



GUYANA

Ministry of Agriculture and Natural Resources

**REPORT ON THE GEOLOGICAL
SURVEY DEPARTMENT FOR
THE YEAR 1964**

Geological Survey Department

P.O. Box 789

Georgetown, Guyana

1968

GEOLOGICAL SURVEY DEPARTMENT
Ministry of Forests, Lands and Mines

ANNUAL REPORT 1964

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

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I. Introduction

The function of the Geological Survey Department is to establish the nature and distribution of the mineral resources of British Guiana and to undertake such investigations as seem necessary to encourage their utilisation.

The basic work of the department consists in one form or another of systematic geological reconnaissance and mapping, with the application of detailed studies as suggested by results and continuous reappraisal of earlier observation. In this programme highly effective guidance is already at hand in that the general distribution of mineralization for the northern half of the country has already become manifest and from the current application of modern exploration techniques by which targets can be pin-pointed.

During 1964, as for the past few years previously, the Department fell within the responsibilities of the Minister of Trade and Industry.

During 1964, total expenditure amounted to W.I. \$592,601 of which W.I. \$553,047 was derived from local resources and the remainder from Development and Welfare funds.

II. Review of the Year

Staff

Senior professional staff strength, already cause for concern, weakened during the year. At the year end there were eight vacancies in the senior staff establishment of twenty-one, with more impending.

Dr. R.T. Cannon, Senior Geologist, resigned with effect from 12th November, in order to take up a post-doctoral fellowship at McGill University in Canada. Dr. Cannon had been a member of the Survey since 1954.

Dr. G. Harden, Geochemist, did not renew his contract, finding a post in Canada and subsequently transferring to the United Kingdom.

Mr. J.W. Carter, Geologist resigned with effect from the 1st November in order to take up a post with the University of Guyana, and Mr. L.L. Fernandes also accepted a similar post, the latter appointment becoming effective from 1st January, 1965. Mr. Carter originally joined the Geological Survey in 1950, qualifying as a geologist in 1958, whilst Mr. Fernandes was appointed a geologist in 1960. Both obtained post-graduate degrees whilst with the Department. The loss of these two officers was a severe blow to progress in Guianisation of the Department: they have however assumed an important function in introducing into the country for the first time the opportunity for basic training in geology.

Mr. F. Guardia completed his contract on 30th October and did not seek renewal.

New appointments were Mr. E. Biggs, Geologist, and Mr. N. Rodwell, Geophysicist, who assumed duty on 23rd January and 11th April respectively. Owing to the unfortunate illness of his younger son, Mr. Biggs, was compelled to request release from his contract and left the country on 31st January, 1965.

Mr. J.H. Bateson who has been with the Department since 1957 was appointed Senior Geologist retrospectively from September 1962.

Mr. H.C. Campbell was appointed Chief Clerk with effect from 8th July, Mr. P. Francois, who had been acting in the post, resuming duties with the Public Works Department.

Higher Degrees

Mr. M.W. Carter continued his studies at Carleton University under a Canadian Commonwealth Scholarship. His work has been directed towards an M.Sc. in geochemistry, and the experience and training gained promises to be of the utmost value to the Department.

Mr. M.A. Lee, also on a Commonwealth Scholarship, in this case in geophysics at the Imperial College of Science and Technology in London, pursued his studies during the year. Again, this specialist training in modern exploration techniques is essential for the fullest effect to be accorded to the Department's search for mineral deposits.

Specialists

Mr. Mr. J.R. Macdonald, Economic Geologist attached to the Geological Survey under the United Nations Technical Aid Programme, arrived in Georgetown on an assignment of one year's duration on 27th September. He will examine all records in the Department pertaining to the occurrence of mineralization and advise on the formulation of exploration programmes. Soon after his arrival Mr. Macdonald became rapidly impressed by the volume of data available and highly optimistic of the future prospects for sub-surface mining.

Mr. D.R. Curry of the Directorate of Overseas Geological Surveys visited British Guiana from 17th August to 18th October under the auspices of the United Nations Technical Assistance Board, in order to supervise the installation of a Hilger and Watts Large Quartz Spectrograph provided under the United Nations-British Guiana Aerial Geophysics Project. Mr. Curry initiated the training of operators and established a set of standards. Both the Mineral Resources Division of the Overseas Geological Surveys and Mr. Curry personally have subsequently taken kind and active interest in the progress of work with this important instrument.

Mr. D. Miller of Boyles Bros., Canada, arrived in the country on 25th September, 1964, to take up an assignment as driller under the U.N. Special Fund Project. Mr. Miller undertook supervision of the drilling operations and training of locally recruited drillers and crews.

Visitors

A very welcome visit was received from Dr. S.H. Shaw, Director of the Overseas Geological Surveys, from 21st June to 23rd June. The opportunity was taken of discussing various problems affecting the Department and the form in which cooperation from the Directorate might best take. One very prompt manifestation of this assistance was afforded in the arrival soon after Dr. Shaw's visit of Mr. D.R. Curry in connection with the setting up of the spectrograph.

During his visit Dr. Shaw attended the Departmental Conference of Senior Technical Staff which, under ordinary circumstances, are held twice annually in order to discuss progress of work.

Dr. N.J. Snelling of the Age Determination Unit of the Overseas Geological Surveys also made a welcome visit from 29th June to 19th July. Dr. Snelling has taken close interest in age determination work for British Guiana which has resulted in the general stratigraphic framework of the country's geology now in substantial part being firmly established. Dr. Snelling undertook a familiarisation tour of certain critical traverses in preparation for the second phase of the age determination programme now to be initiated. Opportunity was taken of the occasion for Dr. Snelling to address senior technical staff on radiogenic dating methods.

Mr. G. Moorehead, on an assignment of attachment to the Ministry of Trade and Industry under U.N. auspices and to advise on the revision of the Mining Laws of the territory, revived a frequently presented proposal for the amalgamation of the Geological Survey Department and the Mines Division of the Ministry. With the emphasis of the Geological Survey Department activities now aligned more to direct mineral exploration and less to regional reconnaissance the proposal has gained force and was under active consideration at the year end.

Conference, Visits and Tours of Inspection

A conference of senior professional staff officers was held on 25th and 26th June.

Tours of inspection by the Director during the year included visits to field parties in the Merume, Putareng and Groete Creek. A familiarisation traverse in company of Dr. R.T. Cannon was made of the important section between Kamaria and Waiamu in the Guyuni.

At the request of the Government of Antigua Dr. Martin-Kaye spent four weeks in the island from December 6th. Advice had been sought over the serious water shortage then being experienced as a result of prolonged drought.

Mr. P.B.H. Bailey, Deputy Director, whilst on leave, attended the N.A.T.O. Conference on Palaeomagnetism held at the University of Newcastle from 1st to 10th April.

Also during his leave, Mr. Bailey paid an official visit to Israel in order to make investigation into the feasibility of training young Guianese in Geology in that country.

III. The United Nations Aerial Geophysical Project

The United Nations Special Fund-British Guiana mineral exploration programme provides for airborne geophysics over selected areas of the interior of British Guiana, accompanied and followed by appropriate ground surveys. Involving a total expenditure of U.S. \$1.4 million, the United Nations contribution lies mainly in contractual services and the provision of equipment, whilst counterpart from British Guiana is mainly in the form of personnel and other services.

Mr. E. Wicherts was appointed Project Manager in March 1964. He had previously been associated with a somewhat similar programme in neighbouring Suriname, and replaced Mr. G. Shaw, previous Project Manager, who concluded his assignment in the latter part of 1963. Between the departure of Mr. Shaw and the arrival of Mr. Wicherts, the Director of the Geological Survey acted as Project Manager.

As originally scheduled the scheme was intended to commence at the beginning of 1962 and conclude at the end of 1964. The Plan of Operations was not signed, however, until the middle of 1962 and during 1963 it became apparent that the airborne work would fall even further behind schedule. A revised Plan of Expenditure was prepared by Mr. Wicherts proposing expenditure of the scheme to the end of 1965, and this was accepted by the United Nations with only minor modification.

The Aero Service Corporation which had been awarded the contract for the airborne surveys submitted master copies of aeromagnetic maps and a report on them at the beginning of 1964. The maps consist of seventy-three 1: 50,000 scale aeromagnetic sheets and six 1: 200,000 scale compilations, three showing interpretation. Dye-line copies of the maps can be obtained from the Geological Survey Department.

In their report, the Aero Service Corporation commented that the airborne magnetometer survey, in the northern area, indicate the geology and structure to be extremely complex. The regional strike in the western part of the area is generally northwest-southeast; elsewhere it is east-west, northeast-southwest, or not notably developed. In several regions, extensive dike systems, zones of faulting, and suggestions of major regional structure are evident from the magnetic coverage.

In the southern area, the regional strike is northeast-southwest, but it is offset and complicated by an east-west fault system. On contrast to the northern area, where a large number of rock units could be correlated with the mapped geology, almost no correlations could be made in the south.

Seven strong magnetic anomalies were recommended for field study as possible magnetite ore deposits. These are located in Barama SE, Apaiqua SE, Georgetown SW, Potaro NE, Omai NW and Kanaku SW. An eighth anomaly, on the Omai NW quarter degree square, located beyond the compiled portion of the survey, but apparent at the end of the magnetic records, was also recommended for field investigation.

The report was not received early enough in 1964 to be utilised in the formulation of the field programme for the first season. It does not appear, however, as if the programme, which had taken preliminary data into account, would have differed materially.

With the completion of the aeromagnetic programme in 1963 the contract aircraft and crews left the country and there were no airborne operations during the first half of 1964. A Canso aircraft equipped with the Barringer Input System airborne EM arrived on September 24th and commenced flying shortly thereafter. Various technical problems resulted in slow output at first, and a misfortune was manifested when it transpired that the magnetic field prevailing in British Guiana was of too low an intensity to yield satisfactory response in the magnetometer equipment installed. It was necessary therefore to proceed with the electro-magnetic work without the advantage of parallel magnetometer records.

The airborne EM phase will involve flying of 17,000 line miles at an approximate cost to the United Nations Special Fund of U.S. \$220,230. The flying will be spread over ten areas selected in conference between the Project Manager, Mr. A. Rattew of the Aero Service Corporation, and the Director of Geological Survey, and based upon the aero-magnetic data known distribution of mineralisation, and geological considerations. At the year end 4,297.7 flight line miles of data had been accepted by the Project Manager.

A considerable quantity of equipment has now been received in Georgetown for the purposes of the scheme, and all the principal items have been put to prompt use. Included amongst items received for the Geological Survey Headquarters is a Hilger and Watts Large Quartz Spectrograph which will be particularly valuable in speeding and extending the range of geochemical determinations undertaken in the Geological Survey Laboratory.

The majority of Departmental field operations and, in consequence, much of headquarters activity throughout the year were aligned for Project purposes. The value attributed to these services was U.S. \$120,300 for the first half of the year and U.S. \$128,660 for the second, a total of U.S. \$248,960 and in excess of the requirements of the Plan of Expenditure. The cumulative value of Government counterpart from the commencement of the scheme to the end of 1964 amounted to U.S. \$474,580. Although at one stage it was feared that Government counterpart might fall behind requirements owing to staff shortages and financial restriction, it is very satisfying to record that this had not proved to be the case.

IV. Field Work

Despite weakened professional staff strength and unusual Departmental problems very gratifying progress was made. Indeed, 1964 may well prove to have included field programmes leading directly to the establishment of a subsurface mining industry in British Guiana.

In the drilling programme at Haimaralli the first substantial occurrence of base metal mineralization in the entire Guyana Shield was demonstrated. At Aranka, drillsite preparation was undertaken at a locality which, on drilling during the current year (1965) is materializing as a copper-gold prospect.

Geochemical surveys in the Groete Creek area indicated a copper anomaly which later work has confirmed and shown of great interest. Similar surveys at Eagle Mountain have demonstrated the occurrence of two important molybdenum anomalies. The old Peter's Gold Mine was relocated and established as a potential drilling target, and drilling since initiated has given encouraging results. In the Pomeroun Head an earlier report of the occurrence of Haematite was confirmed and a minimum of 25 million tons is estimated.

This record is extremely gratifying, all the more so in that if this return is made from such a limited period it is apparent that a major breakthrough in the mineral exploration of British Guiana has been made. The Department has no doubt that the continued application of the same techniques will be similarly rewarding and, in fact, additional leads are manifesting themselves.

Regional map work, of which there is already a solid foundation for much of the country, although much remains to be done, had to take second place. Except in special cases, such as was undertaken was tied to more direct economic studies. Included in the latter programmes were the Itaki Hills, the Dukwarri headwaters and the Upper Pomeroun. Of longer term purpose were granite studies in the Quartzstone, Kopang and Arenu, whilst special stratigraphic work was undertaken in the Sarima and Waini rivers, and in the Makapa area of the upper Guyuni.

A full list of field operations is given below and a resume of results follows. An important proportion of these expeditions were designed as counter-part contribution and ground follow-up for the United Nations Special Fund Aerial Geophysical Survey Project and were accepted as such by the Project Manager.

The programme in field operations for the year is shown in the following table:

Table

Allocation of Geologists to field operations was as listed below. The localities are shown on the accompanying map (Fig. 1)

First Field Season

A.	Aranka	Geology, geochemistry, geophysics	Mr. C.N. Barron Mr. F. Guardia
B.	Haimaralli	Drilling	Mr. C.D.G. Black Dr. G. Harden
C.	Eagle Mountain	Geochemistry	Mr. E.R. Biggs Mr. J.H. Bateson
D.	Putareng	Geology, geophysics	Mr. L. Fernandes
E.	Makapa	Geology, geochemical reconnaissance	Mr. C.N. Barron

First Field Season (Continued)

F.	Merume	Mineral prospect	Mr. G. Sampson
G.	Kurupung	Geological reconnaissance	Mr. G. Sampson
H.	Aremu-New England	Geology, geochemistry	Mr. J.W. Carter
I.	Itaki	Geology, geophysics	Mr. F. Guardia Mr. G.N. Rodwell
J.	Groete Creek - Mariwa	Geology-geochemistry	Mr. R.H. Hewins
K.	Quartzstone-Aremu Rupa and Kopang Granites	Geology and geochemistry	Dr. S. Singh
L.	Lr. Barama-Waini	Geology reconnaissance geochemistry	Dr. R.T. Cannon

Second Field Season

M.	Itaki	Geology, geophysics geochemistry	Mr. F. Guardia Mr. G.N. Rodwell
N.	Itaki Road	Road routing	Mr. J.R. Briggs
O.	Haimaralli	Drilling	Mr. C.D.G. Black
P.	Aranka	Preparation of road to drill site	Mr. A.O. Edwards
Q.	Dukwarri Head	Reconnaissance geology and geochemistry	Mr. E.R. Biggs
R.	Pomeroon Head	Mineral Prospect; regional reconnaissance	Mr. P.B.H. Bailey Mr. G.A. Sampson
S.	Kurupung	Geological Reconnaissance and geochemistry	Mr. R.H. Hewins
T.	Tikwah	Geochemistry	Mr. R.H. Hewins
U.	Takutu	Drilling	Mr. C.D.G. Black
V.	Kamarang	Palaeontological collect- ing	Mr. J.H. Bateson
W.	Matthew's Ridge	Geology and geophysics	Mr. L.L. Fernandes Mr. G.N. Rodwell
X.	Peter's Mine	Geology and geochemistry	Mr. C.N. Barron

During 1964 the Geological Survey undertook investigations in 19 separated areas of the country. The character of the expeditions naturally varied with their purpose and ranged from drilling operations at semi-permanent camps to brief reconnaissance of areas indicated of interest by various forms of existing data.

General Reconnaissance

MAKAPA

During April 1964, a stream sediment sampling and reconnaissance geological survey programme was undertaken in the Makapa area, Cuyuni River, by Mr. C.N. Barron in order to assist its evaluation as a possible target for an airborne electromagnetic survey. The survey covered the Cuyuni River from four miles above Koama mouth to 2 1/2 miles below Kanaimapai Creek, and some forty miles of trail were cut in the area south of the river in connection with geochemical reconnaissance.

The rocks of the area are divided by a prominent discontinuity into the north-striking Cuyuni formation in the south and a roughly east striking series correlated with the Haimaraka Formation on the north. The discontinuity was considered by Mr. C.N. Barron, geologist in charge of the expedition, as probably an unconformity. Both formations are affected by folding about south-east axes, the axial plane foliation forming the regional southeast schist belt of the area, probably emphasised by later dislocation.

Two hundred and sixty (260) sediment samples were collected from areas as known or likely mineralisation and analysed for cold extractable copper. Only four samples appeared as probably anomalous and two as possibly anomalous. Since these samples were widely separated, no geochemical anomaly can be regarded as having been established.

KURUPUNG

Airborne magnetics have demonstrated a pronounced anomaly in the Lower Kurupung. In the first field season of 1964 reconnaissance was undertaken in order to ascertain whether there was any obvious cause of this anomaly, and this reconnaissance was extended in the second season with further geological observation and geochemical work.

The first season's reconnaissance was carried out by a party under Mr. G. Sampson after the close of the Merume operations. Nothing was seen that might give rise to the anomaly and the magnetic pattern established on the ground suggested that the causative body may lie at some depth.

Further check was made during the second field season by a party under Mr. R.H. Hewins who extended the area covered and undertook a geochemical sampling survey. The results showed no evidence of mineralisation.

DUKWARRI

Airborne magnetic surveys undertaken during the current United Nations programme showed the Dukwarri head region to be an area of magnetic activity. Some gold has been recovered from this region in the past which had not been surveyed by the Department. Reconnaissance geology and geochemistry were undertaken, about 90 square miles in the vicinity of the Dukwarri river being traversed by a party under Mr. E.R. Biggs accompanied at the outset by Mr. J.H. Bateson.

The Dukwarri river rising in the Cuyuni-Barama watershed flows into the Cuyuni River about 120 miles from Bartica. Outcrops are scant in the region surveyed. The Iroma Granite intrudes metamorphosed, mainly amphibolitic, members of the Cuyuni Formation which here also includes metasediments and metavolcanics, the latter ascribed to the keratophyre-spillite association. A small re-entrant from the main outcrop of the Devil's Hole Gneisses occurs within the area. The Iroma granite complex where examined could be differentiated into five varieties: hornblende, biotite, hornblende-biotite, porphyritic and dioritic.

Although abandoned gold workings are found at various points in the Dukwarri River Valley no gold is being worked anywhere in the area at the present time. Reputedly some of the workings have yielded diamonds in the past but recent search by two parties of prospectors failed to find any indications either in the terraces of the Dukwarri or in the river bed just off the Dukwarri mouth.

Geochemical analyses of 127 stream sediment samples showed only four as probably anomalous in copper content but these were widely separated and not confined to any particular drainage basin. Possibly anomalous zinc and nickel values were also recorded amongst the samples but overall the results do not call for further work at the present time.

A small aeromagnetic dipole anomaly appears to be located on a fault inferred from apparent displacement of granite and metasediment. Dip needle measurements seem to have located this on the ground in a laterite cap region. No surface evidence of mineralization was encountered however.

Ground Follow-up ARANKA

Investigations in the Aranka area, commenced in 1963, were continued in 1964. In consequence of encouraging results preparations were made for a drilling operation in the field season of 1965.

The Aranka goldfield lies to the north of the Aurora-Akaiwong section of the Cuyuni. It has been one of the most productive of the country's goldfields despite the fact that all operations were confined to the surface. The field has long been abandoned. As part of the Department's field policy of working over all such areas with geochemistry preliminary reconnaissance was undertaken during March to early May 1963. This exercise was followed by a short geophysical and geochemical re-examination of the most promising area in February 1964.

The preliminary sediment prospecting programme gave results of only marginal interest but the soil sampling programme carried out in early 1964 in the richer gold locality gave positive results for copper. The 1964 work further defined the geochemical copper anomaly, the maxima of which attained 800 parts per million copper, and established the occurrence of a parallel overlapping magnetic anomaly. Both of these anomalies are superimposed upon a gold anomaly established by a Canadian mining company in about 1935. Electromagnetic surveys revealed no conductors of any size however, nor was any response recorded when the area was subsequently flown by airborne EM. Geologically, the anomalous area overlies southeast trending phyllites immediately

south of the Aranka granite; the east west trend of both magnetic and soil copper anomalies suggests their relation to the granite margin rather than to the shearing.

A zone or zones of disseminated copper, gold and pyrrhotite mineralization are suggested by the surveys, of strike length about 1200 ft. Subsequent drilling has indeed confirmed the occurrence of copper mineralization. Analytical data are however, awaited.

During the latter part of the second field season a working party from the Haimaralli drilling operations commenced tracing a route from the Cuyuni for the 11 miles to the proposed drillsites. To aid this, and similar enterprises of the future, the Department purchased an agricultural tractor which has proved a very valuable acquisition.

ITAKI

Mr. G.N. Rodwell, geophysicist, undertook ground magnetometer and electromagnetic surveys within the area of interest, previously located on the ground by Mr. F. Guardia, from airborne magnetic data.

Analysis of the data, both air and ground, supported by surface geological observations, suggests that the anomaly results from a near-surface basic body containing a few percent of ferromagnetic material.

No anomalous trends were recorded by the electromagnetic work, even over the weak Zn-Ni-Cu geochemical anomaly.

As it seemed probably at one stage that drilling would be required for investigating the anomaly, a rough road suitable for tractors was cut for 15.7 miles from 23 miles - the Issano road to provide access to the Itaki area. Mr. J.R. Briggs, Field Observer supervised this work. In the event the road is not required as access for drilling parties it would be useful to prospectors and for forestry purposes.

AREMU

Airborne magnetometry over the Aremu has clarified the major structural features of the region, and this has stimulated re-examination, a task already scheduled on the basis of known mineralisation. The Aremu was subjected to exploration by the Anaconda Company in the late 1940's when drilling, trenching and tunnelling were undertaken in the vicinity of the old Aremu Mine. The mine itself was worked early in the century when gold was recovered from quartz veins.

Mapping disclosed the occurrence of granites of the Younger Granite Group intruding amphibolites, mudstones, phyllites, greywackes and quartzites, all characteristic of the Cuyuni Formation of the Mazaruni Group.

Mudstones form the most extensive outcrop of the area but are rarely seen fresh. Ferruginous mudstones form a distinct band within these finer grained sediments, sometimes containing numerous pseudomorphs after pyrite. Hornblende-rich amphibolites appear to have been formed by thermal metamorphism of basic volcanic rocks. Previously these amphibolites have been mapped as belonging to the Bartica Assemblage but in the opinion of the geologist in charge of the expedition, Mr. J.W. Carter, this cannot be supported. Younger granites are represented by the Aremu batholith, a typical hornblende-biotite granite, and another body of hornblende-biotite granite which may be an offshoot of the Aremu.

The greywackes and quartzites are the oldest rocks of the area; these are overlain by the finer grained sediments which have given rise to phyllites. They have been folded about WNW axes and there appears to be a syncline running through the area covered by the survey. Refolding appears to have taken place at least in the vicinity of the mine and about ENE axes.

Geochemical work demonstrated the occurrences of coincident copper and zinc anomalies 3000-4000 ft. long in the mine area. Soil copper values range up to 400 parts per million, zinc to 800 parts per million.

Airborne electro-magnetic surveys have been flown over the Aremu since the work mentioned above was undertaken. Several anomalous responses were obtained and the region is scheduled for further examination in 1965. It can be hoped that some overland access routes may be developed in this promising section of the hinterland thereby facilitating exploration.

GROETE CREEK

This region is still of particular interest as a substantial amount of gold was recovered from surface workings in earlier years. Because of its easy accessibility to Bartica and to tidewaters of the Essequibo of which it is a minor tributary.

Rocks of the Blue Mountains Formation are cut by granites of the Younger Granite Group. The Blue Mountains Formation here includes minor metasediments, garnet quartzites and actinolite quartz schists. Plagioclase amphibolites, actinolite-schists and epidote-chlorite-actinolite schists occasionally contain relict volcanic textures. It appears that quartz-albite-epidote-almandine sub-facies conditions existed but that equilibrium was not reached.

The Groete Creek granites are auriferous. Assimilation of basic material has produced a marginal hornblende-granodiorite (containing pyroxene) which grades to a biotite-epidote-granite. Epidote occurs as a primary mineral even where contamination is not evident.

Foliation directions are conformable to the granite margins.

Geochemical analyses of soil samples for copper, zinc, and nickel content indicated an area of anomalous copper values to the south of the Black Creek tributary. This area ties in with a region of old surface operations for gold. In the current year (1965) the anomaly has been demonstrated by infill work as of considerable interest. Soil copper values in excess of 300 parts per million and ranging to over 1000 parts per million extend over an area 3,300 feet long and from 100 to 400 feet wide. Clay samples collected by Mr. J.R. Briggs,

Field Observer, on follow-up programme have yielded surprisingly high (up to 2 %) copper values. This Groete Creek anomaly clearly presents a priority exploration target.

MARIWA

Geological and geochemical surveys were undertaken by Mr. R.H. Hewins in the vicinity of the Mariwa and Tupuru Creeks which join the Guyuni in the region of Swarima Island. A zone of surface gold workings extends into the area which is purported in an old record of the traveller's tale variety to have produced copper at one time. A soil sampling programme and geological re-examination were designed for the area of greatest apparent interest.

The area between Mariwa and Tupuru Creeks is underlain by rocks of the Blue Mountains Formation and include amphibolites with hornblende garnet and oligoclase, and staurolite-garnet quartzites metamorphosed to the staurolite-garnet sub-facies. Metadolerite occurs in a broad outcrop. To the west, a group of gneisses occurs between the amphibolites and the Aremu-Quartzstone batholith. All rocks, except the gneisses are affected by an early north-west foliation: the later cataclastic foliation trending northeast affects the gneiss also.

Gold has been recovered from surface workings only in this area; whilst quartz float is common it appears to be usually barren. Visible gold was noted once by the party, in a stringer in the Blue Mountains Formation amphibolites near the gneiss margin. Pyrite was encountered to a minor extent, mainly in the metadolerite in the southeast of the area.

For the geochemical programme, soil samples were collected at 200 ft. intervals along lines cut across the strike, and subsequently analysed for copper, zinc and nickel for which 50, 40 and 260 parts per million were respectively calculated as the threshold of possibly anomalous values. Plotted results showed a definite association of anomalous copper values with laterite caps whilst anomalous nickel values tend to occur away from the laterite areas. The composition of the laterite may reflect the composition of the underlying rock, although concentration or leaching of metals during laterization must complicate the picture. Anomalous values are sporadically developed except over the laterite and afford little indication of mineralization.

MATTHEW'S RIDGE

Mr. G.N. Rodwell, Geophysicist, paid a short visit to the mining operations of Manganese Mines Management Ltd., at Matthew's Ridge, North West District, with ground EM equipment, in order to establish whether the manganese ore gave a response to this prospecting technique. Only very weak anomalies were detected and it became apparent that the method would have no useful application for prospecting for manganese under conditions comparable to those at the ridge.

Mr. L.L. Fernandes also paid a visit to the mining operations at Matthew's Ridge for familiarization purposes and to undertake observations on the geological structures exposed.

The sedimentary rocks of the area fall within the Matthew's Ridge Formation. Exposures at the mine are of completely weathered rock, but minor structures are well preserved and permit structural analysis. Good structural evidence was established suggesting that the mine area lies on the northern limb of a major anticline which plunges at shallow angle to the east. Dependent folds on two scales show a relationship to parent folds consistent with the sense of bedding plane slip on fold limbs.

PETER'S MINE

A five week operation was undertaken in the latter part of the second field season in the vicinity of Peter's Mine, Puruni. At the mine locality at the turn of the century a rich auriferous quartz vein was located and sub-surface workings eventually developed. The mining company operated from 1905 to 1910 workings being taken through three levels to 400 ft. in depth. At the time of closure, ore running 1 oz. to the ton was being recovered. During the operations a 65 mile road was driven to the mine from Kartabu Point near Bartica.

The mine locality is of much interest and presented itself as a possible drilling target, no exploratory work of this nature having been undertaken by the mining company. Moreover, the known occurrence of other gold veins in the region, and responses during airborne electromagnetic surveys suggested priority attention.

The party successfully located the mine; geochemical and other prospecting showed gold extensively distributed in the general area, and also demonstrated the existence of a geochemical chromium anomaly. Chromium has been shown in British Guiana to be a geochemical tracer element for certain gold occurrences.

On the basis of the results it was determined to undertake drilling and further surveys in the area during 1965. These have since been initiated and have yielded encouraging results so far as they have yet been pursued. At the mine locality drill core showing silicification, pyritization, and other evidence of mineralization, including vein quartz with visible gold have been recovered. The operations continue.

LOWER BARAMA RIVER

During the first field season Dr. R.T. Cannon mapped in the Kokerit Landing-Wanamu River region of the Lower Barama River and in the lower reaches of the Waini and Imotai rivers. Considerable difficulty was experienced owing to the exceptionally low stage of the water resulting from prolonged drought conditions. Normal Geological Survey bateaux could not be used and corials had to be obtained.

In the Barama it was found that the sediments of the Cuyuni Formation have been folded with well defined foliation, defining belts of schists and often obliterating sedimentary features. These schist belts reflect the regional metamorphism as is well known from the Cuyuni Formation throughout northern British Guiana. Chlorite, sericite and tremolite-actinolite are typomorphic.

The foliations defined by the above metamorphic minerals consistently dip northwards, away from the Aranka-Wanamau Granite and become steeper towards the latter. The schist belts towards the granite margins are extremely fine grained and cataclastic. In addition the foliation is locally warped. It appears likely that these effects are due to emplacement of the granite, causing local warping and stretching of the pre-existing foliation resulting in marginal shearing parallel to the latter. The parallelism of all these features also suggest that the pre-existing foliation structurally controlled the emplacement of the granite.

The amphibolites and basic rocks occurring as a mantle to the north of the granite were examined geochemically by stream sediment drainage reconnaissance. The results suggest that further examination should be made in the east of the region, there being here a concentration of probably anomalous values of Zn and Cu.

WAINI RIVER

Previous mapping in this area had indicated granitic areas notable for muscovite-bearing rocks. Dr. Cannon, who was transferred to the region after his work in the Barama, considers the rocks as part of an integral gneiss complex which he provisionally terms the Waini Gneisses in which intrusive granites occur.

The Waini Gneisses occupy most of the area examined and most lithological types are noteworthy for being potash-rich with abundant muscovite and microcline. Such a large area of potash-rich gneisses is apparently unique in British Guiana and, where the surrounding country rocks are mainly mudstones, phyllites and fine grained rocks of the Barama Group, a potash-rich sequence is of considerable interest. A major metamorphic episode within which a migration of K_2O is important appears likely. The granitic intrusions of the area appear minor and probably accompanied the later deformation of the foliation and banding.

Geochemistry EAGLE MOUNTAIN

Eagle Mountain, situated near mile 118 on the Bartica-Potaro Road has long been known as centred in a mineralized area. Gold has been produced from numerous surface workings and a very small output is still maintained. From 1947 to 1949 the Anaconda Company undertook a 55 hole drilling programme drove several adits in search of a gold lode which could have been the source of the gold in the neighbouring creeks. The results of this programme were disappointing but in the last stages of the exploration molybdenite was encountered both in an adit and in three or four of the drill holes. The best intersection is stated in the report to be 93 1/2 ft. running from 0.103 % to 0.14 % Mo with values running spottily up to 1.0 % Mo. A molybdenite-bearing outcrop was also noted as well as scheelite in one of the adits.

The molybdenite was met when a change of drilling exploration policy resulted in examination of the Minnehaha Structure, a powerful fault system running through the area. The occurrence was noted as of interest, but at that time these values did not call for particular attention. Rising demand and prices for molybdenite have now altered the position and the area has been clearly revived as an exploration target.

Following reappraisal of available records in 1963, it was determined to sample soils for geochemical analysis over and adjacent to the four intrusions of the area. The work was undertaken by Mr. J.H. Bateson and E.R. Biggs.

Area 1 covered the granite at Dickman's Hill and Turtle Creek, and a smaller body in the lower Mahdia Creek. Almost 45 miles of line were cut for the sampling programme which, however, yielded only 1,718 samples owing to swamp and the prevalence of old surface workings. Area 2 included the Eagle Mountain granite and yielded 763 soil samples from 18 miles of line. Area 3 covered the Quintette Creek granite. 5 1/2 line miles were cut, yielding 2,560 samples.

Owing to the rather large number of determinations required from this programme, analysis was held up pending the installation of the newly acquired spectrograph. In consequence the analytical work had not been concluded at the year end and at the time of writing is only now approaching termination. Final appraisal cannot yet be given but powerful geochemical molybdenum anomalies have manifested themselves in areas 1 and 2. As a result mining company interest is anticipated.

During the course of the surveys a prospector, Mr. H. Green, working claims in the vicinity reported that he had encountered an unfamiliar mineral in the panned concentrates from his workings. After an investigation in the Geological Survey laboratory, and by the Mineral Resources Division of the Overseas Geological Surveys, the mineral was identified as native copper. Associated minerals were zircon, gold, ilmenite, anatase, pyrite and cassiterite, mainly in small amounts. A brief checking operation by the Department has subsequently confirmed these occurrences.

TIKWAH

The gold quartz vein at Tikwah, near the Karanang River, right bank Mazaruni, and its immediately adjacent area was re-investigated by Mr. R.H. Hewins during the second field season. The vein was originally discovered in 1929 and between 1942 and 1949 subsurface working and exploration were carried out by the Tikwah Mining Corporation. The recent programme encompassed geochemical surveys and geological observation in the hope of establishing extensions to the vein system.

The surveys showed that the veins, associated with the development of carbonate, occur in a sequence of unfoliated Cuyuni Formation lavas and meta-sediments at least 17,000 ft. thick. The lavas are mainly albite porphyries spilite-keratophyre association. Conglomerates, mainly derived from the lavas but with some petromict material, are more common than pyroclastics. The sequence has been subdivided into two igneous members and a central sedimentary member less than 4,000 ft. thick. Folding on northwest and northeast axes has occurred. In the north (near the Rumong-Morabisi granite) the rocks are foliated and have suffered green-schist facies metamorphism. The Semang graphic granite may be responsible for the mineralization, which includes gold-quartz veins, widespread replacive epidote, and carbonate and sulphides.

1,118 soil samples and 17 stream sediment samples were collected for analysis, but the results do not appear to be of any recognisable significance.

Mineral Prospects

MERUME

The Chromium mineral Merumite, recently shown to be a mixture of eskolaite and hydroeskolaite, occurs apparently exclusively in the Merume River valley, the Merume being a tributary of the Mazaruni. It is as yet only recorded in the alluvials, and intermittent work by the Department and mining interests over several years has now defined the distribution in the alluvials fairly closely, and has discounted the suggested source as the adjacent Roraima dolerite sills.

A field party under the direction of Mr. G. Sampson undertook a prospecting programme below and on the flanks of Bracewell Hill in the vicinity of First Falls, Merume, mainly in the hope of encountering merumite in situ. Particular attention was paid to quartz veins cutting the Haimaraka Formation but these proved barren and can probably be ruled out as a source. The evidence suggests that the bulk of the merumite occurs at a restricted alluvial concentration of little economic importance.

Bracewell Hill consists of Roraima type sediments which, however, appear to be a quartzitic conglomerate development of the Haimaraka Formation. The alluvial flat carrying the merumite is underlain by fine grained well bedded water-laid tuffaceous quartzites.

POMEROON

The occurrence of haematite in the Upper Pomeroon was recorded by P.K. Hall in 1954. Deposits had been encountered during the course of exploration for manganese by the African Manganese Company. During the second field season Mr. P.B.H. Bailey, Deputy Director, and Mr. G. Sampson reinvestigated the locality as part of a reconnaissance survey designed to complete mapping of the Puruni N.E. Degree Square.

Geologically the region consists of a mudstone-phyllite suite and amphibolitised basic intrusives of the Barama Group intruded by granite. Quartzites occur as impersistent lenses in the mudstones which are generally ferruginous. The upper Pomeroon Granite is typically a coarse grained two-mica microcline leucogranite. Structural data are sparse and at present defy interpretation, but in this area the regional foliation is steep or vertical with an ENE trend and there is some suggestion of a later N-S foliation.

Four haematite bodies were found to lie near the southern margin of the upper Pomeroon Granite which forms a broken semi-circular outcrop round the haematite zones. The bulk of the deposits are immediately associated with amphibolite whilst the smallest body is apparently associated with pink massive mudstones and dark fine grained quartzites. It appears that the deposits represent injection, segregation or replacement bodies related to the granite intrusion.

The haematite is a hard, massive coarse grained specular variety. Grab samples averaged 73 % Fe_2O_3 , the highest being 80.8 % Fe_2O_3 , P_2O_5 , SiO_2 and MnO_2 contents are generally low, whilst TiO_2 averages 4.4 %.

As with the Putarent magnetite body, details of the geologic relations of the Pomeroon haematite are obscured by laterite and re-cemented float. A minimum of 25 million short tons is suggested on the assumption that the haematite occurs as isolated tabular bodies averaging 50 ft. in thickness. The available sparse and equivocal data suggest that this assumption is unlikely and the outcrops are part of more deep seated bands or lenses in bed-rock. Hence the figure for tonnage given above is likely to be an underestimate. Drill hole exploration is indicated.

The locality lies about 10 miles due north of Tinamuth Falls on the Guyuni River and about 35 miles from the Essequibo estuary. There is little doubt that the deposits will be exploited sooner or later.

PUTARENG

A field party under the direction of Mr. L.L. Fernandes undertook an investigation of the geology and economic possibilities of a magnetite deposit previously known to occur in the Putareng. First noted in 1939 and identified as magnetite in 1950, the deposit gave a clearly defined and strong response, although of limited extent, during the United Nations aeromagnetic programme of 1962-63.

The ground survey showed that the magnetite occurs in several small bodies which lie within granite near its contact with metamorphosed country rocks. The largest magnetite body forms the core of a hill, the slopes of which have a heavy cementing blanket of secondary iron oxides, and has a length of about 1200 ft. The width is uncertain owing to the superficial ironcrete, although ground magnetometry suggests a maximum width of about 350 ft. Analyses of the surface outcrops of the deposit show an iron content of 44-54 % Fe_2O_3 . The quantity of magnetite immediately accessible in the deposits is suggested as about ten million tons.

The granite, part of the variable Putareng granite batholith, in the area is a mesocratic medium-coarse grained hornblende biotite granodiorite whilst the country rocks are quartzites and amphibolites ascribed to the Mazaruni group. The proportion of iron minerals in the granite increases as the magnetite deposit is approached, eventually becoming the main constituent.

The size of this iron deposit, in its rather remote location, does not appear sufficient to render it a commercial prospect at the present stage of the country's development. Unfortunately the airborne magnetics do not suggest any other occurrences in this immediate vicinity.

Drilling HAIMARALLI

Drilling operations in the Haimaralli Falls area of the Guyuni were brought to a conclusion in 1964. The results, if not spectacular, have been very encouraging in that the first substantiated base metal prospect in the entire Guyana Shield has been demonstrated. The occurrence is now established as a target for future mining exploration and in the work the Department gained valuable experience in drilling operations, the first undertaken, and in follow up on geochemical data.

In 1961 the geologists R.T. Cannon and P.M. Allen noted a small showing of secondary copper mineralisation near Haimaralli Falls in the Devil's Hole region of the Cuyuni River. The copper mineral subsequently proved, unexpectedly, to be Brochantite. In succeeding field seasons adjacent country was subjected to geochemical survey, and five areas of anomalously high soil copper content were brought to light. Three of these were discounted as probably of no significance and drilling was undertaken on one. Weak copper mineralization was encountered. With the acquisition of United Nations' drilling equipment shift was made to the original discovery locality, and primary attention was devoted to this until the end of the programme.

During 1964, seven holes were drilled, totalling 4,794 ft. with 95 % core recovery. Five of the holes were drilled in the vicinity of Haimaralli Falls itself.

DDH No. 4 Haimaralli Falls - 578'

The drill hole was designed to test metasediments below the brochantite outcrop and eventually to intersect the contact with the adjacent granite. The granite was not encountered. At this time boreable surveying equipment was not available although inclinations were obtained by etch tube.

0 - 30 ft.	Alluvium
30 - 180 ft.	Pyritiferous amphibolite
180 - 480 ft.	Coarse grained greenschists
480 - 520 ft.	Amphibolite
520 - 550 ft.	Pyritiferous schists
550 - 578 ft.	Silicified metasediments

A 150 ft. intersection from 237 ft. to 278 ft. averaged 0.22 % Cu with the best intersection in the 12 ft. from 267 ft. to 278 ft. running 0.6 % Cu.

DDH No. 15 Haimaralli Falls - 771'

With the failure of DDH No. 14 to cut the granite contact a further attempt was made in DDH No. 15 which again failed to do so, probably owing to the deflection of the drill hole along a boundary fault zone.

0 - 30 ft.	Alluvium
30 - 185 ft.	Pyritiferous amphibolite
185 - 640 ft.	Greenschists
640 - 720 ft.	Pyritic schist
720 - 771 ft.	Metagreywacke

Analysis for copper showed interesting values between 275 and 326 ft. and 453 and 490 ft. which included 4 ft. at 0.6 % and 4 ft. at 0.4 % Cu, and between 640 and 700 ft. including 9 ft. at 0.5 % and 7 ft. at 0.4 % Cu.

DDH No. 16 Haimaralli "Area A" - 503'

This drill hole was follow-up work on a geochemical anomaly area which hoped to intersect a steeply dipping cover mineralised zone at a point where improved values had been postulated. The results were disappointing;

0 - 40 ft.	Alluvium
40 - 113 ft.	Residual overburden
113 - 503 ft.	Metasediments: silts and greywackes carbonatized and cataclased.

DDH No. 17 Haimaralli "Area A" - 591'

This drill hole was designed to investigate along the strike a zone indicated previously in holes 12a and 4 as copper enriched. The results were disappointing;

0 - 30 ft.	Clays
30 - 180 ft.	Residual clays
180 - 591 ft.	Variety of amphibolites with cataclastic zones.

DDH No. 18 Haimaralli Falls - 554'

0 - 15 ft.	Alluvium
15 - 270 ft.	Granite sheared contact
270 - 554 ft.	Metasediments and greywackes often cataclased.

The 76 ft. section 487-554 ft. ran 0.3 % Cu with 2.15 % over 1 ft. at 495 ft. Cu mineralization was associated with cataclasis. A 9 ft. inter-section, 524-553 ft. averaged 0.7 % Zn.

DDH No. 19 Haimaralli Falls - 695'

This hole was designed to investigate a wedge of metasediment between granite.

0 - 20 ft.	Alluvium
20 - 162 ft.	Granite
	Faulted contact
162 - 613 ft.	Metasediments with cataclased bands
613 - 666 ft.	Granite
666 - 695 ft.	Metasediments

At 26 ft. intersection, 335 - 361 ft. averaged 0.7 % Cu, including 9 ft. at 1.1 % Cu. 0.6 % Cu occurred in the 9 ft. from 302 - 311 ft., and 4 ft. from 435 - 439 ft. ran 0.9 % Cu. Best zinc values were 0.2 % between 336 and 343 ft.

DDH No. 20 Haimaralli Falls - 1102'

DDH No. 20 was drilled to deep test the metasediments between DDH No. 14 and No. 18 and is the longest hole drilled by the Department to date.

0 - 20 ft.	Alluvium
20 - 49 ft.	Granite
	Mylonite junction
49 - 650 ft.	Schistose metasediments
650 - 1102 ft.	Metasediments with intercalated schists, fine grained amphibolites and ? extrusive volcanics.

Between 159 and 246 ft. an 86 ft. section averaged 0.13 % Cu including a foot intersection at 164 ft. and 1.6 % Cu. 49 ft. between 1042 and 1091 ft. ran 0.40 % Zn. 10 ft. between 734 and 744 ft. ran 0.23 % Zn.

25 samples from DDH No. 18 have been run qualitatively by spectrograph for Au and Ag. All showed Ag and two had some Au. The recognition of gold spectrographically suggests that assayable values are present, although this is not the case for silver. Assay and further analytical work, besides petrologic study is required for these cores but has had to be shelved for the present.

Further detail on this drilling programme may be had on application to the Geological Survey. During the year operations in the field were under the charge of Mr. C.D.G. Black whose problems were at one stage materially aggravated by the low level of the Guyuni. Geological Survey bateaux, servicing the expedition, were taking two weeks in the rough trip between Bartica and the Drill site. The Aero Service Corporation, who hold the United Nations contract for aerial geophysical surveying saved a serious hold up during this period by dropping a drill part from the air.

TAKUTU

As previously reported, in the earlier stages of the U.N. Scheme the Project Manager of that time, Mr. G. Shaw, agreed that it would be of interest to extend every fifth flight line of the aeromagnetics to be flown over the Kanukus northwards over the Northern Rupununi Savannas, the Takutu basin as it has come to be called. The aeromagnetics demonstrated the accumulation of sediments in the basin to be of considerable thickness, and subsequent gravimeter work in combination with the magnetic data was interpreted as indicating depths-to-basement of up to 20,000 ft.

During the second field season of 1964, the Acker Drilling rig was moved to Lethem to commence a programme of shallow hole drilling through the alluvial and lateritic cover in order to obtain more information on the very sparsely outcropping formations beneath. It is hoped that palynological work may throw light on the concealed stratigraphy and structure. The programme was not pursued far in 1964 and was continued in 1965.

Special Geological Problems

Granite Studies: QUARTZSTONE-AREMU, RUPA, KOPANG

In further continuation of a longer term project of investigation of British Guiana granites and their relation to mineralisation, special surveys were undertaken on three granites of the Guyuni River basin: the Quartzstone-Aremu, the Kopang and the Rupa. These studies, which will include trace element analytical work, are aimed at establishing explorational guidance on the basis of compositional distinctions between the various granite types encountered in mineralised areas. Unfortunately, owing to staff shortages, the programme has now had to be interrupted.

Typically, the Quartzstone-Aremu batholith is formed of a medium to coarse grained biotite-hornblende granite, but shows some considerable variation in composition. Almost structureless in the core it possesses a

strongly foliated shell some two to three miles in width. Occasional xenoliths of country rock and a few larger enclaves are contained near the margins. The foliated shell is often sheared along steeply dipping zones, sometimes developing flinty mylonites and elsewhere imparting a gneissic appearance.

Emplacement appears to have involved multiple injection, the foliation of the shell being imparted by a second phase of injection of granitic material into the still molten interior of the original body. The foliated margin in the south east of the batholith has previously been referred to gneisses of the Bartica Assemblage but this has not been supported by the current work.

The batholith is associated with gold mineralization, surficial deposits having been extensively worked in earlier days along a belt about a mile wide along the contact with the country rocks from the south east margin through the south to the western margin of the granite. Gold was produced from the contact country rocks, the marginal granite itself and the gold quartz veins. The veins are commonly associated with shear zones which themselves show evidence of mineralisation.

The Rupa granite proved to be extremely poorly exposed. It is a biotite granite with some hornblende. The steeply dipping schistosity of the country rocks, largely mudstones, suggests forceful injection, the granite itself having developed a strong foliation in its margin.

Gold has been recovered from the Rupa Creek and appears to be derived from the marginal granite.

The Kopang granite was found even more poorly exposed than the Rupa, although in the bed of the Kopang Creek itself fairly good outcrops occur here. The country rocks were observed these were grey and red finely laminated mudstones. The granite itself is massive and biotite rich with a fine grained marginal facies. Prospecting for gold proved disappointing and it would seem that mineralization is either weak or absent.

PARUIMA, KAMARANG

Following a report from Venezuela that a pollen assemblage had been recovered from a shale horizon in the Roraima Formation of Cerro Venamo, near the Wenamu head and close to British Guiana border, Mr. J.H. Bateson paid a brief visit to the upper Kamarang, in the same general region, in order to re-examine a series of hornfelsed shales reported from the Roraima Formation of this area several years ago, and to sample them for palynological examination. Radiogenic dating of the Roraima has comparatively recently placed it as of considerable age, Lower Proterozoic; the completely contradictory date suggested by the pollen discovery in Venezuela, Mesozoic, thus occasioned considerable surprise and has presented a problem demanding early resolution.

The survey confirmed the presence of hornfelsed sediments but showed them to be a more important development than previously envisaged, and total some six or seven hundred feet in thickness. The sequence proved identical both lithologically and in thickness to that recorded from the Kopinang some 110 miles to the southeast and there are at least five intermediate areas in which the existence of similar rocks have been recorded. The information obtained thus adds much weight to the contention that there is a widespread and stratigraphically important dominantly argillaceous unit in the middle Roraima Formation.

The problem of the disparity of age determinations between the radiographic and pollen dating has not yet been positively resolved although it appears most likely that the pollen may have been introduced by unusual contamination.

V. Age determinations

During 1964 the Age Determination Unit of the Directorate of Overseas Geological Survey made substantial strides in its valuable work on the absolute dating of rocks from British Guiana.

Fifteen Potassium-Argon determinations were made for the Department during the year as listed below. They included seven determinations on micas from the South Savanna granite and associated sediments in order to establish the dates of emplacement and metamorphism. Subsequent to the conclusions reached in 1964, the age of the granite's emplacement, then placed at about 1,700 million years has been revised, as best estimate, to 1880 ± 150 m.y. Recrystallization of the biotite under shearing took place at about 1100 to 1200 m.y.

In the north of the colony, three determinations were undertaken on gneisses and an associated granite, together with three determinations on granitic rocks the relation of which to mineralization has already been established.

An age determination on sericite schist from the Aurora area was the first undertaken on the Barama-Mazaruni Assemblage, a group of considerable importance in that most of the country's gold has been derived from it.

Finally, the oldest age yet recorded for the country ($2,595 \pm 125$ m.y.) was determined for the riebeckite granite of the striking monadnock of Makarapan in the centre of the colony.

Age Determinations (1964)

(1)	South Savanna Granite	Biotite	1300 ± 50 m.y.
			1190 ± 45 m.y.
		(Biotite	1685 ± 70 m.y.
) (Muscovite	1720 ± 70 m.y.
Country rock	Biotite	1930 ± 75 m.y.	
		1550 ± 60 m.y.	
	Intensely sheared granite	Biotite	1265 ± 50 m.y.
(2)	Gneisses in the north of the Colony		
	Augen Gneiss, Bartica Assemblage	Biotite	1840 ± 55 m.y.
	Hornblende biotite gneiss, Barama Hornblende		2085 ± 90 m.y.
	Altered synkinematic granitic	Muscovite	1870 ± 55 m.y.

(3) Sericite schist from Cuyuni Formation	Whole rock 1820 \pm 80 m.y
(4) Makarapan Riebeckite Granite	Riebeckite 2595 \pm 125 m.y.
Morabisi Granite	Biotite 1840 \pm 55 m.y.
Mariaka Granite	Biotite 1710 \pm 50 m.y.
Tigri Granite	Hornblende 1945 \pm 75 m.y.

VI. Palynological Research

The Department continues to retain the services of Professor Th. van der Hammen of Leiden University who is undertaking a programme of palynological studies into the younger rocks of British Guiana. In addition the Department acts as co-ordinating agency for a pollen research project sponsored by the Demerara Bauxite Company and Reynolds Metals Company in British Guiana, and N.V. Billiton Maatschappij and Suriname Aluminum Company in Surinam.

During the year Professor van der Hammen continued his work in detail on the Tertiary and Cretaceous rocks of the coast, the general stratigraphic range of which he had previously established. This study, undertaken jointly with Mr. T.A. Wijmstra is the subject of a paper published early in 1965 (Leid. geol. Meded. dl.30, 1964).

Samples from the Takutu drilling (see p. 31) are under examination by Professor van der Hammen. Other material from the Takutu Formation was kindly examined by the Palynological Laboratory of Shell Trinidad Ltd. The pollen assemblage obtained is considered as indicative of Jurassic, older than Purbeckian.

VII. Mineral Development

BAUXITE

Demerara Bauxite Company

Despite serious difficulties arising from social disturbance, 1964 shipments of bauxite and alumina products from Mackenzie by the Demerara Bauxite Company maintained fairly high levels although production was below anticipation.

Shipments of dried bauxite to metallurgical industries overseas totalled 533,000 long tons, compared with 678,000 tons in 1963. However calcined bauxite to the abrasive and refractory industries reached a new record level of 463,000 long tons, 98,500 tons greater than the previous year. Shipment of alumina also reached a new high, the 1964 figure being 292,000 long tons as compared with 222,000 tons in 1963.

Products were shipped to 30 different countries during the year, with the greater part of the dried bauxite going to Canada, the United States, the United Kingdom, Japan and other European countries. Alumina was shipped to Canada, Norway and Switzerland. The value of 1964 shipments is expected to

be approximately \$58 million. A total of 264 vessels called at Mackenzie during the year.

Some major additions to production capacity were made during 1964. A new mine was established at Kara Kara and an electrically powered 480-W walking dragline was acquired to strip overburden there. In addition, a small bucket wheel excavator was put into operation at Maria Elizabeth mine. In the bauxite plant new facilities were largely completed in 1964 to manufacture synthetic mullite, a high grade refractory material, and to recover additional quantities of bauxite from washer plant tailings. Eventual investment in these new plants will reach W.I. \$4.5 million.

Progress was made in the development of the Mackenzie community with the establishment of the Greater Mackenzie Development Trust, described as a community bank. This has been provided with \$3 million in cash and property by Demba. Company owned houses were sold to employees, and other residential and commercial property was donated to the trust. It is expected that the Local Authority for Mackenzie will be established early in 1965.

According to the Company, production and sales forecasts for 1965 are favourable. The purchase of additional heavy equipment for handling overburden is scheduled, and seismic surveys to assist in bauxite exploration is planned. Additional drilling equipment is also being purchased.

Reynolds Metals Company

Bauxite shipments from the Reynolds Metals Company during 1964 totalled 305,600 Long Dry Tons. This is slightly more than 1963 but is below the average of the last four years, which is 342,400 tons.

Under AID auspices, an experimental cut has been made in the Berbice Bar which, at present, is some three feet shallower in the channel than that of the Demerara River. The experimental cut will provide means of determining the siltation rate and hence cost of maintaining the bar when it is completely dredged.

Mr. J.H. Langenberg, Company Geologist, left British Guiana in October. His replacement, Mr. E.J. Reynose, arrived soon afterwards.

MANGANESE

Manganese Mines Management Ltd.

During the year under review 116,881 wet tons of manganese ore were produced while 136,123 wet tons were shipped from Port Kaituma to Chaguramas, Trinidad.

Two more hills, Nos. 8 and 9, to the west of all previous workings were brought into production during the latter half of 1964. A Wemco Remer Jig was installed and commissioned in No. 1 Washing Plant and preparations were well advanced for the installation of a second unit for the No. 2 Washing Plant.

No prospecting was carried out beyond the bounds of the Mining lease in 1964, all geological work being confined to the Mine area. Drilling and the driving of an adit (534 ft.) into Hill No. 5 was undertaken to outline and sample the ore bodies in depth.

Improvements in communications were continued by the resurfacing of existing roads, a number of new access roads constructed and in general maintenance of the rail road.

DIAMONDS

In 1964 a total of 109,681 metric carats (value approx. \$5,484,050 B.W.I.) of diamonds was produced. This was an increase of 9,933 metric carats (10⁰/₀) on the 1963 production and was entirely due to increased activity in the Potaro District where a large number of suction pumps have come into operation. There were no new discoveries during the year, the Potaro, Upper Mazaruni and Ekereku districts remained the main centres of mining activities. Suction pumps which pump diamondiferous gravels from the river beds to the surface continue to increase in numbers and are replacing divers, it is estimated that some 60⁰/₀ of the diamonds recovered during the year were from outfits equipped with these pumps. Many areas which were abandoned as uneconomical by the older diving outfits are now being economically exploited by suction pumps. One problem affecting suction pump equipment is mechanical failure, which often involves lengthy stagnant periods while waiting for replacement parts.

The quality of the diamonds recovered during the year was approximately 55:45 gem stones to industrials. Stones of 5 and 6 carats were exceptional; 1/2 carat stones being the main runs.

GOLD

The total of 2,110 ounces (value \$137,150 B.W.I.) declared at the Lands and Mines Department for the year was a decrease by 25⁰/₀ on the 1963 production. Although the production from the North West District was doubled, that of the main producers, the Potaro, Mazaruni and the Cuyuni Districts dropped to less than half of the 1963 figure.

At El Dorado Mine in the Kaburi District, a small quantity of gold is being recovered from gold quartz veins by hand crushing. This is carried out by the caretaker to pay his expenses. At Baramita also, old dumps of gold-bearing quartz vein material are being worked. The amount of gold recovered from gold quartz veins during the year, however, is insignificant and alluvial (including elluvial) gold remains predominant. In the Mazaruni District, some diamond mining outfits equipped with suction pumps are recovering gold as a by-product.

Negotiations and litigation continued in connection with the resuscitation of the dredging operations of British Guiana Consolidated Goldfields Ltd., the broken backbone of the colony's gold production while the dredges remain dormant.

1962

1963

1964

	Amount	Value on (Export) Amount	Amount	Value on (Export) Amount to Sept. 1963	Amount	Value Export
DIAMONDS						
PRODUCTION	100,145 carats		99,748 carats		109,682 carats	\$ 5,484,050 (Approx.) (on production amt.)
EXPORT	91,371 "	\$ 3,638,692	66,096 "	\$ 2,422,878	103,681 "	\$ 4,473,352
GOLD						
PRODUCTION	1,903 ozs.		2,848 ozs.		2,111 ozs.	
EXPORT	200 "	\$ 11,501	452 "	\$ 32,184		\$ 137,180 (on Production value)
MANGANESE						
PRODUCTION	271,103 tons		140,473 tons		116,881 tons	Value on Export Amount
EXPORT	230,162 tons	\$ 6,695,705	123,930 tons	\$ 3,646,559	128,578 tons	\$ 4,042,848
ALUMINA						
PRODUCTION	208,042 tons		222,143 tons		291,575 tons	
EXPORT	214,639 tons	\$22,715,374	131,195 tons	\$13,710,309	245,195 tons	\$26,735,134
BAUXITE						
PRODUCTION	3,035,828 tons		2,342,289 tons 380,555 "	\$11,417,157	2,478,160 tons 753,834 tons	\$20,901,833
EXPORT	366,277 tons (Calcined) 1,465,266 tons (other)	\$14,121,250 \$16,994,176 <hr/> \$31,115,425	(Calcined) 534,573 tons (other)	\$ 1,891,093 <hr/> \$13,308,250	(Calcined) 585,452 tons (other)	\$ 9,256,194 <hr/> \$30,158,027

VIII. Headquarters

LABORATORIES

a) Chemical

As in the previous year the majority of analyses carried out in the laboratory were in support of the mineral exploration programme. Over 23,000 geochemical determinations were carried out as compared with 19,500 during the previous year and 13,000 in 1962. This reflects considerable credit on the laboratory staff who were short-handed and who were diverted for a substantial period by the installation of the new spectrograph, and worked for the most part of the year with the senior supervisory post of Geochemist vacant.

A Hilger and Watts Large Quartz Spectrograph purchased under United Nations project at a cost of W.I. \$ 31,000 was received in March and finally installed in May. Training of personnel and setting up of standards continued until October, and it was not until the end of the year that the instrument could be turned to routine work. During 1965 the range and number of geochemical determinations will be greatly increased as a result of the acquisition of the spectrograph.

As noted elsewhere, the Geological Survey was very fortunate in being able, under the auspices of the United Nations Technical Aid Bureau and with the kind cooperation of the Directorate of Overseas Geological Surveys, to obtain the services of Mr. D.R. Curry of the Mineral Resources Division of the Directorate in the setting up of the spectrograph and preparation of standards and preliminary training of personnel. The personnel selected were Mr. M.A.A. Shariff, Acting Scientific Assistant, and Mr. M.D. Hope, Technical Assistant.

Work completed during the year may be tabulated in summary as follows:

(A) Petrological

1346 thin sections cut
77 polished sections prepared
21 magnetic separations

(B) Geochemical

A total of 23,126 geochemical determinations were completed as below, the figures being also compared with those of 1963:

	Sb	As	Cr	Co	Cu	Pb	Ni	Mo	Zn	W	Total
1963	76	1014	117	124	8714	4386	2021	370	2758		19,580
1964	-		471	57	8664	144	6044	439	6907	400	23,126

(C) Chemical

99 silicate and miscellaneous analyses were completed
44 Gold assays

analyses

(D) Spectrochemical

36 Determinations were completed. The spectrograph was placed on routine work late in the quarter.

b) Geophysical

At the beginning of the year the Geophysical section scarcely warranted the name, possessing no staff. Geophysical work and maintenance of geophysical and electronic instrument were undertaken by other members of the staff with aptitudes in this direction. The arrival of Mr. G.N. Rodwell, Geophysicist, and the temporary appointment of a workshop technician saw the section on much firmer footing at the year end.

The Department now possesses geophysical equipment for ground magnetometer, self-potential, resistivity, and electromagnetic surveys. Communications equipment has been greatly extended and includes, amongst others, seven single-side band transmitters. One of the latter is maintained permanently set up in the Geophysics workroom for scheduled radio contact three times per week during evening hours with drilling expeditions for discussions on progress and drilling policy. Contact with field expeditions is otherwise maintained through the Government internal radio communications station ZFX.

A suitable range of electronic testing equipment has been assembled and has proved very necessary, repair and maintenance requirements on bush-used instruments being heavy.

DRAWING OFFICE

The Drawing Office plays a particularly crucial part in the work of the Geological Survey since it is in map form that much of the laboriously obtained data from the field is finally presented to the public. Much depends upon the care and accuracy with which the maps are prepared. The Department's Drawing Office, designed on internationally proven practice, maintained a high standard of production of work during 1964 despite surrounding difficulties.

Main occupations during the year consisted in compiling and drawing maps for Geological Survey publications, expedition reports and records. In addition, maps were prepared for the immediate purposes of the United Nations-British Guiana Aerial Geophysical Survey Project. For these over 250 tracings were made.

Geochemical maps and diagrams are now being prepared in increasing number and now that the Department is engaged in diamond drilling operations drill hole logs and related diagrams are requiring drawing office attention.

A considerable amount of work evolved from United Nations activities in the country in addition to those directly related to the Aerial Geophysical Project. Maps were specially prepared for the publication of V.V. Fedynsky and S.N. Simakov on British Guiana's oil prospects, due to appear during the current year, and a series of Exclusive Permission and Mining Lease maps were drawn for the report of a team of specialists examining the bauxite industry. In order to assist the U.N. Soil Survey Project to complete their work on schedule a quantity of checking and printing work on soil maps was undertaken. Over 400 prints using approximately 3,000 square feet of paper were made for this purpose.

During the year the Department accepted responsibility for draughting work for the Mines Division of the Ministry.

Miss I. Lowe, seconded to the U.N. Soil Survey Project from May 1961, returned to the Department on 31st March 1964. Her drafting work had been much appreciated by the Soil Survey team. Later in the year she undertook a five-month tour of training in specialist techniques under AID auspices in drawing offices of the United States Geological Survey.

3,886 dyeline prints were made, using 13,450 sq. ft. of paper.

LIBRARY

The space available for the storage and easy access of books and other publications in the Geological Survey Library is now completely filled. Extension is planned for 1965.

The stock of books now amounted to 10,559 an increase of 782 over the previous year's holdings. 749 publications were issued on loan during the year.

During 1964 the library received 63 different periodicals of which 30 were obtained by subscription and 33 free or on an exchange basis. 57 of these periodicals are of scientific or technical nature and 6 of administrative, commercial, or general interest.

The library maintained a wide distribution of the Department's publications to 200 Universities, Colleges, Libraries, Geological Surveys and similar organisations, and individuals. The publications of many of these institutions were received in exchange. A total of 4,887 copies of Geological Survey publications were issued, 794 on sale and the remainder free.

In addition to the direct purposes of the Department itself, the library continued to be of service to local prospectors, prospective investors and to the general public.

During the year the library became a participating member of the British Guiana Libraries Cooperation Group - a group formed to coordinate library activities in the country in order to give maximum service to the public. The Geological Survey agreed to take part in the compilation of a Union Catalogue.

The acting Supervisor of Library and Records, Miss R. Harry, attended a three-month course of lectures sponsored by the B.G. Libraries' Cooperation Group from May to July.

Publications

Publications printed, or obtained for sale or free distribution were as follows:

- 1) A palynological study of the Quarternary of British Guiana, by Th. van der Hammen, Leid. geol. Meded. dl. 29, 1963. 356 copies

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| 2) | Report on the Geological Survey Department for the year 1961. | 500 copies |
| 3) | Report on the Geological Survey Department for the year 1962. | 600 copies |
| 4) | Bulletin No. 32: Bibliography of the geology and mining of British Guiana, by C.G. Dixon and H.K. George | 950 copies |
| 5) | Bulletin No. 34: Bauxites and laterites of British Guiana, by D. Bleackley | 1,000 copies |
| 6) | Bulletin No. 35: The Geology of the Bartica Assemblage, by R.T. Cannon | 500 copies |
| 7) | Possible microfossils found in the Roraima Formation in British Guiana, by P.B.H. Bailey, Nature, Vol. 202, 25 April 1964. | 100 copies |

Publications in progress of preparation, and expected to be issued in 1965, include Records Vols. II, III and IV, together with Bulletins No. 36, 37 and 38.