COMMONWEALTH OF AUSTRALIA

DEPARTMENT OF NATIONAL DEVELOPMENT

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

RECORDS 1968/133

GEOCHEMICAL ORIENTATION SURVEY
WAU. NEW GUINEA.

by

R.G. Horne

GEOCHEMICAL ORIENTATION SURVEY,

WAU, NEW GUINEA

by

R.G. Horne

Record 1968/133

GEOCHEMICAL ORIENTATION SURVEY : WAU, NEW GUINEA

by

R.G. Horne

Record 1968/133

CONTENTS

GEOCHEMICAL ORIENTATION SURVEY

WAU, NEW GUINEA

by

R.G. Horne

SUMMARY

The geology of the area around Wau and Edie Creek has been checked and partly re-mapped. Representative geochemical samples were collected from each rock type and its overlying soils. All operating mines and prospects in the area, and a number of abandoned ones, were sampled; check samples for fire assay were collected from the auriferous material. In addition, a number of stream sediment samples, - 80 mesh and panned concentrates, were collected.

The results show that silver and arsenic, which have an established relationship with gold, are the most useful pathfinder elements for that metal. All the metallic and semi-metallic elements determined, with the exception of vanadium, have been introduced with the gold during a single prolonged mineralizing phase. Vanadium may have an earlier origin.

No marked concentration of any element determined is associated with any specific rock type.

INTRODUCTION

The area around Wau and Edie Creek was selected as being suitable for a geochemical orientation sampling project because it was the centre of the Morobe Goldfield. This area shed most of the alluvial gold which has been dredged and sluiced from the Bulolo River and its tributaries during the past thirty five years. In addition, the results of recent alluvial mining indicate that gold is still being shed into the rivers and streams.

Profitable auriferous lode mining has been carried out over a number of years, but operations are now on a very reduced scale. Since the commencement of systematic mineral exploration about 1930, geological mapping and investigation have been carried out by a number of workers, and have included the evaluation of alluvial deposits, prospects and underground workings; the study of regional metamorphism and mineralization; and a detailed study of gold fineness and its relationship to different acid igneous intrusions. (Various reports by Dow, Fisher, Noakes and Rade.)

Prior to 1964, when this project was commenced, conventional prospecting methods were used. These included stream panning, loaming, sluicing, alluvial and lode drilling, and bulk sampling. Fire assays remain the standard method of accurately evaluating the gold and silver content of samples. It is certain that these standard methods of prospecting for gold have located the main auriferous lodes in the area. However, it is possible that the technique of geochemical sampling and analysis may locate additional small lodes which are covered by detritus. The advantages of the method are its relatively low cost of analysis, applied to numerous small samples, producing approximate values for selected elements. The results can be assessed for individual elements, or for groups of elements where known element associations occur.

A geological map with an approximate scale of 1 inch to 1,000 feet, which was compiled in 1930 by H.M. Kingsbury for New Guinea Goldfields Ltd, was selected as a suitable base map for the project. This map has been checked and the geology and topography modified with the aid of recent air photographs. The northern half of the sheet was re-mapped.

Sampling was commenced in 1964; however, owing to other priorities it was not completed until June 1966. The object of the sampling was to obtain a sufficient number of samples from each rock unit, both of the rock and of the overlying soil, to determine the principal metallic elements contained in each unit.

The accessibility of the area is good both by motor road and footpath, owing to the continued presence of a mining population. However, this population is now diversifying to agriculture, owing to the steady decrease of income being derived from alluvial mining.

PHYSIOGRAPHY

All drainage in the Wau area runs into the Bulolo River, whose elevation in this area is approximately 3,000 feet, and which flows in a northwesterly direction to join the Watut River. At Wau the Bulolo River runs through a wide valley, which in late Pliocene times was partly filled by a lake. Further downstream, commencing in the vicinity of Kulolo Creek, the river is confined to a gorge which has been cut mainly through Otibanda agglomerate.

The Little Wau, Edie, and Webiak Creeks, which flow in a northeasterly direction to join the Bulolo River, deeply dissect the area mapped, leaving a large central mass known as Mount Kaindi, the summit of which is about 8,000 feet above sea level.

Most of this country was originally forested, but the floor of the Wau valley has been cleared for cultivation which now extends up the valleys of the Little Wau and Edie Creeks.

DESCRIPTION OF ROCK UNITS

Mesozoic (? Palaeozoic)

The oldest rocks in the Morobe Gold Field are the Kaindi Metamorphics, which consist of slate, phyllite and micaceous schist, with lenses of re-crystallized limestone and beds of greywacke and pebble conglomerate.

The thickness of this complex of meta-sediments is unknown. Deposition is thought to have occurred in several stages in a marine environment, commencing in the late Palaeozoic, and extending to the Cretaceous. Fossils appear to be absent except in the final stage.

The massively bedded slates, phyllites, and schists show a slaty cleavage. The predominant rock type is a grey-blue slate composed of quartz granules and flakes of micaceous minerals, mainly biotite, with some plagioclase and varying amounts of chlorite, pyrite, sphene, magnetite, ilmenite, and rutile (Fisher, 1944).

Adjacent to the later acidic intrusives, the Kaindi Metamorphics have been subjected to contact metamorphism, which has resulted in the formation of hornfels, gneiss, and andalusite schist, and a general silicification of the rocks. Less alteration has occurred adjacent to the later smaller porphyry intrusions.

<u>Tertiary</u>

The <u>Morobe Granodiorite</u>, of batholithic dimensions, intrudes the Kaindi Metamorphics discondantly. The constituent minerals are quartz, potash feldspar, andesine, biotite, and some augite. Auriferous stringers and lenses of quartz with accessory minerals also intrude the Kaindi Metamorphics near the contacts.

The Morobe Granodiorite intrudes Cretaceous Snake River Greywacke (Dow, 1961), which is possibly an upper member of the Kaindi Metamorphics (Smit, 1966), and it is unconformably overlain by Miocene sediments (Fisher, 1944). It is therefore considered to be of Lower Tertiary age. Radiometric age determinations for this intrusive rock are expected to be available shortly.

<u>? Miocene</u>

A Miocene age is tentatively assigned to the <u>Lower Edie Porphyry</u> which intrudes the Kaindi Metamorphics and outcrops in its type locality in the northern corner of the area investigated (Fig.1). This porphyry appears to have intruded the metamorphic rocks at a considerable depth, as it is a medium grained quartz-biotite porphyry composed of large phenocrysts of quartz, biotite, andesine, and some hornblende and magnetite. This rock is petrologically similar to the earlier granodiorite and the later porphyries and volcanics.

Pliocene

Following the emplacement of the Lower Edie Porphyry, further porphyries were intruded and volcanicity occurred. The time relationship of these events are uncertain:-

(a) Unclassified Porphyries

These porphyries, which are of similar composition to the Lower Edie Porphyry, appear to have intruded the Kaindi Metamorphics closer to the surface, as they are not so well crystallized and their groundmass is finer. Concurrently with the intrusion of these porphyries, violent volcanic activity occurred, and large quantities of agglomerate were produced, which are described as part of the Otibanda Formation.

(b) Namie Breccia

This is a volcanic breccia of blue-grey colour, formed almost entirely of fragments of schist and Lower Edie Porphyry, with little volcanic material. The different occurrences of the breccia were probably ejected from separate diatremes. Local sorting, and rounding of fragments indicate partial deposition in water. At Golden Ridges, where a maximum thickness of 500 feet has been measured, the breccia has been intruded by auriferous mangano-calcite veins, and gold is also finely disseminated through the oxidised breccia at Golden Peaks.

Near the old Enterprise Mine in Slate Creek, the breccia overlies agglomerate of the Otibanda Formation without any apparent line of demarcation.

It is possible that the rhyolite and rhyolitic breccia (see Pleistocene) occurred as a late phase of this volcanism.

(c) Upper Edie Porphyry

The type locality of this intrusive porphyry extends across the upper Edie Creek. The fresh rock is a light grey dacite with abundant white feldspar and occasional large phenocrysts of quartz and biotite. These occur in a fine groundmass of quartz, feldspar, and biotite. This rock is not well crystallized and is often altered. At Golden Ridges Mine a porphyry of similar age was found to be intrusive into Namie Breccia.

(d) Otibanda Formation

This is a sedimentary formation which consists of a pyroclastic member overlain by a lacustrine member. Crustal movements, which occurred during the volcanic activity which produced the agglomerates, dammed the Bulolo River resulting in the formation of a fresh water lake. The age of the lacustrine member as determined from fossils and interbedded pyroclastic material is Late Pliocene (Plane, 1965).

The pyroclastic member consists of large quantities of agglomerate composed of fragments of schist, granodiorite, and Lower Edie Porphyry in dacitic volcanic material similar to that of the unclassified porphyries. Obsidian and rhyolite are locally developed.

The lacustrine beds which are formed of clay, mudstone, unconsolidated sandstone and conglomerate, dip locally to the south and east.

Pleistocene-Recent

In the later stages, or following the drainage of the lakes, rhyolite and rhyolitic breccia were extruded to the west of Wau. This was followed by rapid erosion of the lake beds, and material washed down from the slopes of Mount Kaindi formed piedmont deposits which partly covered the lake sediments and the volcanics between Kunai and Namie Creeks.

GEOLOGICAL HISTORY

In the late Palaeozoic and Mesozoic Eras, the oldest rock unit, known as the Kaindi Metamorphics, was laid down as marine sediments. Most of it appears to have been laid in moderately deep water. Lenses of crystalline limestone, beds of greywacke, and pebble conglomerate occur within the formation. Fossils appear to be absent, except in the Cretaceous stage.

During the late Cretaceous or early Tertiary, these sediments underwent regional dynamic metamorphism, which resulted in the formation of slaty cleavage (Smit, 1966). At this time, these sediments were also locally intruded by granodiorite which resulted in local silicification and the formation of hornfels, gneiss, and quartzite. A later associated acid intrusive, the Lower Edie Porphyry, possibly intruded the Kaindi Metamorphics during the Miocene Period, and was followed by further porphyritic intrusions, terminating with the Upper Edie Porphyry in the Pliocene Period.

It is not known when this area became terrestrial; the tectonic movement which caused the uplift may have been partly associated with the period of dynamic metamorphism mentioned above. However, during the Pliocene Period, and concurrent with the last intrusion of porphyry, large quantities of volcanic agglomerate and breccia were produced, which were deposited under terrestrial and lacustrine conditions, in a physiographic environment similar to that now in existence. Earth movements caused by the volcanic activity probably dammed the river. Lacustrine sediments which accumulated above the agglomerate have been dated from plant and animal fossils as late Pliocene (Plane, 1965).

The lake which covered the floor of the Wau valley was drained during the Pleistocene Period owing to differential movement of the terrain and erosion of the agglomerate.

Rhyolite was extruded between Wau and Golden Ridges. This was followed by erosion of the lake beds and the deposition of coarse piedmont material from the slopes of Mount Kaindi over these beds and the adjacent volcanics.

LODE CLASSIFICATION AND MINERALOGY

Fisher (1939a) has subdivided the auriferous lodes of this area into four groups as follows:-

(a) The Edie Creek Stringers

These occur largely within the area of chloritoid schist at the head of Edie Creek, the erosion and concentration of which has produced the bulk of the alluvial gold recovered.

(b) The Edie Lodes

A group of previously mined ore bodies normally 3 to 4 feet wide (but in places up to 15 feet wide), also located within the area of chloritoid schist. They are aligned along a northwest-trending line of fissuring, and probably associated with the Upper Edie Porphyry.

(c) The Day Dawn Lode

Similar to the Edie Lodes, but located partly along the Kaindi Metamorphics-Upper Edie Porphyry contact, and partly in a fissure zone within relatively unaltered Kaindi phyllite.

(d) The Golden Ridges Lodes

Large, comparatively flat lying disseminated ore bodies located within Namie Breccia.

For the purposes of this geochemical survey, these auriferous lodes have been reduced to two types, namely those confined to fractures, and those disseminated within the Namie Breccia.

FRACTURE ZONE LODES The natural host rocks of those lodes confined to fractures, namely (a), (b) and (c) above, are the Kaindi Metamorphics or their derivatives which have been extensively fractured and disturbed by numerous intrusives. As a result, these lodes are likely to be restricted in size.

The Edie Creek Stringers are "a series of small, rich, quartz-gold stringers ... seldom more than an inch thick or a few yards in length" (Fisher, 1939a), which contain a high percentage of low fineness gold. These stringers cover a wide area and are related to the Edie Lodes. Similar auriferous stringers occur in the contact zones surrounding the other Tertiary igneous intrusive bodies, namely the granodiorite and the earler porphyries. Areas of this type, known to have shed considerable quantities of gold, occur around Zenker's and Garden Creeks, and also in the upper reaches of Sandy Creek to the north of the Bulolo River (Fisher, 1935 b & c).

The Edie Lodes include the Edie Nos 1, 2, 3, 4, and 5 Lodes, Kareeba Lode, Slate King, Surman's Vein and Enterprise at the northwestern end of the fissure zone; and Day Dawn South to the southeast. The Edie No.1 lode lies within the Upper Edie Porphyry, while the rest are located within the zone of chloritoid schist, which is an alteration product of the phyllite (Fisher, 1939a). The Day Dawn Lode, which occurs separately, has been included in this group.

The auriferous lode material filling these large fissures consists mainly of quartz and calcite in soft manganese oxide; the quartz often occurs as stringers. Other minerals which have been determined are hematite, limonite, rhodochrosite, manganite, psilomelane, pyrolusite, sphalerite, galena, tetrahedrite, chalcopyrite and very minor cinnabar (Noakes, 1941; Fisher, various reports).

Elements which may be expected to occur in significant quantities on the surface associated with the bodies are, therefore, silver, manganese, zinc, lead, copper and antimony.

Free gold with a fineness of 490 to 540 parts per thousand also occurs in these Upper Edie lodes; this is thought to be related to the Upper Edie Porphyry. The silver-gold ratio is very high near the surface; the additional silver is thought to occur mostly in refractory silver manganite (Fisher, 1939a).

Other known fissure lodes of this type occur at the head of Maori Creek and in the Upper Kunai Creek valley and also in Anderson's Creek to the northwest of Wau.

At the Golden Parallelogram (Ribroaster,) there appears to be less manganese dioxide in the fissures than elsewhere.

<u>DISSEMINATED LODES</u> The auriferous lodes which occur in the volcanic Namie Breccia are of the disseminated replacement type. The mineralizing solutions appear to have been associated with a later porphyry related to the Upper Edie Porphyry. This porphyry intrudes the breccia in the Golden Ridges and Golden Peaks area and has been injected through fractures in the underlying metamorphic rocks.

At Golden Ridges the lodes occur as tabular discontinuous bodies within the unoxidised Namie Breccia, whereas at Golden Peaks most of the oxidised breccia is auriferous. No auriferous lodes have been worked in the Slate Creek and upper Webiak Creek Breccia bodies.

The principal minerals in this type of lode are, in addition to gold and silver:- calcite, quartz, rhodochrosite, pyrite, manganite, pyrolusite, psilomelane, sphalerite, chalcopyrite, galena, and tetrahedrite. The proportion of sulphide minerals generally increases downwards. The significant elements are therefore silver, manganese, zinc, and lead with, possibly, copper and antimony.

From this summary it is apparent that the potentially significant metallic elements are identical in the two groups of lodes. Of these elements only silver, manganese and lead have a low mobility under the prevailing conditions (Hawkes and Webb, 1962).

COLLECTION OF SAMPLES AND ANALYSIS

The principal object was to obtain a representative suite of samples of each known rock type, including weathered rock material and the overlying detritus. All the accessible worked and abandoned auriferous ore bodies and prospects were sampled. In localities where the material sampled was considered to be of economic grade, check samples were collected for gold and silver determination by fire assays, to be reported in dwt/long ton, dry weight. These results are recorded with the corresponding geochemical analytical results in Appendix I.

Details of multiple samples collected are recorded in Appendix II.

A number of stream sediment samples were collected; these included both - 80 mesh and panned concentrates. These were taken where possible in streams which drained large areas, or streams which appeared to contain boulders of a particular intrusive rock type.

The first 70 geochemical samples collected were sent to the Bureau of Mineral Resources Laboratory in Canberra, where they were

12

analysed by spectrochemical methods. The rest of the geochemical samples were sent to the Australian Mineral Development Laboratory in Adelaide where they were analysed by atomic absorption methods. This has resulted in slight differences in the reported background concentrations.

Fire assays for gold and silver on material corresponding to the first 70 samples were carried out by Mr J.C. Wise of the Division of Mines in Port Moresby, and the rest by Mr A.J. Winterford, of New Guinea Goldfields Ltd, Wau.

DISCUSSION OF RESULTS

General

In the following discussion, the elements for which geochemical analyses have been carried out are considered in their order of significance as pathfinders for gold, which is the only metal that has been mined economically in this area.

The gold concentrations in the first 70 samples were determined by spectrochemical methods at the B.M.R. Laboratory. However, this method does not appear to be sufficiently sensitive to determine gold concentrations, as is shown by a comparison of the geochemical and fire assay results recorded from the first 21 samples (see Appendix I). Gold will therefore not be considered below.

Molybdenum has also been omitted from the list of elements considered, since only 70 determinations were made, most of which gave a negative result.

Results for cadmium, chromium and vanadium are also incomplete, since analyses for these elements were not carried out by both laboratories.

Histograms on which concentrations are plotted against frequency for the elements silver, arsenic, manganese, nickel, copper, cobalt and lead (Fig. 6), show that frequencies are a maximum at background values, and diminish sharply with increase in concentration. Histograms for the elements zinc, chromium and cadmium show similar, but less marked, trends. All these diagrams indicate that the values for each element form a single population. In addition the general coincidence of the anomalous values of these elements as shown in Appendix I, indicates that they were introduced by the same, or related, phases of mineralization as those which carried the gold. These phases of mineralization are known to have originated from a single magmatic source, but extended over a considerable period of time (Fisher, 1945).

The histogram for vanadium shows a wide concentration range with no single pronounced frequency maximum, indicating a more uniform dissemination of this element. Also, anomalous vanadium values are not usually associated with anomalous values of the other elements. From this it is concluded that vanadium was not a significant constituent of the mineralizing fluid.

Significantly anomalous geochemical values for each element were determined by the method recommended by Hawkes and Webb, namely "to take the median value as background and to estimate threshold as that value which is exceeded by no more than 2½% of the total number of observations, excluding markedly high erratic values".

(a) Silver (Fig.2)

This element has an established relationship with gold in the form of the alloy electrum. The relationship is clearly illustrated in a comparison of the geochemical silver values and the gold fire assays in the first twenty-seven sample results. A.D. Haldane, of the Bureau of Mineral Resources, has advised that silver is readily amenable to analytical determination, and is therefore one of the most suitable pathfinder elements for gold.

The background values for silver agree in general with the averages given in Hawkes and Webb. Background values recorded during this survey show little variation over the whole of the area except in and adjacent to the southern extension of the Lower Edie Porphyry body, where values are very slightly higher.

Anomalously high silver values occur in localities where high gold values are known to occur, as follows:-

(i) Old Enterprise Mine (fissure filling).

(ii) Upper Edie Creek (fissure filling).

(iii) Recent Entérprise workings, Merri Creek (fissure filling).

(iv) Ribroaster Mine (Golden Parallelogram) (fissure filling and contact).

(v) Golden Peaks (disseminated).

14

Silver values recorded serially outwards from the large fissure exposed in the upper part of Edie Creek show an immediate decrease to background value outside the limit of the fissure.

Localities where anomalous silver values were expected, but do not occur are:-

(i) In additional samples from the Golden Peaks breccia

(ii) In the Golden Ridges breccia

(iii) At Day Dawn Mine.

However, the results show that, in all except one sample from the Golden Ridges body, the corresponding gold assays are not significantly high. It is possible that the un-alloyed silver content of this ore is low.

No anomalous high values occur either in the -80 mesh sediment samples collected, or in the panned sediment samples, indicating that any silver which is not alloyed with gold occurs in an unstable form. Above background concentrations occur in stream sediment samples from Merri Creek and Little Wau Creek. The Merri Creek values are probably attributable to mill tailings which at that time were being carried by this creek.

At the current silver price of 117 cents per troy ounce, concentrations in excess of 450 ppm (15 ozs/ton <u>in situ</u>), could be considered as being of potential economic interest.

(b) <u>Arsenic</u> (Fig.2)

This element also has an established relationship with gold, and is a recognized pathfinder element for that metal. Again this close relationship is evident in the Wau area from a comparison of the results obtained from the first twenty-seven samples.

There is a considerable difference in the background values for this element recorded by the two systems of analysis used. Hawkes and Webb give the following averages.
Felsic igneous rocks:- 1.5 ppm, shale:- 4 ppm, and average soil 5 ppm. These are comparable with the values recorded in this survey.

With the exception of the anomalously high values related to known mineralized localities, slightly higher background values are apparent in samples collected from areas of Namie Breccia in the Ridges area, and also locally within the Lower Edie Porphyry, particularly in the southern extension area as noted for silver.

Anomalously high arsenic values occur in the following localities where high gold values are known to occur:-

(i) Old Enterprise Mine (fissure filling)
(ii) Upper Edie Creek (fissure filling)
(iii) Day Dawn Mine (fissure filling and contact)
(iv) Ribroaster Mine (fissure filling and contact)
(v) Rikeni's Prospect (fissure filling)

In the Upper Edie Creek fissure, arsenic values do not decrease regularly but maintain a comparatively even concentration to a distance of three feet from the margin of the fissure, then decrease to background at a distance of 5 feet.

Localities where anomalous arsenic values were expected but do not occur are:-

(i) In the Namie Breccia at Golden Ridges and Golden Peaks (disseminated)
(ii) Recent Enterprise Workings (fissure fillings)

In the Namie Breccia higher background values occur as mentioned above. However in the Recent Enterprise Workings a gold assay of 6.0 dwt/ton was obtained where no arsenic was detected. It is considered possible that additional samples might show higher concentrations of arsenic.

A high value was obtained from a panned concentrate from Little Wau Creek, and other moderately high values occur in sediment samples from Webiak, Namie, and Kunai Creeks. Of these, Little Wau Creek carries the highest concentration of associated gold. Arsenic probably occurs in the limonitic fraction of the sediments carried by these watercourses.

(c) Manganese (Fig.2)

Black manganese dioxide is the principal readily visible indicator for gold in the Wau and Edie Creek area, and has been one of the main prospecting guides for lode gold. Manganese dioxide from pyrolusite and manganite forms a major constituent of nearly all the near surface auriferous fissure filling material. It also occurs in the oxidised Namie Breccia, where its concentration provides a useful visual guide to the probable gold content of the Breccia in localities where it is mined in open-cut workings.

The average manganese content of the rocks, soils and ores of the area (7,152 ppm) is very much higher than the averages of the other elements determined, and also very much higher than the equivalent averages given by Hawkes and Webb (felsic igneous rocks 600 ppm, shale 385 ppm). The correlation between gold assays and the manganese values is not particularly marked; however, the correlation with silver values is more significant, and anomalously high manganese values correspond broadly with the higher silver values.

The manganese content of the Golden Ridges and Golden Peaks Breccia is higher than the general average for the area. These two breccia bodies are partly auriferous, whereas the body adjacent to Wau has a very low known gold content. However, the Ribroaster Mine results are consistently and abnormally low in manganese compared to other auriferous lodes in this area.

The manganese content of the stream sediment samples is generally low, indicating that hydrous manganese oxides do not form a large fraction of the stream sediments.

The manganese values appear to show that manganese is a moderately reliable pathfinder element for gold; however the black manganese oxide is potentially more significant as a visual auriferous indicator.

(d) Nickel (Fig.3)

The concentrations of this element in the area are low, as would be expected in this geological setting. However, there is an apparent relationship between this metal and gold. It is probable that nickel occurs mainly in the iron sulphides which are included in the auriferous fissure clays.

Background concentrations appear to be lowest in the felsic igneous rocks, and slightly higher adjacent to contacts and in the Kaindi Metamorphics. This corresponds well with averages given by Hawkes and Webb.

Anomalous nickel values occur at the following localities:-

(i) Old Enterprise (fissure filling)
(ii) Upper Edie Creek (fissure filling)
(iii) Golden Peaks (disseminated)

Higher concentrations also occur at:-

(i) Recent Enterprise workings, Merri Creek (fissure filling)
(ii) Day Dawn Mine (fissure filling and contact)
(iii) Rikani's Prospect (fissure filling)

On the Upper Edie Creek fissure, the concentration decreases outwards from the margin. However, inclusions of country rock in the fissure clay have low concentrations.

Higher nickel concentrations would be expected in other samples collected from the Namie Breccia and most of these are in fact slightly above the average background. Higher concentrations occur in the Little Wau Creek Valley and in the Otibanda Sediments.

Concentrations in stream sediment samples are noted in Webiak, Kunai and Wau Creeks. In these sediments, the nickel possibly occurs in hydrated nickel silicates.

(e) <u>Copper</u> (Fig.3)

There is a slight relationship between this metal and gold; in fact all the elements discussed to this point bear a definite concentration relationship to each other, as minerals containing these elements are known to occur in the lodes.

Copper values are generally higher in samples collected from the metamorphic rocks than from the felsic igneous rocks. This corresponds with averages given in Hawkes and Webb.

18

Anomalous copper values occur at:-

(i) Upper Edie Creek (fissure filling)
(ii) Recent Enterprise Workings (fissure filling)
(iii) Rikani's Prospect (fissure filling).
(iv) The Namie Breccia in the Ridges Area (disseminated)

Concentrations which are higher than the average background occur at:-

(i) Old Enterprise Mine (fissure filling)
(ii) Ribroaster (fissure filling and contact)
(iii) Saire's Prospect (fissure filling)
(iv) In the Otibanda Sediments exposed in Koranga Creek

Panned concentrate samples show moderately high concentrations except in three of the creeks which enter the Bulolo River from the northeast. The copper probably occurs in manganese dioxide and limonite particles. Under existing conditions where the pH is low, primary ore minerals containing copper would readily decompose and dissolve as copper salts.

(f) Cobalt (Fig.3)

This element also bears a close relationship to the elements discussed above, although anomalous values are of a lower order.

Background values again are comparable with averages given in Hawkes and Webb. There appears to be a slightly higher average background concentration in the metamorphic rocks than in the felsic intrusive rocks, which also is in agreement with the general findings in other areas.

Anomalous cobalt values occur at the following localities:-

(i) Old Enterprise Mine (fissure filling)
(ii) Upper Edie Creek (fissure filling)
(iii) Day Dawn Mine (fissure filling and contact)
(iv) Golden Peaks (disseminated)
(v) Bikani's Prospect - (fissure filling)

Cobalt values do not decrease regularly away from the fissure in Edie Creek, and the inclusions of Upper Edie Porphyry in the fault clay have a very low cobalt content.

Localities where anomalous values would be expected, but do not occur, are:-

(i) Recent Enterprise workings (fissure filling)
(ii) Ribroaster (fissure filling)
(iii) Golden Ridges (disseminated)

The anomalous cobalt values appear to predominate in the high elevation workings in the southern part of the sheet area, while the mining areas to the north at a lower elevation, i.e. on the northern slopes of Mount Kaindi, generally have only background values. These differences may be attributable to variations in temperature and pressure conditions during emplacement (Fisher, 1945).

A number of panned stream concentrate results show high values. As with copper, the cobalt probably occurs in manganese dioxide and limonite particles.

(g) Lead (Fig.4)

Galena has been noted in most of the auriferous ore bodies in this area, including the Edie Creek Lodes which occur along the main line of fissuring in the Upper Edie Creek area. The recorded values for lead, however, show no anomalous concentrations in lodes which have been sampled along this fissure zone or at Day Dawn Mine. This indicates that lead could not be regarded as a reliable geochemical pathfinder element for gold in these areas.

The only tentative explanation for the apparent lack of anomalous lead concentrations in these areas is that galena is a relatively unstable mineral. However, this is not a complete explanation, as no lead was detected in the three samples from the Old Enterprise Mine, which were collected from the underground workings.

In the Ridges area, additional anomalous values would normally be expected in the areas of Namie Breccia where mineralization occurs disseminated through the rock.

Lead anomalies show only a partial correspondence with those of silver, and background lead values over the various rock types appear to be lower than the averages given in Hawkes and Webb.

Stream sediment samples generally give low results, except for the panned concentrate samples from Little Wau and Kunai Creeks, indicating that any lead which is not in solution occurs in the heavy sediment fraction.

(h) Zinc (Fig.4)

Sphalerite occurs in all the known lodes in this area; and the zinc content of the rocks and soils appears to be higher than that for most of the other metallic elements. This is illustrated by the wide range of concentrations shown on the histogram.

A comparison of the concentrations over various rock types with the corresponding averages given by Hawkes and Webb, indicate that the zinc content of the rocks around Wau is lower than these averages.

Anomalous zinc concentrations occur in the auriferous lode fissure sampled in Upper Edie Creek, in the Recent Enterprise workings, and in the Namie Breccia orebodies at Ridges. However, they do not occur at Rikani's Prospect or at the Ribroaster Prospect. There is a general correspondence between the zinc and lead anomalies, but it is not as close as might be expected.

The results from a number of the panned concentrates and the -80 mesh stream sediment samples indicate that a considerable quantity of zinc is carried in the stream sediments, but concentrations in the streams entering the Bulolo River from the right bank, draining an area of granodiorite, are generally low. In this area secondary concentration has occurred.

(i) Chromium (Fig.5)

The number and distribution of samples analysed for chromium do not cover the whole area. The results show a definite relationship between chromium and gold, i.e. most of the samples which were collected from known auriferous lodes also show anomalous chromium concentrations.

Background chromium concentrations over felsic igneous rocks are generally higher than the averages given by Hawkes and Webb, whereas background concentrations over the metamorphic rocks are low. Generally there is a wide range of concentrations similar to those for zinc.

The values in the panned concentrates are noticeably high, even in streams draining from the northeast, confirming the stability of chromite under local conditions of marked chemical decomposition.

(j) Cadmium (Fig.5)

The number and distribution of samples analysed for cadmium is similar to those analysed for chromium.

Hawkes and Webb state that cadmium has a universal association with zinc, and a comparison of the analytical results for these elements shows a broad correspondence of anomalous results, (see Appendix I). Only background concentrations were recorded at Rikani's Prospect and the Ribroaster.

A comparison of the corresponding histograms shows that the largest number of cadmium values occur at a concentration of about 4 ppm, followed by a sudden decrease in frequency; whereas the lowest zinc concentrations form the greatest proportion, with a comparatively even decrease at higher concentrations. These differences seem to be partly attributable to the limitations of the analytical method for determining the concentrations of cadmium. This element has a comparatively low concentration level, yet no concentration lower than 2 ppm is recorded.

Background concentrations in the Wau area are considerably higher than the averages given in Hawkes and Webb (felspathic igneous rocks:- 0.1 ppm; shale:- 0.5 ppm).

(k) Mercury (Fig.5)

A significant, but restricted relationship is detectable between the mercury concentrations and those of silver, arsenic, manganese, zinc and lead. This is also an established relationship in other areas.

A determination of the median background level, using the method recommended by Hawkes and Webb, gives a concentration of 1.5 ppm Hg; the average background value was determined as 0.44 ppm. These figures do not include the values from stream sediment samples.

A comparison of these values with the averages given by Hawkes and Webb for different rock types, shows the general level in

22

this area to be high. The averages given by those authors are:- igneous rocks: 0.06 ppm; mafic rocks: 0.09 ppm; felsic rocks 0.04 ppm; and shale: 0.4 ppm. A slightly higher than normal background level for mercury is to be expected in this area, as cinnabar has been noted as a minor mineral constituent of the lode fissure material.

No one rock type in the area shows mercury concentrations significantly above the average for the whole area. However, higher concentrations occur at some contacts, namely in the upper and middle Edie Creek, at Daw Dawn, and at the Ribroaster (Golden Parallelogram).

No marked concentrations occur in the highly auriferous lode fissure sampled in the Upper Edie Creek area. The concentrations recorded in the samples from the Enterprise fissure zone are slightly above average, and those from the Ribroaster fissure zone and contact area are significantly higher. A red mercuric stain has been seen in rock fissures here. In the areas of disseminated mineralization at Golden Ridges and Golden Peaks the concentration level is average, with the exception of one erratically high value.

The stream sediment samples do not show any areas of consistently above average concentrations. However, slightly higher than background levels are recorded in the two samples collected from the lower Webiak Creek. Mercury is recorded as having a low mobility in aqueous solution.

(l) Vanadium (Fig.4)

The first seventy samples which were sent to the B.M.R. Laboratory in Canberra were analysed for vanadium, but this element was not included in the determinations which were carried out by Australian Mineral Development Laboratories.

Vanadium is the only element of those for which analyses are available whose anomalous values show no relationship to those of the other elements. From this it can be concluded that vanadium was not a significant element in the mineralizing solutions which were associated with the Tertiary acid intrusions in this area. Vanadium was probably disseminated through the metamorphic rocks prior to the intrusive phase.

The histogram for this element shows a wide range of concentrations with no pronounced maximum, indicating a general dissemination of this element rather than a localization such as is characteristic of epigenetic mineralization.

The background vanadium concentrations recorded in samples from the intrusive rocks are comparable with averages for equivalent rock types given by Hawkes and Webb. However, the background concentrations from the metamorphic rocks are low. Vanadium, which occurs mainly in mafic minerals, is not regarded as a useful pathfinder element for other metals. The main anomalous vanadium concentrations occur in the headwaters of the Mystery, Merri and Cockley's Creeks.

CONCLUSIONS

The most useful pathfinder elements for gold in this area are clearly silver and arsenic. These elements both have a known established relationship with gold. Other elements which are related by origin to this association are manganese, nickel, copper, cobalt, lead, zinc, mercury, chromium and cadmium. These elements, with the exception of cadmium, all show a pronounced maximum frequency of concentration in the low background range. The samples containing anomalous concentrations of these elements also show a general correspondence, indicating that they were introduced during the same, or related, phases of mineralization; namely those which introduced the gold. The gold is known to have been introduced over a period of time, but was derived from a single magmatic source (Fisher, 1945).

The origin of the vanadium appears to have been earlier than that of the other elements. The frequency distribution of concentrations shows a wide range, with no pronounced maximum, and anomalous concentrations do not coincide with those of other elements. Vanadium was probably introduced into the metamorphic rocks during their initial period of sedimentation, whereas in the igneous rocks it was not concentrated in the residual metalliferous fraction of the magma.

There are no outstanding associations of any of the elements determined with any particular rock types in this area, and background concentrations are generally comparable with the averages given by

Hawkes and Webb for the same rock types. However, slightly higher background concentrations of nickel, copper, cobalt, and zinc occur in the metamorphic rocks of the Little Wau Valley. Also, the three main outcrops of Namie Breccia to the west of Wau give higher than average background values of arsenic, nickel and zinc.

No anomalies are recorded in Lyall's, Slate or Upper Webiak Creeks, and this particular area as a whole has only produced very limited quantities of gold.

Concentrations of the elements determined from the panned sediment sample collected in Little Wau Creek are consistently high, indicating that this water course drains an area which is shedding a high proportion of metalliferous material. The sediment carried by Edie Creek may be of similar composition.

The four streams sampled which enter the Bulolo River from the northeast, draining an area of Kaindi Metamorphics, Granodiorite and Otibanda Sediments, generally have a low content of the elements determined. Only in Beenleigh Creek has there been a high cobalt value recorded, with moderate values of nickel and copper. These creeks, with the exception of Beenleigh Creek, have all produced high fineness alluvial gold, particularly Sandy Creek. The general lack of associated elements may be partly due to the fact that the gold in this area occurs as secondary deposits, derived from beds of conglomerate.

RECOMMENDATIONS

The object of additional geochemical sampling in this area as a follow-up to this orientation programme would be the location of auriferous lodes which have not previously been found by the traditional gold prospecting methods.

Geochemistry as a tool in mineral exploration is particularly suited to assisting in the location of lodes which are covered by eluvial material. In the area covered by Figure 1, the most promising localities of this nature are:-

(i) The Upper Edie Creek area, particularly that area within the boundary of the chloritoid schist.

(ii) The areas of Kaindi Metamorphics surrounding the intrusive porphyry bodies and the granodiorite.

Both of these localities are known to be currently shedding gold. Experience has shown, however, that the chances are not favourable of locating a payable auriferous lode or a stockwork, as most of the gold shed in these areas appears to be derived from scattered small quartz stringers. However, the lodes and stockworks which have been located generally have a high gold content.

Allowance should be made for slips and previous ground movement in this area, when assessing the results of geochemical soil sampling. In some localities linear sampling along the base of steep slopes adjacent to the stream courses would be preferable to normal grid sampling; this method is particularly effective for testing talus slopes.

Other localities which warrant sampling are:-

(i) The Namie Breccia body adjacent to Wau

(ii) Kapoul Creek and the Upper Watut River drainage basin adjacent to Edie Creek

(iii) The Kaindi Metamorphic rocks adjacent to the Morobe Granodiorite in the Sandy Creek area, to the north of the area covered by the present investigation.

REFERENCES

DOW, D.B., 1958 - Geological Report on Merri Creek Mine. Edie Creek, New Guinea. Bur. Miner. Resour. Aust. Rec. 1959/33 Terr. of N. Guin. Rep. (unpubl.)

DOW, D.B., 1961 - The Relationship between the Kaindi Metamorphics and Cretaceous rocks at Snake River, New Guinea. Bur. Miner. Resour. Aust. Rec. 1961/160 (unpubl.)

FISHER, N.H., - Geological Report on the property of Day Dawn (New Guinea) Ltd. Terr. of N. Guin. Rep. (unpubl.)

FISHER, N.H., - Geological Report on the Golden Parallelogram. Terr. of N. Guin. Rep. (unpubl.)

FISHER, N.H., 1935a - Geological Report on Day Dawn South. Terr. of N. Guin. Rep. (unpubl.)

FISHER, N.H., 1935b - Geological Report on Lower Edie Creek, New Guinea. Terr. of N. Guin. Rep. (unpubl.)

FISHER, N.H., 1935c - Geological Notes on the Sandy Creek Area. Terr. of N. Guin. Rep. (unpubl.)

FISHER, N.H., 1935d - Geological Report, Edie Creek Gold Mining Co. Terr. of N. Guin. Rep. (unpubl.)

FISHER, N.H., 1938a - Geological Report on Anderson's Creek Lode. Terr. of N. Guin. Rep. (unpubl.)

FISHER, N.H., 1938b - Geological Report on the Property of Mount Kaindi Prospecting and Treatment Syndicate. Terr. of N. Guin. Rep. (unpubl.)

FISHER, N.H., 1938c - Geological Report on Upper Ridges Ore-body. Terr. of N. Guin. Rep. (unpubl.)

FISHER, N.H., 1939a - Metasomatism Associated with Tertiary Mineralization in New Guinea. Econ. Geol. Vol. 34, No.8, pp. 890-904

FISHER, N.H., 1939b - Ore Geology of the Day Dawn Mine. Econ. Geol. Vol. 34-2, pp. 173-189

FISHER, N.H., 1940 - Geological Report on the Enterprise Mine, Edie Creek, New Guinea. Terr. of N. Guin. Rep. (unpubl.)

FISHER, N.H., 1944 - Outline of the Geology of the Morobe Goldfield. Proc. Roy. Soc. Qld. 55(4) pp. 51-58

FISHER, N.H., 1945 - The Fineness of Gold, with special reference to the Morobe Goldfield, New Guinea. Econ. Geol. Vol. XL, No.7

27

HAWKES, H.E. & WEBB, J.S., 1962 - "Geochemistry in Mineral Exploration".
Harper & Row, N.Y.

NOAKES, L.C., 1941 - Report on Edie Creek Mine, New Guinea Goldfields Ltd.
Terr. of N. Guin. Rep. (unpubl.)

PLANE, M.D., 1965 - Stratigraphy and Vertebrate Palaeontology of the Otibanda Formation, Morobe District, N.G.
Bur. Miner. Resour. Aust. Bull. No.86

RADE, J., 1951 - Reports on geological reconnaissance work in the Mount Kaindi and Otibanda Creek Areas 1950-1951.
Unpubl. Rep. New Guinea Goldfields Ltd.

SIEDNER, G., 1959 - Geological Report on Upper Ridges Mine, Wau, New Guinea.
Bur. Miner. Resour. Aust. Rec. 1959/5 (unpubl.)

SMIT, J.A.J., 1966 - A review of the Relationship between the Cretaceous Rocks and the Kaindi Metamorphics at Snake River, N.G.
Terr. of N. Guin. Invest. Note No.64304

24

APPENDIX ~~II~~ I, LIST OF GEOCHEMICAL RESULTS.

p.27,

ATOMIC ABSORPTION ANALYSIS OF SAMPLES FROM WAU AREA (A.M.D. L.

PARTS PER MILLION.

Sample NO.	FIRE ASSAYS dwt/ton Au	FIRE ASSAYS dwt/ton Ag	Ag	As	Mn	Ni	Cu	Co	Pb	Zn	Cr	Cd	Hg	Sample Type
642200176			.5	30	1600	6-	14	9	10-	66	22	4	0.15-	
177			1	90	1450	20	28	24	35	210	60	6	3.00	SED
178			4	500	3300	47	56	78	55	480	243	10	2.00	Panned
179			.5-	10-	265	6-	8	6-	11	39	72	2	0.15-	
180			.5-	10-	20	6-	20	6-	10-	13	40	2	0.30	
181			1	100	960	17	37	6	39	71	47	4	0.15-	
182			.5	30	2100	8	14	9	15	90	22	3	0.15	
183			.5	250	2150	6-	26	18	27	48	40	4	0.30	
184			.5-	10-	775	11	52	21	11	68	47	4	0.30	
185			.5-	250	50	8	20	12	11	24	35	4	0.30	
186			.5	10-	550	14	9	21	11	75	273	5	0.20	Panned
187			.5-	10	240	14	9	6	10-	31	115	4	0.15-	SED
188			.5-	10	450	6-	9	6-	10-	28	87	2	0.30	Panned
189			.5-	10	340	8	13	6-	10-	31	72	4	0.40	SED
190			.5-	10-	385	8	14	6	10-	25	100	4	0.30	Panned
191			.5-	10-	300	14	22	6	10-	46	47	4	0.15-	SED
192			1	20	485	29	78	55	11	58	128	4	1.50	Panned
193			.5-	10-	400	26	49	15	11	75	140	5	4.00	SED
194			2	401	555	44	72	45	27	74	186	5	1.00	Panned
195			1	20	385	14	28	6	11	58	72	3	0.50	SED
196			86	700	1200	47	118	55	177	200	170	6	3.00	Panned
197			6	100	2000	23	63	18	19	85	22	4	0.40	SED
198			.5-	10-	245	26	35	18	10-	85	29	3	0.20	

NOTES:- a = sought but not detected. - = less than + = greater than.

SED:- Stream sample (-80 mesh)

Panned:- Stream sample, panned heavy mineral concentrate, not sieved.

A.A.:- Atomic absorption.

29

	FIRE ASSAYS dwt/ton dwt/ton		ATOMIC ABSORPTION ANALYSIS OF SAMPLES FROM WAU AREA (A.M.D. L.) PARTS PER MILLION.											
Sample NO.	Au	Ag	Ag	As	Mn	Ni	Cu	Co	Pb	Zn	Cr	Cd	Hg	Sample Type
642200141			.5-	10-	155	6-	9	6-	10-	60	28	4	0.50	
142			.5-	10-	290	6-	8	6-	10-	392	52	4	0.50	
143			.5-	10-	330	38	40	9	11	87	32	4	0.15	
144			.5	10-	235	6-	14	6-	19	99	22	4	0.30	
145			1	100	1000	54	88	21	111	19	60	5	1.50	
146			.5-	20	125	6-	8	6-	14	15	35	4	25.00	
147			.5-	10-	53	6-	5	6-	75	10-	35	4	3.00	
148			.5-	10-	17	6-	4	6-	6	27	47	2	0.20	
149			.5-	10-	53	6-	13	6-	11	60	10	4	1.00	
150			.5-	10-	118	6-	44	6-	15	39	60	3	1.00	
151			.5-	40	80	6-	24	6-	32	19	10	3	0.30	
152			.5-	20	385	6-	9	6-	38	11	60	2	0.15	
153			.5-	10-	170	6-	8	6-	65	11	22	2	0.20	
154			.5-	10-	155	6-	8	6-	50	10-	22	4	0.30	
155			.5-	20	385	14	26	15	60	10-	47	3	0.15-	
156			.5-	100	1450	60	137	29	111	19	22	4	0.40	
157			.5-	20	775	11	18	9	109	10-	40	4	0.40	
158			.5-	10-	3850	6-	18	21	54	11	140	3	0.20	
159			.5-	10-	870	6-	13	9	45	10-	35	2	0.15-	
160			.5-	10-	190	6-	8	6-	28	10-	22	2	0.30	
161			.5-	10-	40	6-	22	6-	33	11	40	4	0.30	
162			.5-	20	60	6-	13	6-	50	10-	22	4	0.30	
163			.5-	30	30	6-	18	6-	10-	18	22	4	0.15	
164			.5-	10-	100	6-	16	6-	10-	31	40	2	2.50	
165			.5-	20	240	14	11	6-	10-	74	87	2	0.30	
166			.5-	10-	3700	8	14	12	10-	98	47	4	0.20	
167			.5-	10-	430	26	34	15	11	80	47	3	0.15	
168			.5-	10-	340	6-	16	9	15	19	40	3	0.15-	
169			.5-	10-	50	6-	8	6	10-	52	40	3	0.30	
170			.5-	10-	635	6-	9	9	10-	50	35	3	0.15-	
171			.5-	10	470	6-	5	6	10-	60	47	4	0.15-	
172			.5-	10-	470	6-	11	9	10-	50	47	4	0.15	
173			.5-	70	155	6-	8	6-	11	36	40	3	0.15	
174			.5-	10-	255	6-	11	6-	10-	53	35	4	0.40	
175			.5-	10	1600	6-	13	6	10-	59	22	4	0.15-	

p.29

APPENDIX I

SPECTRO-CHEMICAL ANALYSIS OF SAMPLES FROM WAU AREA (B.M.R. LAB)
PARTS PER MILLION. (Notes at end of tables)

Sample No.	FIRE ASSAYS dwt/ton Au	FIRE ASSAYS dwt/ton Ag	Au	Ag	As	Mn	Ni	Cu	Co	Pb	Zn	Hg	V	Mo	Sample Type
						A A					A A				
642200001	2.68	113.74	a	400	700	34,500	80	50	80	a	190	0.80	10	2	
2	5.30	142.76	15	400	700	8,750	60	40	60	a	85	2.00	25	1	
3	5.72	42.14	10	300	500	80	60	25	8	a	28	0.60	5-	a	
4	48.82	1094.70	a	1000	300	420,000	1000	5000+	40	a	8000	1.00	a	5	
5	33.82	1754.58	a	1000+	300	435,000	150	300	15	a	8750	0.15	a	7	
6	3.80	182.28	a	150	300	20,000	15	100	7	10	303	0.15	40	a	
7	1.44	54.04	a	10	500	9,750	a	50	3-	5-	270	0.80	7	a	
8	0.60	16.62	a	30	300	16,500	35	80	10	15	135	0.40	60	a	
9	0.66	7.90	a	80	300	3,200	15	80	10	15	115	0.40	80	a	
10	0.70	25.46	a	80	a	8,250	30	40	12	10	185	0.15-	60	a	
11	0.52	3.80	a	2	a	283	7	12	3	5	55	0.15-	100	a	
12	0.30	10.42	a	2	a	2,880	5	15	10	5	65	0.15-	60	a	
13	Tr	Nil	a	2	a	2,180	5	15	8	15	103	0.15-	80	a	
14	0.54	117.28	a	200	a	41,500	25	60	25	50	275	0.30	60	2	
15	0.32	12.72	a	7	500	5,500	7	20	15	a	170	0.15-	60	1	
16	-	-	a	2	a	3,500	a	15	12	5	75	0.40	50	a	
17	-	-	a	2	a	1,260	a	15	12	10	60	0.15	80	a	
18	Tr	Nil	a	1-	a	2,100	15	10	50	5	98	0.15	60	1	
19	Tr	Nil	a	a	a	1,430	5	15	10	10	108	0.30	60	a	
20	Tr	Nil	a	2	a	1,460	7	12	7	5	115	0.60	60	1	
21	2.06	9.08	10	50	700	6,500	20	20	15	5	78	2.50	25	2	
22	-	-	25	60	a	12,000	7	15	7	25	118	1.50	40	a	SED
23	-	-	a	70	a	20,500	5	15	5	25	138	1.50	30	a	SED
24	-	-	a	15	a	3,300	12	40	12	100	125	1.50	80	a	SED
25	-	-	a	a	a	108	a	25	3	5-	20	1.50	80	a	
26	-	-	a	5	a	2,430	5	40	20	15	62	1.00	150	1	
27	6.00	299.4	a	1000	a	29,000	20	100	3-	1000	285	0.80	5	7	
28	-	-	No	Result		128					20	0.40			
29	-	-	a	a	a	550	5	20	10	5	50	0.15-	80	a	
30	-	-	a	1	a	2,180	15	50	20	5	75	0.40	150	1	
31	-	-	a	a	a	395	5	30	12	5	60	0.20	150	a	
32	-	-	a	a	a	93	a	20	a	a	48	0.60	30	a	
33	-	-	a	2	a	395	5	50	12	10	70	0.30	80	a	SED
34	-	-	a	a	a	88	a	25	a	a	43	0.15	50	a	
35			a	1-	a	750	17	25	20	5-	88	-	80	a	SED

ATOMIC ABSORPTION ANALYSIS OF SAMPLES FROM WAU AREA (A.M.D. 1)
PARTS PER MILLION.

Sample NO.	FIRE ASSAYS dwt/ton Au	FIRE ASSAYS dwt/ton Ag	Ag	As	Mn	Ni	Cu	Co	Pb	Zn	Cr	Cd	Hg	Sample Type
642200106	4.6	15.8	8	1100	40	6-	30	6-	130	22	19	4	5.00	
107	64.6	87.8	132	3700	129	6-	20	6-	3000	25	148	3	1.00	
108	4.0	3.4	2	200	35	6-	22	6-	73	14	92	4	0.80	
109			1	400	245	6-	54	6-	60	60	78	5	0.30	Panned
110			6	500	325	6-	58	6-	60	75	38	4	0.40	SED
111			.5-	30	960	11	5	6-	10-	100	41	4	0.40	
112			3	600	2650	69	162	39	292	700	86	7	1.50	Panned
113			2	400	830	8	86	11	197	390	120	6	1.00	Panned
114			.5	200	625	11	40	6-	109	210	78	2	0.80	SED
115			2	500	515	11	78	12	322	111	38	4	0.15	
116			.5	50	370	6-	52	6-	10-	31	12	3	0.15-	
117			.5	70	830	20	28	6	19	94	25	4	0.15-	
118			.5	100	960	17	30	9	43	176	112	5	0.15-	
119			1	60	2250	14	30	12	39	140	75	4	0.15	
120			.5-	30	790	34	34	9	15	111	103	4	0.30	
121	0.4	33.8	.5	30	475	17	26	6	19	93	30	2	0.30	
122			.5-	10	950	17	52	12	15	157	49	5	2.50	
123			.5-	10	580	6-	30	6	35	93	21	6	2.00	
124			.5-	10	675	6-	46	18	35	41	24	5	0.15-	
125	Nil	Nil	1	70	1800	11	34	12	68	71	27	4	0.40	
126			.5	10-	1400	17	11	6-	10-	91	12	3	0.15	
127			2	250	6400	17	11	6-	27	20	25	3	0.80	
128			.5	10-	4400	11	13	6-	19	800	19	4	0.15	
129	8.70	18.30	67	90	10000+	8	137	6	437	830	229	10	1.00	
130	1.40	2.80	1	100	6500	8	26	6-	19	107	25	4	0.60	
131			.5-	50	790	14	28	6-	19	99	12	4	0.30	
132			.5	300	135	6-	74	9	10-	30	68	4	1.00	
133			.5	10-	100	6-	11	6-	11	54	19	3	0.20	
134	2.50	58.4	200+	40	10000+	34	630	6-	2350	10000+	208	45	0.80	
135	0.10	1.8	2	100	3200	14	28	6-	27	127	25	3	0.30	
136	148.02	117.8	200+	200	10000+	120	42	39	10-	480	120	4	1.00	
137			1	300	880	17	52	6-	23	99	16	4	0.40	
138			.5-	10-	30	6-	5	6-	11	14	12	4	0.60	
139			.5-	10-	165	6-	26	6-	11	55	22	9	1.20	
140			.5-	10-	280	6-	11	6-	10-	68	19	2	0.20	

ATOMIC ABSORPTION ANALYSIS OF SAMPLES FROM WAU AREA (A.M.D. 1.)
PARTS PER MILLION.

Sample NO.	FIRE ASSAYS dwt/ton Au	dwt/ton Ag	Ag	As	Mn	Ni	Cu	Co	Pb	Zn	Cr	Cd	Hg	Sample Type
64220071			21	300	640	6-	74	6	3050	80	22	4	1.50	
72			1	150	267	6-	46	6-	77	36	32	3	1.00	
73			3	300	336	6-	26	6-	327	30	32	3	0.80	
74			1	70	1720	8	30	6-	130	120	12	2	0.15-	
75			.5-	10-	1580	23	78	27	73	270	45	4	0.15-	
76			2	400	625	6-	54	9	95	68	48	2	0.40	
77			1	50	2350	50	74	18	60	240	200	4	1.50	Panned
78			2	300	1610	14	58	9	99	290	52	3	1.00	Panned
79			.5	70	800	54	76	33	19	151	48	3	0.15-	
80	0.2	0.6	3	300	1180	47	93	24	27	106	35	3	0.40	
81	0.2	5.6	1	900	4050	32	74	18	15	113	41	2	0.80	
82			.5-	10-	900	32	60	18	15	63	45	6	0.15-	
83			1	10-	360	41	83	18	10-	98	78	4	0.30	
84			1	20	980	20	56	24	11	75	60	4	0.40	
85			7	10-	1320	14	18	6	11	75	41	3	1.00	
86			.5	20	80	6-	18	6-	11	38	52	3	0.15-	
87			.5-	30	611	8	28	6	10-	58	38	3	0.15	
88			.5	10-	3700	29	22	21	15	114	18	3	0.15-	
89			.5	200	166	6-	20	6-	10-	22	32	2	0.30	
90			.5-	10-	772	11	18	9	11	83	10	3	0.30	
91			.5-	60	44	6-	18	6-	10-	5	46	3	0.40	
92			.5-	10-	1360	17	18	6	19	98	12	3	0.15-	
93			3	500	557	17	44	6-	43	55	52	3	0.50	
94			.5-	10	1870	17	11	6-	10-	127	12	3	0.15-	
95			2	80	5750	11	37	74	168	310	12	4	0.15-	
96			3	100	1000	34	72	29	357	690	52	7	0.15	
97			1	10-	3400	17	34	12	422	320	28	6	5.00	
98			.5	20	1550	6-	8	6-	23	42	25	4	1.50	
99			.5-	10-	2000	6-	20	6	10-	68	12	2	0.15	
100			.5-	30	270	6-	14	6	10-	48	18	3	0.80	
101			.5-	10	36	6-	26	6-	27	41	22	3	0.15	
102			.5-	10-	1000	6-	11	15	15	37	32	3	0.40	
103			2	1200	1500	11	56	12	19	85	18	4	0.40	
104			1	70	220	6-	47	6-	158	35	52	4	0.15	
105	25.0	524.6	7200	2700	150	6-	28	6-	1620	35	25	4	8.00	

p.32

SPECTRO-CHEMICAL ANALYSIS OF SAMPLES FROM WAU AREA (B.M.R. LAB.)

PARTS PER MILLION

Sample No.	FIRE ASSAYS dwt/ton Au	FIRE ASSAYS dwt/ton Ag	Au	Ag	As	Mn	Ni	Cu	Co	Pb	Zn	Hg	V	Mo	Sample Type
						A A					A A				
642200036	-	-	a	a	a	1,700	a	40	20	5	80	0.15-	100	a	
37	-	-,	a	a	a	1,500	5	40	20	5-	175	0.20	200	a	
38	Tr	Nil	a	1	a	380	5	20	7	5	85	0.15-	100	a	
39	Tr	Nil	a	a	a	180	a	2	a	a	22	0.15-	20	a	
40	Tr	Nil	a	2	500	47	a	7	a	5	15	0.30	80	a	
41	-	-	a	a	a	220	a	15	3	5	43	0.15-	60	a	
42	-	-	a	a	a	490	a	12	3-	a	118	2.00	7	a	
43	-	-	a	a	a	420	a	15	3-	5	55	15.00	80	1	
44	-	-	a	a	a	515	5	20	5	10	63	-	40	a	SED
45			a	a	a	1,150	a	12	8	5-	33	0.40	30	a	
46	-	-	a	a	a	180	a	20	3	5	65	0.15-	40	a	
47	-	-	a	a	a	330	5	15	10	10	80	0.15-	80	a	
48	-	-	a	a	a	290	a	12	8	5	58	0.15	80	1	
49	-	-	a	a	a	30	a	12	a	5-	22	0.30	40	a	
50	-	-	a	a	a	350	a	7	5	5-	68	0.15-	40	a	
51	-	-	a	1-	a	8	a	15	a	15	5	40.00	30	a	
52	-	-	a	a	a	8	a	10	a	5	2.5	0.30	30	a	
53	Tr	Nil	a	1-	a	8,950	10	15	10	a	65	0.15-	40	a	
54	0.48	Tr	a	a	a	5,950	5	15	10	a	118	0.15-	25	a	
55	-	-	a	a	a	230	a	3	3-	5-	8	0.30	40	a	
56	-	-	a	a	a	73	5-	15	3-	a	28	0.15-	25	a	
57	-	-	a	1-	a	3,350	12	20	25	5-	143	1.00	40	a	
58	-	-	a	a	a	1,150	7	30	12	5-	108	0.60	50	a	SED
59	-	-	a	a	a	580	5	20	12	5-	93	0.15-	60	a	
60	-	-	a	1-	a	1,080	10	20	12	5-	98	0.15-	40	a	SED
61	-	-	a	1-	a	625	10	20	12	5-	155	0.15-	60	a	SED
62	-	-	a	a	a	700	5-	2-	8	5-	113	0.15-	40	a	
63	-	-	a	a	a	145	a	5	a	a	85	0.15	15	a	
64	-	-	a	a	a	1,030	a	3	7	5-	83	0.40	40	a	SED
65	-	-	a	a	a	5,400	a	2-	3	5-	50	0.20	25	a	
66	-	-	a	a	a	8	a	2-	a	a	2-	0.20	50	a	
67	-	-	a	a	a	18	a	2-	a	5-	2.5	0.60	50	a	
68	-	-	a	a	a	18	a	2	a	5-	10	0.15	25	a	
69	6.90	9.30	a	3	a	20	a	20	a	700	20	0.15	40	a	
70	-	-	a	a	a	305	a	10	a	5-	58	0.15-	30	a	

APPENDIX II

Details of multiple samples collected (see Fig. 1)

Samples 1, 2 and 3

Collected from the underground workings of the old Enterprise Mine at the northern end of the major fissure zone which at the time of sampling had been re-opened. The samples were collected from the 2nd Level at distances of about 150 feet apart. Their approximate surface localities are shown on the map.

Samples 4 to 12

Collected serially outwards from the centre of a large auriferous fissure 3 feet wide, being part of the main fissure system which at the time of sampling was being mined.

Samples 4 and 5 were collected from fault clay and manganese dioxide.

Samples 6 and 7 were collected from Upper Edie Porphyry inclusions in the fault clay.

Sample	8 -	1	ft	from	fault	margin	in	U.E.	Porphyry
"	9 -	3	"	"	"	"	"	"	"
"	10 -	5	"	"	"	"	"	"	"
"	11 -	10	"	"	"	"	"	"	"
"	12 -	20	"	"	"	"	"	"	"
"	13 -	50	"	"	"	"	"	"	"

These samples were collected on the south side of the fault from well exposed weathered Upper Edie Porphyry.

Samples 14 and 15

1 foot channel samples collected outwards from the contact between weathered Kaindi phyllite and weathered Upper Edie Porphyry respectively.

Samples 38, 39 and 40

Collected from the wall of a road cutting respectively:- 2 feet within a large manganiferous inclusion of phyllite in Upper Edie Porphyry, and 2 feet and 7 feet from the inclusion.

Samples 71 to 74

Collected at intervals in alluvial workings. Of these samples, 71 and 73 were collected from material which was regarded by indigenous miners as ore.

Samples 129 and 130

Collected from mangano-calcite ore and partly oxidised auriferous Namie Breccia respectively at the same locality in the open-cut workings above Golden Ridges.


WAU GEOCHEMICAL ORIENTATION SAMPLING
AND MAPPING.
B.M.R. SAMPLE CODE PREFIX:- 6422.
ORIGINAL MAP BY H. M. KINGSBURY. 1930.
SCALE: 1 inch ≙ 1,000 feet.
(GRID:- MAGNETIC)
1000 0 1000 2000 3000 4000 5000 feet
Fig. 1
REFERENCE
RECENT to PLEISTOCENE
ALLUVIUM
Qra
Alluvium, river outwash, & dredge tailings.
Qpp
Qpr
PLIOCENE
OTIBANDA FORMATION
Sedimentary Member
Tpo
Clay, mudstone, gravel, sandstone, conglomerate.
Pyroclastic Member
Tpop
Volcanic Agglomerate (schist, gran'dte, Low. Edie Porph., & dacitic volcs.)
UPPER EDIE PORPHYRY
Tpeu
Quartz, feldspar, biotite porphyry.
NAMIE BRECCIA
Tpn
Volcanic Breccia (schist, Low. Edie Porph., some volc. material).
UNCLASSIFIED PORPHYRY
Tpu
Quartz, biotite, andesine, hornblende, porphyry.
MIOCENE ?
LOWER EDIE PORPHYRY
Tmel
Quartz, biotite, andesine, hornblende porphyry.
Lower Tertiary
MOROBE GRANODIORITE
Tlm
Granodiorite.
MESOZOIC ? PALAEOZOIC
KAINDI METAMORPHICS
Mk
Slate, phyllite, micaceous schist.
SYMBOLS
Geological boundary – position accurate.
Geological boundary – position approximate.
Geological boundary – position inferred and concealed.
Bedding – strike & dip.
Cleavage – strike & dip.
Cleavage – strike only, dip indeterminable.
Vertical banding — intrusive rock.
Stream.
River.
River incised.
Road.
Vehicle track.
Track or water race.
Power line.
Geo-chemical Sample locality.
Prospect.– little or no production.
Mine – not being worked.
Open-cut being worked.
Open-cut not being worked.
Alluvial workings.
Open-cut mine.
Rock slip or breakaway.
Fault, concealed.
LOCALITY MAP
TERRITORY OF NEW GUINEA
PAPUA
Lae
Wau
Port Moresby
WAU
EDIE CREEK
BULOLO
RIVER
KUMULU
CLIFFSIDE
LITTLE WAU CREEK
BIG WAU CREEK
MOUNT KAINDI
P & T. Relay Stn
Golden Chance
Ribroaster
Reduction Mill
Lutheran School
Hospital
Enterprise
Day Dawn
Day Dawn South
Rikon's
Power Line
track
40,000 N
35,000 N
30000 N
25000 N
20000 N
15000 N
10000 N
5000 N
45000 E
40000 E
35000 E
30000 E
25000 E
20000 E
15000 E
10000 E
Geology revised and amended by R.G.Horne.
To accompany Record 1968/133
B55/A14/47


WAU GEOCHEMICAL ORIENTATION SAMPLING
PROJECT
METALLIC ELEMENT CONCENTRATION
SILVER/ARSENIC/MANGANESE
SCALE: 1 inch ≏ 1,000 feet.
Watercourses.
Geological Boundary.
•14 Geochemical Sample Point. (parts per million)
0·5- Geochemical Stream Sediment Sample. (parts per million)
200 Geochemical Stream Sediment Sample (Panned). (parts per million)
a (indicates element sought but not detected).
Fig. 2
Magnetic Meridian (1938)
B55/A14/42
To accompany Record 1968/133

Fig.3.
WAU GEOCHEMICAL ORIENTATION SAMPLING
PROJECT
METALLIC ELEMENT CONCENTRATION
COPPER/COBALT/NICKEL
SCALE: 1 inch ≙ 1000 feet.
Watercourses.
Geological Boundary.
• 14 Geochemical Sample Point. (parts per million)
X 0·5 Geochemical Stream Sediment Sample. (parts per million)
⊗ 200 Geochemical Stream Sediment Sample (Panned). (parts per million)
a (Indicates element sought but not detected)
Magnetic Meridian (1938)
To accompany Record 1968/133
B55/A14/44


WAU GEOCHEMICAL ORIENTATION SAMPLING
PROJECT
METALLIC ELEMENT CONCENTRATION
LEAD / ZINC / VANADIUM
SCALE: 1 inch ≙ 1000 feet.
Watercourses
Geological Boundary.
•14 Geochemical Sample Point. (parts per million)
X 0·5- Geochemical Stream Sediment Sample. (parts per million)
○ 200 Geochemical Stream Sediment Sample (Panned). (parts per million)
a (indicates element sought but not detected).
— Not determined
Fig. 4
Magnetic Meridian (1930)
B55/A14/43
To accompany Record 1968/133

Fig. 5

WAU GEOCHEMICAL ORIENTATION SAMPLING PROJECT

METALLIC ELEMENT CONCENTRATION

MERCURY/CADMIUM/CHROMIUM

SCALE: 1 inch ≏ 1,000 feet.

Watercourses.

Geological Boundary.

• 14 Geochemical Sample Point (parts per million)

✕ 0·5- Geochemical Stream Sediment Sample (parts per million)

⊗ 20·0 Geochemical Stream Sediment Sample (Panned). (parts per million)

— Not determined

To accompany Record 1968/133

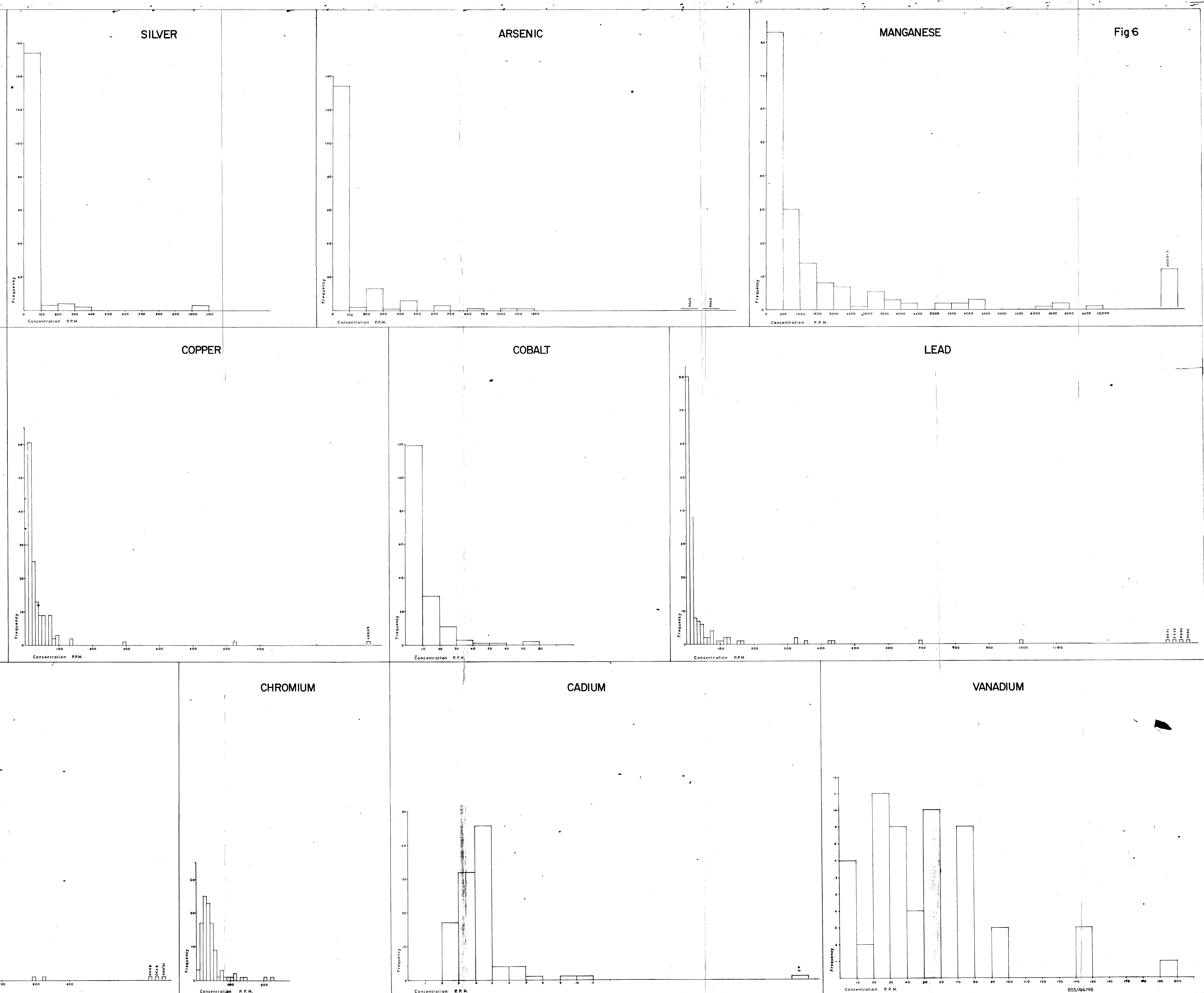
B55/A14/45

GEOCHEMICAL ORIENTATION SURVEY,

WAU AREA.
NEW GUINEA.

HISTOGRAMS
FREQUENCY V CONCENTRATION.

(Frequency denotes number of recordings within given p.p.m. range).

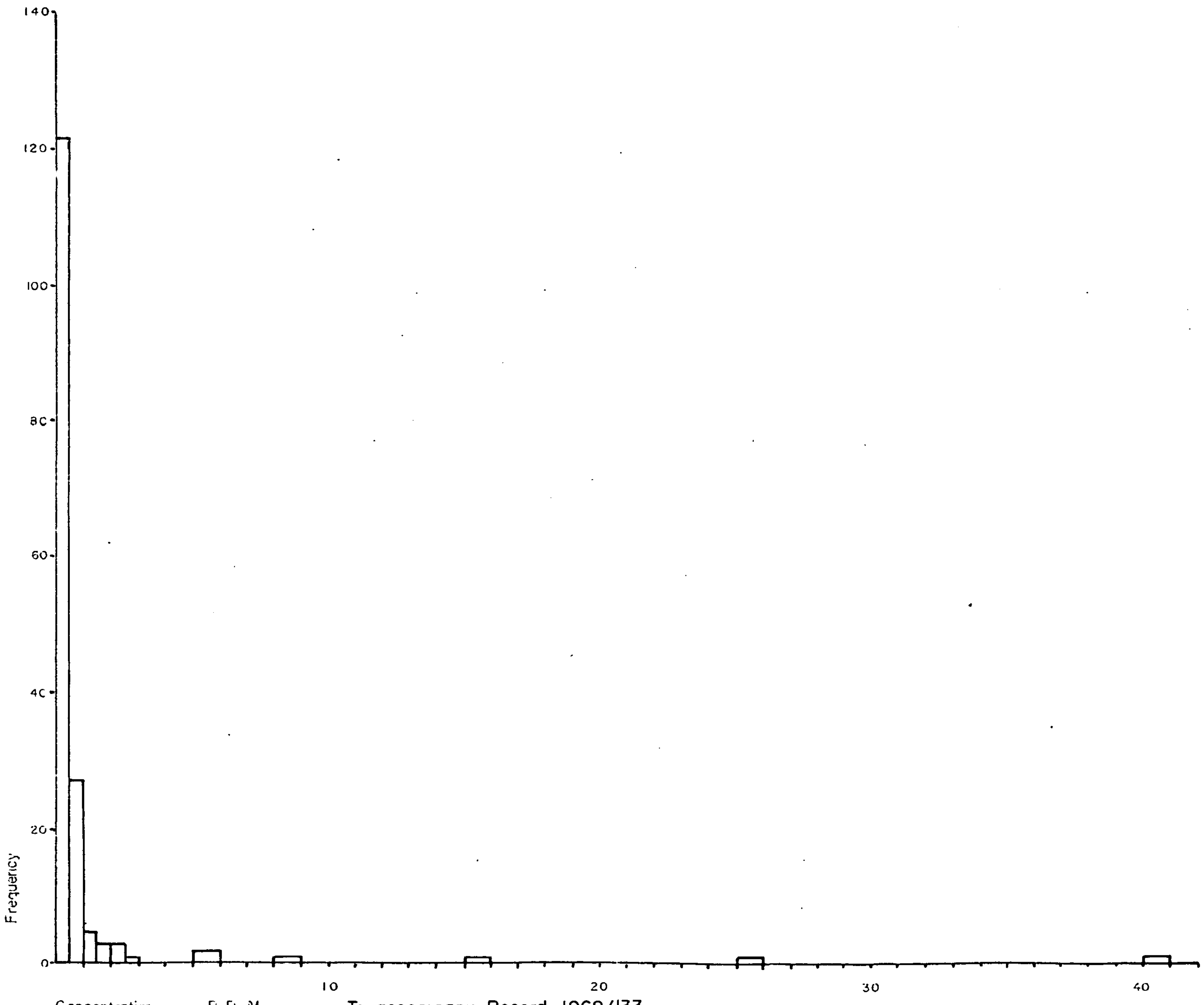


To accompany Record 1958/133

B55/A4/46

MERCURY

Fig. 6



To accompany Record 1968/133

B55/A14/46(b)

36