 17'10", both sections were in microdiorite.

On completion of the examination of airborne EM Anomaly 1 the expedition moved to Anomaly 11 located 1 1/2 miles to the south. The conductive zone was defined by ground geophysics over an area of 0.5 square miles and comprising 14 line miles of Turam, EM gun magnetic and S.P. Surveys. The area was also covered by a geochemical survey and some pitting for deeper soil samples was

also carried out. As a result of this work three possible target areas showing coincident, but weak EM and geochemical copper anomalies with high magnetics and low S.P. closures were established. The geochemical highs were 130 ppm Cu against a background 30 ppm. The first of these targets was drilled (DDH-20) to a depth of 627 ft. No mineralisation of commercial significance was obtained the highest value being 0.11% Cu from 200 ft. to 207'6". The rock was intermediate to basic carbonate veined volcanics with weak sulphide, mainly pyrite, mineralisation throughout. Two drill holes (253 ft. and 380 ft) across the second target area failed to reach bedrock. The excessively deep weathering, and the EM anomaly, may have been caused by a water filled fracture zone. In view of the results of DDH-20 and the low geochemical values over the geophysical anomalies it was decided to terminate the examination of Anomaly 11. Drilling operations were terminated in June.

5. Exploratory Drilling at Tassawini - Barama River by A.K. Banerjee (U.N. Geologist).

The old mine workings lie on the western extremity of airborne EM Anomaly 39 in Area E-14 and about 3 miles west south-west of the diamond drilling sites on airborne EM Anomaly 40. Arsenic is considered a pathfinder for gold at Tassawini and in 1966 the Geological Survey had outlined certain arsenic anomalous areas. In that year two diamond drill holes in the bottom of opencast No. 2 had given some interesting gold values but the core recovery had only been about 31%. The drilling programme completed early in July 1968 consisted of three diamond drill holes 200 ft. and 250 ft. apart along the strike, at 45° vertical angles. The purpose was to test the continuity of the auriferous body below the old opencast workings; to establish the relationship between gold and arsenic in the mineralised zone and the significance of the geochemical arsenic anomaly outlined by the Guyana Geological Survey. A total of 2,424 ft. of drilling in three holes was completed between 21 May and 5 July, 1968.

The three holes encountered mineralised grey phyllite, corresponding to the body which had been worked in the opencasts. The thickness of the zone is 100 to 150 ft. It is sheared, tightly folded and characterised by thin stringers of quartz, pyrite, pyrrhotite and possibly arsenopyrite. On the hanging wall side there is mica schist and on the foot wall there is pronounced silicification and more quartz veinlets. The intensity of shearing and silicification increases towards the north-west and the mineralised sections are distributed over a greater thickness with an increasing number of relatively barren partings in that direction. The sequence includes grey phyllite with some carbonaceous sections and tuffaceous arenaceous grey-green phyllite. The assay data for diamond drill hole 5 from 322 ft. to 372 ft., a visually good looking section, showed low gold values, the best section averaging 0.04 ozs. over a drill core width of 10 ft. Core samples for the remainder of diamond drill hole 5 and for two other holes are still being assayed. DDH 5 was taken to a depth of 994 ft. to explore the depth continuity of the mineralised zones which were worked in opencuts 1 and 3. On visual inspection of the intersection it appears that the mineralisation is much weaker at depth.

D. REGIONAL GEOLOGICAL AND STRUCTURAL MAPPING

1. Photogeological Surveys of Southern Guyana

Dr. J.P. Berrangé of the Institute of Geological Sciences in London, continued his photogeological interpretation and field checking in the southern part of the country. By year end the following 1:125,000 interim photogeo-

logical maps were received:

Kanuku NW, NE, SW, SE
Rewa NW, SW
South Savannas NW, NE, SW
Kuyuwini NW
Kassikaityu NW

2. Structural Map of Northern Guyana

Dr. R. Steiger produced a useful structural interpretation on 1:200,000 scale of the northern portion of the country partly from field work by himself and other geologists, and partly from aerial photographs. This map should provide a useful starting point in stratigraphic-structural elucidation of this part of the country.

E. MINERAL RESOURCES COMPILATIONS

1. Iron Deposits in Guyana:

A compilation of information dealing with iron deposits in Guyana was made by Mr. G.A. Sampson and is available in the Department's Mineral Resources Pamphlet No. 13.

2. Minerals of Guyana in Atomic Energy

Dr. M.A. Lee made a very useful compilation in Mineral Resources Pamphlet No. 12 which summarises the results of previous attempts to locate deposits of radio-active and beryllium minerals. So far the search has been without success though a number of radio-active minerals have been found. Some of the reasons for the failure are examined and some suggestions for future work put forward.

3. Manganese Mining in Guyana, 1968

As a result of the closing down of the manganese operations of Union Carbide at Matthews Ridge, the Director of Geological Surveys made a brief compilation of information and assessment of the situation there. Further geological work will continue at and around Matthews Ridge to ascertain the possibility of continuing the mining operations.

F. ENGINEERING GEOLOGY PROJECTS

1. The availability of stone for Roads, Building Construction and Sea Defences

In response to an urgent request from the Economic Sub-Committee of Cabinet, Dr. H. Schielly, Geologist, was allocated to examine the availability of stone for various construction works in the country. The report was made available to Cabinet Sub-Committee and other Ministries concerned. In abstract, it was found that reserves of the existing and potential quarries have been estimated to be some 20 million tons of solid rock above sea level. If quarried below sea level, between two and three times this tonnage is available. To alleviate the projected serious shortage of stone for anticipated works, large investments in heavy and automatic equipment and in transport fleet are necessary.

The quarry centre of Guyana is around the Bartica area. Small scale quarrying is also done in the Demerara and Corentyne Rivers, but these are only of local significance.

2. Hydro-power development at Tiboku

The Department continued to give geological advice on the appraisal of the site at Tiboku Falls on the Mazaruni River as a potential for hydro-power development. During the first phase of the investigations, a geologist was seconded to the Project.

The Director of Geological Surveys continued to serve as a member of the Technical Co-ordinating Committee for the Tiboku Project.

3. Hydrometeorological Service

The Director of Geological Surveys continued to serve as Chairman of the Hydrometeorological Advisory Board.

IV. UNITED NATIONS – GUYANA MINERAL SURVEY PHASE II

Work under this project gained momentum during the year. The following internationally recruited staff were provided by United Nations:

Mr. Gerald Moorhead	-	Project Manager
Dr. A.K. Banerjee	-	Field Geologist
Mr. M.N. Fargher	-	- do -
Dr. S. Saha	-	Geophysicist
Dr. A.Z. Gedeon	-	Geochemist
Mr. D. Miller	-	Drilling Supervisor
Mr. H. Carey	-	- do -

At the request of the Guyana Government, Mr. M.N. Fargher was withdrawn from the Project in September.

Dr. A.Z. Gedeon completed a 6 month extension of his contract and departed from Guyana in November.

Mr. H . Carey left on the expiration of his contract in December.

Field activities under this Project have been described in the Summary of Field Work.

The helicopter services provided as a sub-contract to Foothills Aviation of Calgary proved to be of great assistance in the administration of field operations.

V. MINERAL DEVELOPMENT

BAUXITE

Demerara Bauxite Company

By the end of the year the effects of major expansion projects initiated in 1966 were beginning to show in increased production of dried and calcined bauxite. There was a slight decrease in the sales of alumina for the

year. Sales for the year were as follows:-

	Sales (long tons)	
	1967	1968
Dried metallurgical grade bauxite	946,720	1,020,954
Calcined bauxite	457,733	521,623
Alumina	282,521	267,298

Prospecting during the year was concentrated mainly in EP 445 and the Red Mud Pond. In EP 445 prospecting took the form of follow-up drilling on locations selected from geophysical surveys. A total of 89 holes totalling 26,969 feet were completed in this lease. In Red Mud Pond a total of 58 holes covering a footage of 16,622 were completed.

Four bucket wheel excavtors of 150, 200, 300 and 600 litre capacities together with two 450-W draglines and three 480-W draglines, shipped a total of 15,727,100 cubic yards of overburden during the year. A total of 2,759,524 long tons of dried bauxite was produced during the year. Of this 1,029,156 long tons went into the production of dried metal grade bauxite; 532,402 long tons into various calcined grades; and the balance was converted to alumina.

Reynolds Metals

Reynolds Metals shipped a total of 905,017 long tons of dried bauxite from Everton during the year as compared with 861,147 long tons for 1967.

MANGANESE

During the latter half of the year the North West Guyana Mining Company announced its intention to cease its mining operations at Matthews Ridge by year end. The Company commenced mining opera tions there in 1961. Government concluded negotiations with the Company for acquisition of the assets in October and at year end the take over was completed.

The Company exported 128,694 long dried tons of manganese of average 37% grade for the year.

GOLD AND DIAMOND

The production of gold and diamond for the year is given below. The 1967 figures are also given for comparison.

District	Diamond (metric carats)		Gold (ozs. troy)	
	1967	1968	1967	1968
Berbice	445.37	-	-	-
Potaro	11,161.72	11,648.51	224	163
Mazaruni	74,020.28	43,602.74	350	3,199
Cuyuni	5,897.95	4,864.76	472	297
North West	-	-	1,330	394
Rupununi	5,826.36	6,195.57	3	35
Total	97,351.68	66,311.58	2,379	4,088

The production of diamond fell by 32% when compared with the previous year. This fall in the production came almost entirely from the Mazaruni District. The reason appears to be a significant shift of activity during the year from around Arawai to the Upper Mazaruni above, Imbaimadai which resulted in a lull in mining.

Gold production increased 72% over the 1967 figure. The increase came exclusively from the Mazaruni District and appears to reflect increased recovery of gold by suction dredges engaged in diamond mining in the district. There was a significant decrease in gold production from the North West District which has been the leading gold producing district for many years.

OIL

The oil sieve was relatively dormant during the year.

Continental Oil Company and Tenneco Guyana Inc., did no work in their 16,000 square miles prospecting lease.

During the year Guyana Shell Ltd made some modifications in the titles of their concessions. They now hold prospecting licences over 7,900 square miles of offshore area and nine 200 square mile blocks onshore. The only field activity by Shell during the year was the shooting additional seismics in OPL 211. This was carried out by Geophysical Service Incorporated of Dallas and was completed in two weeks.

In the Takutu Basin of Southern Guyana there was no activity during the year. Octogan Petroleum and Macmillan Ring Free applied for exploration concession over 2,600 square miles of this basin and while Government approved of the application early in the year the Companies had not taken up their licence at year end.

VI. HEADQUARTERS WORK

Laboratory

Re-organisation of the Sample Preparation and Lapidary Sections of the Chemical Laboratory, which was completed early in the year in order to cope with the Department's intensified mineral exploration work, proved very successful as output was considerably improved in the two sections.

The Fire Assay Laboratory carried out macro-analysis for gold and silver on rocks and cores for the assessment of the potential of current prospects. Inadequate facilities for fire assaying however, necessitated sending overseas a large number of samples for gold and silver determinations. Construction of a new fire and wet assay laboratory commenced in July but was not completed at year end. A new electric furnace provided under the United Nations Mineral Survey Phase II, and other equipment for this laboratory have been acquired and the new laboratory is expected to go into operation during the first half of the new year.

The new Atomic Absorption Spectrometric Laboratory proved its worth during the year. Determinations were mainly for estimating the grade of the base metals in drill-cores from the drilling operations. To date only copper, nickel and zinc have been determined on the Atomic Absorption Spectrophotometer.

The Spectrographic and Colorimetric Sections of the Chemical Laboratory continued to handle competently trace element analyses for the geochemical prospecting work.

Mr. P.R. Johnson, Technical Assistant Grade II resigned from the staff in August, 1968.

Mr. E. Johnson, Technical Assistant Grade I, proceeded on vacation leave in June and resumed duty in September.

Mr. M.A.A. Shariff, Scientific Assistant, proceeded on vacation leave in August and resumed duty in December. During Mr. Shariff's absence Mr. K.S. Robinson assumed charge of the Spectrographic Laboratory.

A summary of work done in the Chemical Laboratory for the year ending 1968:

Petrological Section	Number
Thin Sections	2059
Polished Sections	64
Heavy Mineral Separations	68
Specific Gravity Determinations	37

Sample Preparation Section

	No. of Samples Prepared	Drill-core split (footage)
Geochemical Samples	13,155	
Assay "	2,377	
Core Split		3,914
Total	15,532	3,914

Analytical Section

	No. of Samples analysed	No. of Determinations made
a) Colorimetric Laboratory	13,368	23,078
b) A.A. Spectrophotometer Laboratory	5,125	8,575
c) Spectrographic Laboratory	7,618	44,882
d) Fire-Assay Laboratory	351	803
e) Wet-Assay Laboratory	12	36
Total	26,484	77,274

Drawing Office

Draughting of maps for Geologists' reports continued to be the main occupation of draughtsmen during the year, with geophysical and geochemical maps forming a majority. Seventy (70) maps were prepared for United Nations personnel attached to the U.N.-Guyana Survey Phase II Project. The average rate per draughtsman was six maps per month and a noticeably high standard was maintained especially by the Assistant Draughtsmen. Specialised jobs were undertaken for several other Government Ministries.

Compilation and Mining Records:

Three (3) Quarter Degree topographic map-sheets were compiled as base for the plotting of geological data in the Geological Atlas Series. A draft teotonic map of Guyana compiled under the supervision of the Director, Geological Survey, was completed in the first stage. Maps and Plans were also prepared for the recording of mining information.

Photo-laboratory:

Mr. Arty Freda, Photographic-Specialist at the United States Geological Survey, arrived on March 18 to organise a photo-laboratory and to set up a Robertson 480 Process Camera presented by the U.S.A.I.D. Rudolph Narain, Assistant Draughtsman, had received Mr. Freda's personal training while on an attachment at the U.S. Geological Survey in 1967, and was thus able to assist Mr. Freda in his work. The result of six (6) weeks' work was a modern photographic laboratory and the best process camera in Guyana. This development has opened new horizons for the capabilities of the Drawing Office, such as the processing of colour-proofs; the production of fine-quality copies of photographs, plans, and maps; accurate and quick reductions and enlargements, as well as map-reproduction material including colour-separation overlaps to the lithographic plate stage, and up to a maximum size of 24" x 36". During the year, several Departments requested the services of the camera and photo-laboratory, and external jobs done included precise reductions and enlargements of plans for the Cartographic Section Lands Division enlargement of aerial photographs for the Roads Division, Ministry of Works and Hydraulics; the production of colour-separation positives for the Telecommunications Corporation, and the copying of plans for the Prime Minister's Office. Internal jobs included processing photographs for display and copying a large quantity of photo-mosaics for the Drawing Office Records. The photo-laboratory facilities have been in continuous use since their installation.

Filing and Indexing, Dyeline Prints

A record number of maps - foreign and local - as well as photo-mosaics were filed and indexed for the year. Dyeline Prints made included 1,000 for other Government Departments. Direct positive transparencies were also made using ammonia fumes for developing.

Miscellaneous

New equipment ordered for the year included several type-masters for the Varitype "Headliner" Photo-composing machine. Art work and designs, requiring a high quality of type, could thus be carried out in the section, and the result was the designing of several Report Covers, notably MacDonald's "A guide to Mineral Exploration in Guyana" among other items. A coloured map to feature on the cover of the 1969 Telephone Directory was designed and laid out in the Drawing Office at the request of the Guyana Telecommunications Corporation. Illustrations for Records Volume IV and Records Volume V, were supervised from negative to press stages at the Guyana Lithographic Company where they were printed in black and white. In all, the Guyana Lithographic Company completed then (10) printing jobs for this Department during the year. A photographic display was mounted for the Exhibition at the National Park prepared for Mrs. Gandhi's visit in October. The Drawing Office also contributed to the Department's exhibit at the National Agricultural Exhibition in September.

A Summary of production for the year is as follows:-

Tracings Prepared	(Illustrations for Reports etc.)	.. 372
	(Mining Information)	.. 18
	(For other Departments)	.. 40
		430
Maps Hand-coloured		.. 75
Map Compiled		.. 12
Geologists' maps filed and indexed		.. 285
Other maps	" " "	171
Foreign maps	" " "	.. 75
	Total	531
Photomosaics filed		.. 90
Dyeline Prints	(for U.N. Min. Investigation Project)	.. 800
Dyeline Prints	(for other Departments)	..1,040
	(illustrations for Reports etc.)	..7,960
	Total	9,800

	Sq. ft. of paper used	..	35,244
(May-December)	Photographic Positives	..	623
"	Photographic Negatives	..	259

Library and Publications

The books on the Accession Register amounted to 13,324.

The library received 89 different periodicals of which 55 were obtained by subscription and 34 free or on an exchange basis. 81 were of a scientific or technical nature and 8 of administrative, commerical 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 to March	215	123	111
April to June	163	56	211
July to September	230	28	123
October to December	212	35	29
Total:	820	242	474

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

Table 2 shows new publications printed and stencilled for sale and free distribution during the year:-

Table 2

1)	Records Vol. IV	500 copies
2)	Records Vol. V	1,119 "
3)	Mineral Resources Pamphlet No. 12	200 "
4)	Mineral Resources Pamphlet No. 13	289 "
5)	Bulletin No. 38 "A Guide to Mineral Exploration in Guyana by J.R. MacDonald	1,000 "
6)	Report on the Geological Survey for the year 1967	358 "

7) The search for Mineral Deposits in the Tropical Rain Forests of Guyana - a review of the applications of modern techniques of mineral exploration in the tropical rain forest terrain, by S. Singh (Paper presented at the Fifth Caribbean Geological Conference, St. Thomas, U.S. Virgin Islands, July, 1968).

Table 3 shows the distribution of publications:-

Table 3

	Sold	Free+	Total
Annual Reports	25	379	404
Bulletins	69	140	209
Records Vols. 1 to V	24	260	284
Mineral Resources Pamphlets	25	379	404
Miscellaneous Reports	7	10	17
Free Publications		422	422
Maps	466	1,124	1,590
Proceedings of the 5th Inter-Guiana Geological Conference	2	4	6

Radio and Geophysical Workshop

This section is responsible for the maintenance of communications and geophysical equipment and is under the charge of Mr. R. Belletty, Grade I Technical Assistant.

During the year 3 new RCA SSB-5A Transceiver units were acquired. The network now consists of 12 RCA units. Of these 3, two are equipped with extra pieces of accessories namely (ETC) Electronic Telephone Coupler and a (VOR) Voice Operated Relay unit. With these extra accessories attached to the base station, the geological shortwave network will be coupled with the Government telephone network. This new principle will go into operation as soon as the crystals arrive for the new Geological Survey frequency which has now been selected as S250K/HZ. In the meantime, the 8RA (formerly ZFX) Government frequencies are still employed. All communication equipments were licenced during 1968 for this new frequency. The field network will now operate with 11 RCA's and two collins. One of the three Collins will remain at Headquarters along with one RCA for base operations. Additional units include the DX40 and DX60 Heathkit transmitters, along with the 3 Pye Radio telephone units. The 4 Hallicrafter CB units will be installed in vehicles sometime in the new year. Tests carried out on this project were successful.

+Most on free exchange arrangements with institutions in other parts of the world.

The Radio workshop of the Geological Survey is presently servicing two other departments in their communication problems, namely the Forestry Dept., under the U.N. F.I.D.S. Project, and the Soil Survey of the Ministry of Agriculture. The Forestry Project acquired 4 RCA SSB-5A units and eight Stoner 20 MA SSB units and Mr. Belletty was responsible for installing these and putting them into service. He also trained a technician in routine operation and maintenance. Periodic maintenance and service checks are made by Mr. Belletty. This same service has also been extended to the Soil Survey Section of the Ministry of Agriculture which has acquired two RCA sets. Mr. K. Tross joined the Geophysical Survey during the year as Mr. Belletty's assistant.

Regular Service checks were carried out on other electronic and electrical equipment in the Department.

The principal serviceable geophysical instruments at year end were:-

2 Turam Electromagnetic sets
1 Abem E-M gun
1 Pye S-P potentiometer
1 Sharpe S-P potentiometer
1 Sharpe combined SP/resistivity set
4 Sharpe Schmidt type Magnetometers (2 vertical, 2 horizontal).
3 Askania Torsion Magnetometers (2 vertical, 1 horizontal).
1 Elsec Proton Magnetometer

Mechanical Workshop

The Mechanical Workshop is responsible for maintenance of all mechanical equipment in the Department and for providing transportation services as required. It carried a staff of (3) three permanent Driver/Mechanics under the supervision of the Foreman Mechanic, Mr. C. Narain resigned from the post of Foreman/Mechanic on the 17th July, 1968 and Mr. Albert Edwards was appointed Foreman Mechanic from that date.

During the year the (3) permanent Driver/Mechanics performed the duties of Drill/Mechanics. They were responsible for the upkeep and maintenance of the Diamond Drills, while they were operating in the field.

The active equipment held at year end consist of:-

4 Land Rovers
1 Morris JR Van
1 Land Rover Truck
2 Tractors (Dexter and Fordson Major)
2 Bombardier Vehicles with trailers
10 Small Outboard Engines (Seagull)
84 Medium " " (Archimedes)
4 40 h.p. " " (Johnson)
1 55 h.p. " " (Johnson)
3 40 h.p. " " (Evinrude)
1 55 h.p. " " (Evinrude)
4 12 volt J.A.P. Charging Plants
6 Honda Generating Plants
2 Petter Engines
4 Chain Saws

1 Fair Banks Morse Generator
1 Good Enough Pump
1 Warsap Rock Drill
6 2500 Watt Winpower Gasolene/Electric Generators
1 Boyles BBS 17A Diesel Drill
4 Boyles BBS 1 Gasolene Drills, two with Hydraulic feeds.
1 Acker Hillibilly Gasolene Drill

A carpentry workshop and a core shed were also added at Headquarters during the year.

VII. CONFERENCES AND VISITS

Conferences:

The Director, Dr. Sobharam Singh visited Surinam from June 7th-9th for a regional meeting to assist in the compilation of a draft Tectonic Map of the Guianas for inclusion in the Tectonic Map of South America.

The Director attended the Fifth Caribbean Geological Conference held in St. Thomas, U.S. Virgin Islands from 1st-5th July. At the request of the Organizing Committee Dr. Singh presented a paper entitled "The Search for Mineral Deposits in the tropical rain forests of Guyana - a review of the applications of modern techniques of mineral exploration in the tropical rain forest terrain".

The Director attended the 23rd Session of the International Geological Congress in Prague, Czechoslovakia which was to have been held from 19th-28th August, but the occupation of Czechoslovakia by troops of the Warsaw Pact countries forced a premature closure on August 23rd.

Visits

During the year the Department saw a greatly increased flow of visitors from the private, public and academic sectors of geology and mining.

APPENDIX I

Staff Availability
Senior Professional

Establishment	Name	Availability
1 Director	S. Singh, B.Sc., Ph.D., F.G.S., F.R.G.S., C. Eng., A.M.I.N.M.	1st January-31st December.
1 Deputy Director	M.A. Lee, B.Sc., Ph.D., A.R.S.M., D.I.C.	1st January-31st December.
1 Geochemist	M.W. Carter, M.Sc.	Resigned w.e.f. 1/10/68.
1 Geophysicist	Vacant	
1 Petrologist/ Mineralogist	A. Choudhuri, M.Sc., Ph.D.	Appointed w.e.f. 28/12/68.
4 Snr. Geologists	C.N. Barron, B.A., F.G.S.	1st January-31st December.
	G.A. Sampson, B.Sc., F.G.S.	Proceeded on Commonwealth Fellowship Training from 10/9/68.
	2 Vacancies	
11 Geologists	J.D.N. Punwasee, B.Sc., F.G.S.	1st January-31st December. Acting Snr. Geologist w.e.f. 1st January.
	H.O. Bruggman, D. Phil.	1st January-31st December.
	W.G. Muller, D. Phil.	1st January-15th June, 1968 Contract expired.
	H. Schielly, D.Sc., Nat. Dip., Ing. Geol.	1st January-31st December.
	F.J.L. Guardia, B.Sc.	1st January-6th March, 1968 Contract expired.
	R. Steiger, D.Sc., Nat. Ing. Geol.	1st January-31st December.
	G. Vallance, B.A.	1st January-31st December.
	A.R. Westerman, B.Sc.	1st January-31st December.
	T. Gyr, B.Sc., Nat. Dip. Ing. Geol.	1st January-5th December, 1968. Contract expired.
	M.C. Hamilton, Dip. Geol. Freiberg.	1st January-31st December.
	6 Vacancies at year end.	
2 Scientific Assistants	M.A.A. Shariff (Spectrograph)	Vacation leave 1/8/68-3/12/68.
	A.O. Edwards (Field)	1st January-31st December.

APPENDIX II

Summary of Expenditure 1968

a) Recurrent Expenditure
Head 29
Ministry of Agriculture and Natural Resources
Geological Survey and Mines

		Amt. Spent 31/12/68
Sub-Head 1.	Personal Emoluments	G $ 253,288.42
2.	Transport and Travelling	24,966.05
3.	Miscellaneous	2,845.57
4.	Library and Publications	3,492.57
5.	Sanitary and Fuel	42.26
6.	Uniforms	1,184.34
7.	Study Courses	-
8.	Rental for Quarters	378.00
9.	Labour and Rations for Labourers	44,987.65
10.	Land and Water Transport	3,960.59
11.	Drawing Instruments, Materials and Equipment.	6,489.59
12.	Revenue Protection	-
13.	Materials for Survey	3,770.53
14.	Repairs and Maintenance of Scientific Equipment.	2,203.23
15.	Printing Maps and Reports	8,053.63
16.	Special Scientific Research	1,483.62
17.	Geophysical Surveys	9,868.90
	Total Recurrent	G$ 367,015.33

b) Development (Capital) Expenditure
Division XIII
Ministry of Agriculture and Natural Resources

Sub-Head 28.	Geological Surveys	555,721.57
31.	Photo-Geological Survey of Southern Guyana	11,500.00
34.	Imperial College Research Bursary	18,900.00
	Total Development (Capital) G $	586,121.57
	Total Recurrent & Development (Capital) G $	953,136.90

(G$ 1 = 4s. 2d. sterling).