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RECORDS:

1964/100

GEOCHEMICAL ORIENTATION SURVEY, ASTROLABE, PAPUA 1964

by

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GEOCHEMICAL ORIENTATION SURVEY, ASTROLABE, PAPUA 1964

SUMMARY

In the Astrolabe Mineral Field, Papua, sixty seven orientation geochemical samples were collected. They included country rock mineralised rocks, gossans, soils, stream sediments, heavy mineral concentrates and magnetite. The samples were analysed to provide information on the type and concentration of trace elements to assist the 1964 geochemical sampling and geological mapping programme. Copper and zinc appear to be the most suitable "pathfinder" elements for location of copper/gold mineralisation.

INTRODUCTION

Sixty seven geochemical samples were collected during an orientation survey of the Port Moresby-Kwikila area in Papua to provide data for the 1964 regional geochemical and mapping programme of the Bureau of Mineral Resources. The samples provide information on the type and concentration of trace elements associated with mineralised and unmineralised rock, gossan capping, soil in vicinity of mineralisation and stream sediments from the general area. Ten heavy mineral concentrates and magnetite samples were also collected from streams draining mineralised and unmineralised areas.

The analyses of these samples are listed in Tables 1 to 7, at the end of this report.

GEOLOGY

The gold-copper deposits of the Astrolabe Mineral Field occur close to the contact of Tertiary calcareous-argillaceous sediments and coarse to fine-grained gabbro. The sediments have been folded isoclinally and are intruded conformably by the gabbro.

Orebodies are lenticular and consist of massive fine-grained chalcopyrite-pyrite to sphalerite-chalcopyrite-pyrite lenses with accessory silver and gold; traces of cobalt, arsenic and manganese have been previously detected in the Laloki ore. Mineralisation appears to have been localised in a calcareous shale member where it has been intersected by minor shears and cross folds.

SUMMARY OF ANALYTICAL RESULTS

Rock Samples (Table 1). The specimens of gabbro contain copper in the range 50 to 100 p.p.m., cobalt 60 to 150 p.p.m., vanadium 500 to 1000 p.p.m. and nickel 5- to 150 p.p.m. Molybdenum, tin lead and zinc were not detected. Two samples of volcanic agglomerate showed lower values of all metals with 15 p.p.m. Cu, 10 p.p.m. Pb, 30 p.p.m. Co, 5 p.p.m. Mo and 300 p.p.m. V. Nickel, tin and zinc were not detected. One specimen of volcanic agglomerate and one specimen of gabbro were analysed for arsenic. The former contained 80 p.p.m. and the latter, less than 3 p.p.m.

Mineralised rock samples (Table 2). The manganese-rich matrix of the Umuyu Goro and Pandora Mines samples presented analytical difficulties with the optical spectrograph. A qualitative scan however showed that nickel, cobalt, copper and vandium are present. Mineralisation at Hector East Mine, Laloki Mine and Mt. Louis Prospect were characterised by high copper and zinc values. In addition, at Laloki and Mt. Louis high lead, molybdenum and tin values occur. Nickel values are low (six values 5 p.p.m. or less, one value 40 p.p.m.), cobalt values sporadic between 5 and 150 p.p.m. and high values of vanadium (100 to 500 p.p.m.) are found only at the Hector and Pandora Mine. Of six rocks analysed, arsenic was not detected in the manganese ore from Pandora mine or in the mineralised rock at Mt. Louis. Only moderate arsenic values of 13 and 43 p.p.m. occur in specimens of weathered mineralised rock at the Hector mine and values of 345 and 245 p.p.m. at the Laloki Mine. Arsenic was not detected at Mt. Louis.

Gossan samples (Table 3). The gossans are all characterised by high or fairly high copper values (200 to 5000 + p.p.m.). Secondary copper minerals were not noted in the boxwork of hand specimens. Molybdenum is anomalous in all specimens (10 to 500 p.p.m.) while lead, in appreciable quantities ($> \frac{1}{2}\%$) occurs in both Hector West and Laloki gossans. Bismuth occurs in the Laloki gossan only. Of three gossans analysed, one at Mt. Louis contained 85 p.p.m. As, another at Hector West Mine contained 1900 p.p.m. and at Laloki Mine the arsenic content exceeded 1900 p.p.m.

Soil samples (Table 4). Samples collected from the C horizon down slope from a gossan at Hector West Mine show higher values of copper, lead zinc and tin than over mineralisation. The Pb, Zn and Sn values diminish within a few hundred feet down slope; copper persists in the range 100 to 500 p.p.m. One soil sample containing anomalous values of Cu, Pb, Zn & Mo was tested for arsenic and found to contain 40 p.p.m.

Stream sediments (Table 5). Stream sediments derived from gabbroic rocks in the vicinity of copper mineralisation show nickel values in the range 80 to 200 p.p.m., cobalt 80 p.p.m., vanadium 400 to 500 p.p.m., copper 150 to 300 p.p.m. Zinc is consistently absent (working limit of detection 100 p.p.m.) and only in one stream near the Hector Mine does a high tin and lead value occur (150 and 100 p.p.m. respectively). Of five stream sediments tested for arsenic only two, contaminated with spoil from mines, showed detectable quantities (20 and 13 p.p.m.). The other streams drained gabbro and Port Moresby sediments.

Streams draining predominantly Port Moresby sediments contain variable amounts of nickel (range 10 to 60 p.p.m.), cobalt 12 to80 p.p.m., copper 40 to 100 and vanadium 150 to 600 p.p.m. Sediment from two streams draining the volcanic agglomerate showed nickel values of 40 and 15 p.p.m., cobalt 40 and 30, copper 70 and 50, vanadium 150 and 500, molybdenum 5 and 5-, lead 5 and 5, one value of 15 p.p.m. Zinc was not detected.

Heavy Mineral Concentrates and Magnetite (Tables 6 and 7).

The large and variable amounts of iron and titanium in the magnetite and heavy mineral concentrates creates difficulties in the precise determination of base metals by optical and X-ray fluorescence spectrographic methods. Copper is found to be present in most samples as a trace and zinc in values between a trace and 300 p.p.m. One samples from

Sapphire Creek which drains several copper mines showed a copper content of 580 p.p.m. and a zinc content of 900 p.p.m.

DISCUSSION

Copper occurs in all the specimens of mineralised rock. Appreciable quantities of lead and zinc occur only in samples from Laloki and Mount Louis. Analysis of gossan from Laloki shows, as one might expect, considerable leaching of zinc. It is probable that copper has also been leached. Arsenic analyses on a few selected samples showed low values (13, 43, 245 and 345 p.p.m.) in mineralisation but gossans from the same mines showed values of 1900 and 1900+ p.p.m. This data is insufficient to draw firm conclusions but the figures do suggest that there may be enrichment of arsenic in the gossan possibly as scorodite.

Unusual components of the mineralised rock at Laloki and Mt. Louis are tin and molybdenum. The molybdenum could possibly be associated with one of the black shales of the Moresby Beds although values of 1000 p.p.m. are high even for enriched sediments. Tin may be associated with the Moresby Beds as cassiterite or it may have been introduced together with the copper as a sulphide. Absence of tin in the gossan may support the latter suggestion.

Copper and, in places, lead values occur in the streams draining mineralisation but zinc values are too low to be detected by the spectrograph (limit of detection 100 p.p.m.). Where background values of copper are high and the contrast of the anomalies poor, the total copper, and zinc values may be only of limited diagnostic value and other methods should also be used to determine 'free' or 'cold' extractable copper, and zinc liberated to the streams by oxidising sulphides. Detectable values of arsenic may persist in streams draining mineralisation. However in the vicinity of the volcanic agglomerate arsenic values related to mineralisation may be obscured by arsenic liberated from the agglomerate.

A study of the distribution of free sulphides (aqua regia soluble Cu, Pb and Zn) in the basic rocks of the area is likely to provide useful data concerning the genetic relationship between basic rocks and mineralisation. It may also help to define areas of high mineral potential. Similarly, systematic analysis of magnetite from these basic rocks for total copper zinc and lead may yield important data relevant to the genesis and location of copper/gold deposits. This genetic association of copper and zinc with the magnetite is likely to have a most useful application in geochemical sampling. Magnetite forms long and persistant trains in the streams and it is possible that the high copper and zinc content of magnetite from mineralised areas may be detected.

CONCLUSIONS

1. Copper, and zinc and, to a less extent, arsenic appear to be the most suitable 'path finder' elements for the location of copper/gold mineralisation in the Astrolabe field. In this orientation survey lack of analytical facilities prevented the determination of cold extractable copper, zinc and lead. However, recent acquisition of an atomic absorption spectrophotometer will allow the determination of both total and cold extractable copper and zinc on all sediment samples. The cold extractable/total metal ratio is diagnostic in the location of this type mineralisation. Total and cold extractable lead may be useful, particularly in follow-up work.

The minus 80 B.S. mesh fraction should be sieved and collected for all stream sediments. Where streams are flowing the sediment should be wet sieved and the fine material submitted to the laboratory in a plastic bag within the normal paper bag. Drying of the sample would fix or make unavailable part of the cold extractable copper. When the streams dry out, however, it will only be possible to submit the sieved dry sediment. pH determinations should be determined on as many streams in the area as possible. This information is important in the interpretation of results.

2. Determination of the total and 'sulphide' copper, zinc and lead in the gabbroic rocks will afford much available information and may provide a unique method for the location of ore deposits. Rock samples to give a coverage of 2 samples per square mile (gabbro outcrop only) should be collected and crushed to $-\frac{1}{8}$" before submission to the laboratory.

3. Determination of copper and zinc in the magnetite separated from the crushed gabbroic rocks is likely to provide supporting data in defining areas of high mineral potential.

4. Determination of copper and zinc in magnetite collected from stream beds may supply supporting or complementary data to that obtained from active stream sediments. The magnetite should be collected with large magnets.

5. Nickel, cobalt and vanadium do not appear to be genetically associated with copper/gold mineralisation and it is unlikely that they will be of value as path finders. High vanadium values could possibly outline areas of basic rocks but there could possibly be observed more readily by noting the amount of magnetite in the streams.

6. A study of the primary dispersion pattern in mineralised rocks of the Astrolabe area should be made by systematic analysis of core material. Core is available for the Laloki and Ventura deposits. Composited chip samples over each foot of mineralisation and over each 5 ft of the hanging and foot walls for 50 ft on each side should provide preliminary information. Again total and 'sulphide' copper and zinc should be determined.

7. No gold analyses were made on the orientation material but development of a sensitive analytical method using an atomic absorption spectrophotometer would make a study of gold distribution in the mineralisation and basic rocks well worth while.

RECOMMENDATIONS FOR THE REGIONAL GEOCHEMICAL EXPLORATION PROGRAMME

1. Collection of active stream sediments at a density of five to ten per square mile over an area of 50 square miles enclosing most of the Astrolabe copper field.

2. In the remainder of the area comprising 350 square miles between Port Moresby and Kwikila, sediment samples to be collected at a density of 5 per square mile in those drainage basin containing gabbro. Where Port Moresby Bed sediments occur unassociated with gabbro, stream sediment samples are collected at a density of 1 to 2 per square mile.

3. Collection of heavy mineral concentrates at the mouth of each drainage basin of approx. 5 to 10 square miles.

4. Collection of magnetite sampes, at the site of each active stream sediment.

5. Collection of samples from all rock types in sufficient numbers to provide a primary geochemical pattern.

6. Collection of samples from basic rocks of a density of 2 per square mile to determine base metal sulphide content and also base metal content of the component magnetite.

7. Collection of all gossanous material for Cu and Zn analysis.

8. An analytical programme discussed with D. Haldane is shown **on Page 6.** It would be preferable if half of each sample is retained in an original condition in case further screening tests are required. This of course does not apply to the wet sediments which have to be dried and sterilised.

RECOMMENDED ANALYTICAL PROGRAMME

TYPE OF SAMPLE	NO. OF SAMPLES	METHOD OF ANALYSIS	NO. OF SAMPLE ATTACKS	ELEMENTS TO BE DETERMINED
Stream sediment and colluvial soil.	1000	A.A.S. Cold extn. (ammonium citrate)	1000	Cu, Zn.
		A.A.S. Total extn. or O.S.	1000	Cu, Pb, Zn, Mo.
		Gutzeit	500	As
Rocks	250	A.A.S. Total extn. or O.S.	250	Cu, Pb, Zn.
		A.A.S. Aqua reqia extraction.	100	Cu, Pb, Zn.
Mineralised rock and core samples	200	O.S. or A.A.S. (Total extn).	200	Cu, Pb, Zn, Bi.
		Gutzeit	200	As
		Gallein or O.S.	100	Sn.
Heavy mineral Concentrate.		X-ray fluorescence.	120	Sn, Cr.
		A.A.S.	60	Au.
Magnetite	up to 500	A.A.S. Total extn.	up to 500	Cu, Pb, Zn.

A.A.S. = Atomic absorption spectrophotometry

O.S. = Optical Spectrograph

ANALYSES OF COUNTRY ROCK

TABLE 1

SAMPLE NO.	DESCRIPTION	Ni	Co	Cu	V	Mo	Sn	Pb	Zn	As
010009	Ventura prospect - fine grained gabbro	150	100	50	500	5-	a	5	a	n.d.
010010	Ventura prospect - gabbro near prospect	30	60	70	500	5-	a	a	a	n.d.
010011	Rouna Rd. 16 miles from Moresby - gabbro	5-	150	100	1000	5-	a	a	a	a
010012	Kwikela - Mt. Louis - Augite trachyte	5	100	10	500	5-	a	a	a	n.d.
010013	Rouna Rd. 13 miles from Moresby - Volcanic agglomerate	5-	30	15	200	5	a	10	a	n.d.
010014	Rouna Rd. 18 miles from Moresby - Volcanic agglomerate	5-	30	15	300	5	a	10	a	80

ANALYSES OF MINERALISED ROCK

TABLE 2

SAMPLE NO.	DESCRIPTION	Ni	Co	Cu	V	Mo	Sn	Pb	Zn	As
010006	Umuyu Goro Mine - Manganese ore	P	P	P	P	P	P	P	a	n.d.
010007	Pandora Mine - Manganese ore	100	100	100	500	5-	a	5	a	a
010018	Hector East Mine - limonite from weathered minln.	5-	5	5000+	100	10	a	20	200	43
010021	Hector East Mine - basic rock impregnated with sec. Cu	5	15	5000+	500	5-	a	10	200	n.d.
010022	Hector East Mine - weathered minln.(malachite)	40	60	5000+	200	5	a	10	1000	13
010053	Laloki Mine - fragment of fresh sulphide-rich ore	5-	5-	5000+	5-	1000	700	1000	1%+	345
010019	Laloki Mine - weathered mineralised rock and gossan	5-	150	5000+	5-	500	a	1000	a	245
010020	Laloki Mine - partly weathered sulphides	5-	150	5000+	5-	100	300	5000+	5000+	n.d.
010002	Mt. Louis - white siltstone in adit	5-	5	1500	20	150	500	1000	200	a

ANALYSES OF GOSSANS

TABLE 3

SAMPLE NO.	DESCRIPTION	Ni	Co	Cu	V	Mo	Sn	Pb	Zn	As
010001	Mt. Louis - gossan from adit	5	12	1000	200	10	a	5	a	85
010003	Mt. Louis - gossan with siltstone, pink staining	5-	10	200	5-	100	a	a	a	n.d.
010016	Ventura prospect - gossan from top of hill	5-	60	500	20	10	a	a	a	n.d.
010017	Ventura prospect - gossan from side of hill	5-	5	500	5-	20	a	5	a	n.d.
010054	Laloki Mine - gossan over mineralisation	5-	5-	5000+	200	500	a	5000+	500	1900+ *
010075	Hector Mine West - gossan opp. side of road to mine	5-	5-	1500	5-	200	a	5000+	500	1900

* Bismuth present

ANALYSIS OF SOIL SAMPLES - HECTOR MINE WEST - Line of soil samples taken at 100 ft intervals from top of hill down west ridge to poultry farm.

TABLE 4

SAMPLE NO.	DESCRIPTION	Ni	Co	Cu	V	Mo	Sn	Pb	Zn	As
010068	Top of hill-medium brown latosolwith fragments of yellow/orange limonitic gossan	10	30	70	150	5	a	5	a	n.d.
010067	100 ft down ridge - weathered rock at 2'3" depth, sandy clay (Moresby Beds)	5	20	1000	100	5	a	50	700	n.d.
010066	200 ft down ridge - weathered rock at 2'3" depth, dark brown clay (probably gabbro)	20	30	1500	100	20	10	100	500	40
010065	300 ft down ridge - weathered rock at 2' depth, (gabbro)	60	30	500	150	5	a	5	a	n.d.
010064	400 ft down ridge - weathered rock at 2' depth (gabbro)	30	20	100	150	5	a	5	a	n.d.
010063	500 ft down ridge - weathered rock at 2'6" depth (gabbro)	30	60	300	200	5	a	a	a	n.d.
010062	600 ft down ridge - weathered rock at 2' depth (gabbro)	20	60	150	150	5	a	a	a	n.d.
010061	700 ft down ridge - weathered rock at 2' depth (gabbro)	20	30	300	150	5	a	a	100	n.d.
Working limit of detection (i.e. minimum detectable value under which precise results cannot be obtained in routine analysis)		5	5	5	5	5	5	5	100	3

ANALYSIS OF STREAM SEDIMENTS - Random samples collected between Port Moresby and Kwikila.

TABLE 5

SAMPLE NO.	DESCRIPTION	Ni	Co.	Cu	V	Mo	Sn	Pb	Zn	As
010073	Stream draining Ventura Prospect (gabbro)	200	80	200	400	5-	a	a	a	a
010074	" " " " "	80	80	300	400	5	a	a	a	n.d.
010057	Stream draining west side Hector Mine	40	60	200	300	5	a	5	a	n.d.
010058	" " " " (Gabbro and Port Moresby beds)	30	40	150	300	5	150	100	a	13
010059	" " " "	30	20	70	150	5-	a	5	a	a
010060	" " " "	20	30	100	200	5	5	5	a	n.d.
010069	Sapphire Creek draining Sapphire Mine (contam.)	20	30	500	300	5	a		a	20
010056	Stream between Hector Mine and Sapphire Creek (P.M. beds)	30	30	100	100	5	a	5	a	n.d.
010055	2nd stream between Hector Mine and Sapphire Creek (Gabbro)	150	80	150	500	5-	a	a	a	n.d.
010071	Tributary of R. Laloki near Sogeri High School (Volcanic and agglomerate)	40	40	70	150	5	15	5	a	n.d.
010076	2nd tributary into R. Laloki (volc.agglomerate)	15	30	50	500	5-	a	5	a	n.d.
010078	Kowo creek (Port Moresby beds)	20	40	70	300	5-	a	a	a	n.d.
010080	Gobarda River (Port Moresby beds)	10	30	50	300	5-	a	a	a	n.d.
010083	Waillalla Creek (Port Moresby beds)	60	60	70	400	5-	a	a	a	n.d.
010086)	Sediments from streams crossing New Rigo Road between Port Moresby and Kwikila (Port Moresby beds)	30	80	70	600	5-	5	a	a	n.d.
010089)		60	40	40	500	5-	a	a	a	n.d.
010090)		10	40	70	500	5-	a	a	a	n.d.
010092)		10	20	40	200	5-	a	5	a	n.d.
010094)		15	20	60	100	5	a	5	a	n.d.
010095)		30	20	70	400	5-	a	a	a	a
010096)		30	40	70	300	5-	a	a	a	n.d.
010097)		60	50	70	150	5-	a	a	a	n.d.
010098)		15	40	70	300	5-	a	a	a	n.d.
010099)		15	25	50	500	5-	a	a	a	n.d.
010100)		15	12	100	150	5-	a	a	a	n.d.
Working limit of detection		5	5	5	5	5	5	5	100	3

ANALYSIS OF HEAVY MINERAL CONCENTRATES

TABLE 6

SAMPLE NO.	DESCRIPTION	Cu	Zn
010077	Kowo Creek	Trace	200
010084	Waillalla Creek	100	Trace
010085	Wahayu Creek	Trace	200
Working limit of detection		100	200

ANALYSIS OF MAGNETITE FROM STREAMS (Hand Magnet fraction)

TABLE 7

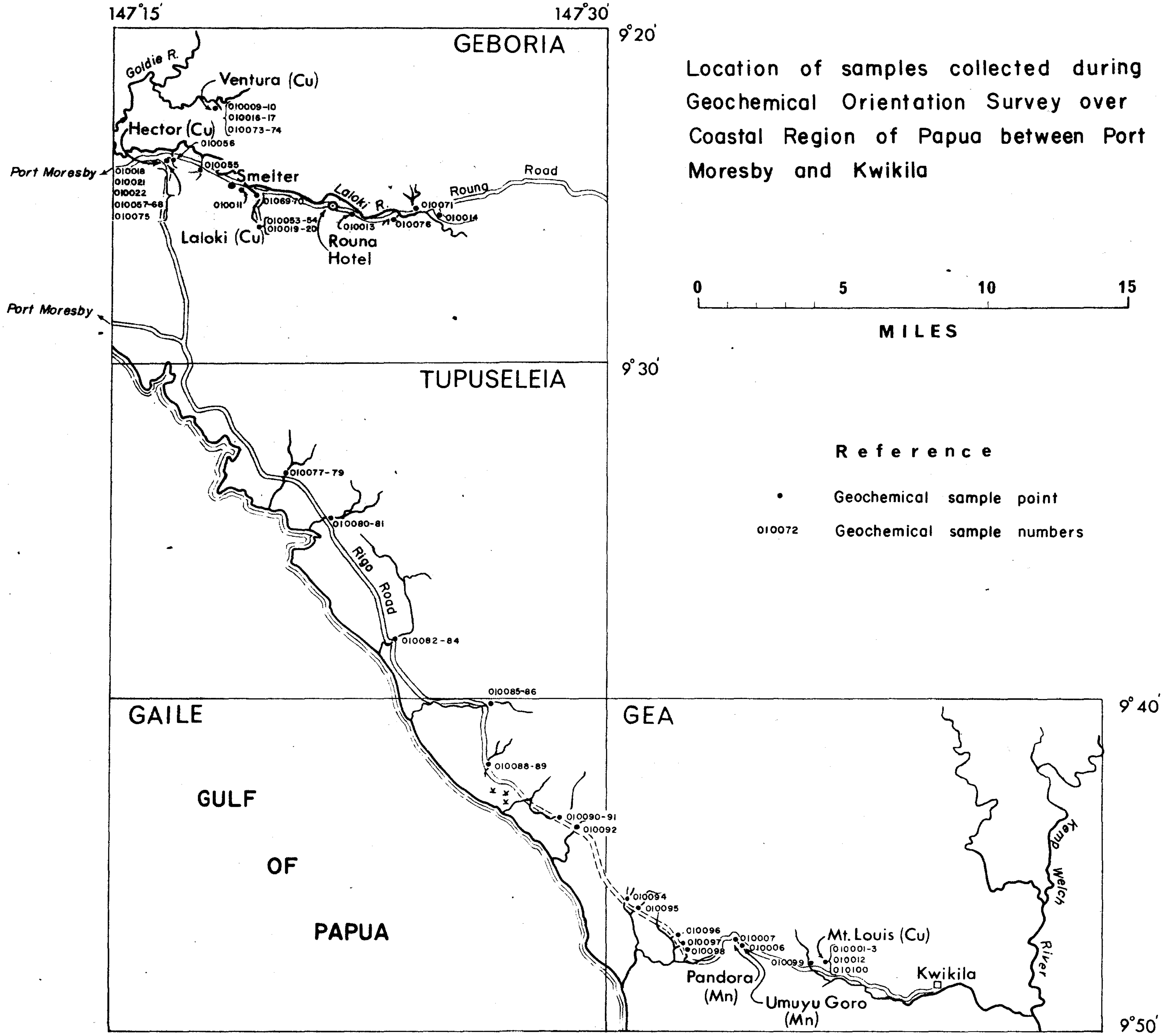
SAMPLE NO.	DESCRIPTION	Cu	Zn
010070	Sapphire Creek downstream from Federal Flag, Moresby King, Merrie England and Lalcki Mines	580	900
010079	Kowo No.2 stream	Trace	300
010081	Gobarda River	Trace	200
010082	Waillalla Creek	Trace	200
010088)	Unnamed creeks	Trace	200
010091)		Trace	200
Working limit of detection		100	200

All values in parts per million a = sought but not detected

5- = detected but less than 5 p.p.m. P = element present but quantitative result not available.

5000+= greater than 5000 p.p.m. n.d. = not determined.

In Tables 1 to 5 analyses of rocks, mineralised rocks, gossans, soils and sediments were made by A.D. Haldane on a Hilger quartz spectrograph. Heavy mineral concentrates and magnetite in Tables 6 and 7 were analysed by S. Goadby on a Phillips X-ray fluorescence spectrograph. Arsenic values were determined by N. Le Roux using the Gutzeit method.



Location of samples collected during Geochemical Orientation Survey over Coastal Region of Papua between Port Moresby and Kwikila

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