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THE PAPUAN ULTRABASIC BELT
WITH PARTICULAR REFERENCE TO ECONOMIC ASPECTS.

by

J. E. Thompson.

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ABSTRACT:

The Papuan Ultrabasic Belt, 230 miles long and up to 20 miles in width, contains olivine-rich rocks which, under certain physiographic conditions, produce nickel concentrations of the lateritic and silicate type. This ultrabasic zone also provides good prospecting territory for cobalt, platinum osmiridium, iron, chromium, asbestos, gold and possibly copper. Major rivers draining the ultrabasic zone and surrounding mountainous country could provide large-scale hydro-electric power for development of local mineral resources and possibly for the treatment of nickel silicate ores imported from existing and potential western Pacific producers.

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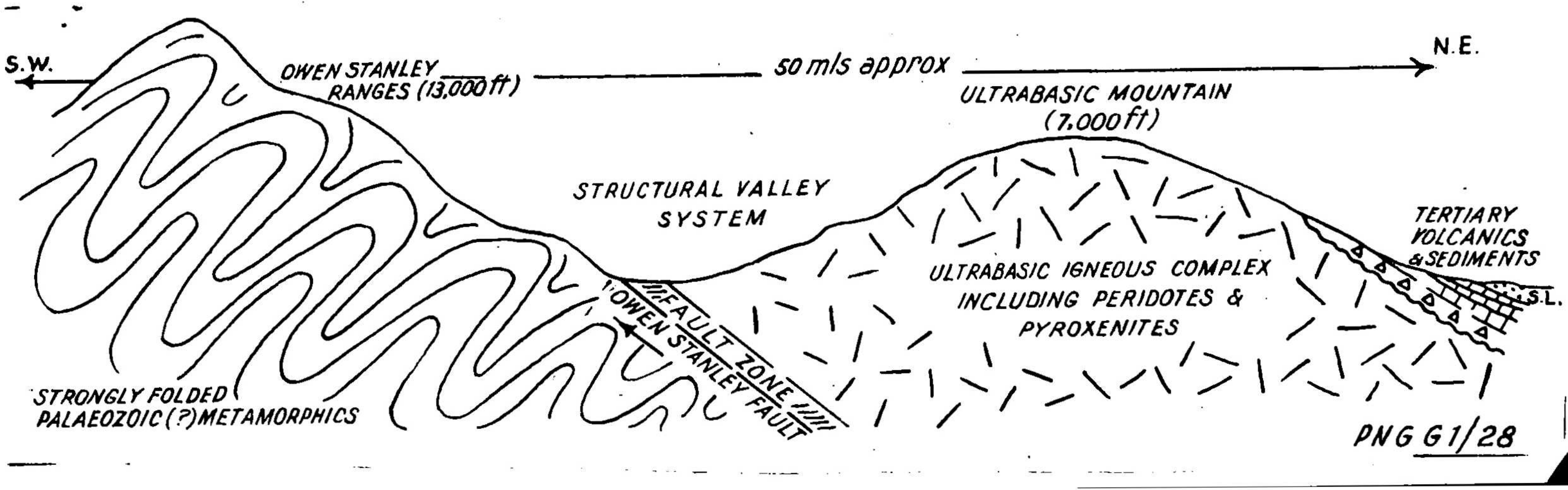
THE PAPUAN ULTRABASIC BELT

INTRODUCTION

The principal zone of ultrabasic igneous rocks now attracting attention as a potential source of nickel and cobalt, and possibly of iron, chromium, platinum, osmiridium, and asbestos, is approximately 230 miles in length and varies in width up to 20 miles. Its total area is roughly estimated as 3,500 square miles, of which approximately 2,400 square miles lie within the Northern District of Papua, the remainder being in the Morobe District of the Trust Territory of New Guinea. This geological province is illustrated on the accompanying map: the boundaries shown by solid lines are well established either by ground observation or from vertical aerial photography, while the dashed line boundaries are less accurate, being based on aerial reconnaissance observations and interpolation. The map also indicates lesser ultrabasic zones in both Territories; their boundaries are not well established and even the positioning of some of them on the map is based on unconfirmed reports. These lesser zones have not yet been examined for the economic ultrabasic mineral associates other than platinum and osmiridium, which have been recovered in conjunction with alluvial gold mining. The major ultrabasic province is referred to below as the Papuan ultrabasic belt, although its northwestern third lies in the New Guinea Trust Territory.

Ultrabasic belts throughout the world characteristically adjoin linear zones of mountain building such as the island arcs. They predominate in island arcs of Tertiary orogeny but are also widespread in older orogenies marginal to continental masses. By virtue of their association with linear tectonics ultrabasic belts are generally elongated.

The Papuan ultrabasic belt forms generally mountainous country parallel to the northeastern flank of the main Owen Stanley Range and is separated from it by a discontinuous valley system occupying a zone along which faulting has been active throughout Tertiary and Quaternary time. This fault zone is a major structural feature and will be referred to as the Owen Stanley fault. It separates the main Papuan mountain system, composed essentially of strongly folded metamorphics of probable Palaeozoic and Mesozoic age, from the younger ultrabasic igneous rocks and overlying unmetamorphosed sediments and volcanic rocks. Movements along this fault zone have contributed to the elevation of the metamorphic mountains on the inland side to heights exceeding 13,000 ft. On the coastal side of the fault, particularly in the ultrabasic country, topographic rejuvenation suggests that general elevating movements are also proceeding, though at a lesser rate than on the inland side of the fault zone. Faceted spur ends facing the Yodda (Upper Mambare) and Waria Valleys suggest that the Owen Stanley fault has been active in Quaternary time, the most recent movements uplifting the inland metamorphic mountains. These faceted spurs also suggest that the fault plane dips at medium angle to the northeast. These relationships are illustrated in the diagrammatic regional section below:



The northeastern margin of the outcrop of the Papuan ultrabasic belt is determined by overlying Tertiary volcanic rocks and marine sediments; thus it is not as regular as the inland fault margin. Pleistocene and recent volcanic activity in the Mount Lamington-Hydrographer Range area has spread a veneer of volcanic ash over much of the ultrabasic country. This ash has been largely removed by erosion, but near more recent volcanic vents and in areas not subjected to severe erosion ash cover still exists. The southeastern extremity of the ultrabasic belt is drained by the Musa River, which flows along the axis of a former major lake. Fresh-water lake sediments, including a coarse gravel formation up to 500 ft. thick, still overlie ultrabasic country, in the area of the deep embayment at the southeastern extremity of the ultrabasic belt.

A wide range of basic and ultrabasic rocks is represented within the ultrabasic belt. The economically important members of the complex are the more basic, non-felspathic facies: the peridotites and pyroxenites. Investigations in other ultrabasic areas containing economic superficial nickel deposits indicate that the nickel content of a fresh rock is closely related to the abundance of the mineral olivine in the rock and that the nickel content decreases sharply in the felspathic facies. This conclusion is supported by the limited ? observations in the Papuan ultrabasic belt. It is therefore economically important that the olivine-rich members of the suite be delineated within the ultrabasic mass. Unfortunately, no system of distribution of petrological facies has emerged from the investigations to date. A lineation suggesting facies zoning roughly parallel to the inland fault margin is apparent in some vertical aerial photographs. Field work thus far has indicated that peridotites and pyroxenites, locally serpentinized, occur at three widely separated localities adjacent to the inland boundary of the ultrabasic zone. The gravel beds of streams draining the centre of the zone contain numerous pebbles of felspathic basic rocks. This may indicate less basic rocks away from the fault margin. Peridotites and pyroxenites are less resistant to stream abrasion, and more susceptible to chemical weathering, than the felspathic basic rocks, and thus pebble assemblages in river gravels may not be truly representative of the country drained. Chemical weathering of peridotites in areas of moderate relief and high rainfall produces a sub-karst type of topography, with a thick soil cover. This feature may be useful in detecting areas of peridotite from aerial photographs. This sub-karst topography is evident on the southwestern flank of the Ajura Kujara Mountains between the Mambare-Chirima River junction and Kokoda, and in the Guava and Owalama Ranges, south of Mount Lamington.

THE ECONOMIC MINERALS OF THE ULTRABASIC AREAS:

The economic minerals usually associated with ultrabasic zones, such as the Papuan ultrabasic belt are, in probable order of importance:

(a) Nickel

(b) Cobalt

(c) Platinum-Osmiridium

(d) Iron

(e) Chromium

(f) Asbestos

(g) Other Minerals.

The usual mode of occurrence of each of the above minerals is discussed below with particular emphasis on aspects of significance to prospecting in the Papuan ultrabasic zone.

(a) NICKEL: Nickel mineralization in ultrabasic zones is essentially of two types, lode sulphides and superficial concentrations due to chemical processes of weathering over nickel-rich primary rocks.

Nickel sulphides are usually associated with iron and copper sulphides in lode systems which extend at depth into unweathered basic and ultrabasic rocks. These sulphide deposits are usually found in the felspathic members of the ultrabasic zones. Approximately 80% of present free world nickel supplies comes from deep mining of sulphide deposits, principally in Canada. No nickeliferous sulphide deposits have yet been located in the Papuan ultrabasic belt, but prospecting has not been directed to this particular type of deposit.

Of more immediate importance locally are the superficial concentrations of nickel which are the products of the weathering and leaching action of rain waters on rocks with a significant primary nickel content (in excess of 0.1%). Free world production from this type of deposit accounts for most of the 20% produced from deposits other than sulphides. These superficial nickel deposits are widespread, generally of low grade, and require costly extraction processes. Many of the deposits are in politically unstable or under-developed countries where the major nickel producers are reluctant to invest the necessary large capital for mining and treatment installations.

Superficial nickel deposits are of two types, lateritic and silicate. These deposits are formed from the same primary olivine-rich rocks by similar weathering agencies. The silicate type of deposit may be regarded as the end product of lateritic weathering (oxidation and subsequent leaching by the agency of carbonated rainwater) under special physiographic conditions. The silicate deposits are characteristically high-grade (3% - 20% Ni), sporadic and localized. Different treatment processes are required for the richer silicates and for the lower-grade lateritic ores. The silicate ores require an arc-smelting process using large scale power development, preferably hydro-electric power, and the laterite ores require a normal smelting process using metallurgical coke. The silicate deposits are concentrations of nickel silicate minerals which accumulate at the base of a residual soil profile and in the zone of open fractures in weathered rock, usually where protected by a soil mantle. Vertical and lateral (down-slope) percolation of rainwaters through residual soils, into which the nickel content of the parent peridotite rock has already been released by oxidation and concentrated by a reduction in volume, produces further concentration by removing nickel in solution to locations where it is entrapped and ultimately crystallizes as various hydrated nickel silicates, usually accompanied by chalcedony. Fractures in the underlying rocks or local variations in profile at the limit of weathering may be loci of silicate deposition. Precipitation of silicates from nickel-rich groundwater reacting with carbonate rocks may also be of local significance.

It is often economical to transport silicate-type ore from several scattered localities to a central processing plant; the economic grade of ore mineable usually being related to accessibility to treatment centres. The Korepa discovery area in the Waria Valley (Lat. 7°54'S. - Long 147°14'E.), is essentially a small silicate deposit overlain by a thin nickel-rich soil profile. The small size of this deposit and its difficult access make it an unfavourable prospect at the present time. However, further successful exploration in adjacent areas could encourage development of local hydro-electric power resources for treatment. Silicate deposits undoubtedly occur elsewhere over the peridotitic members of the ultrabasic belt and search for them should continue.

The more important type of superficial nickel deposit is the "lateritic" type, where large volumes of nickeliferous soils (1-2%Ni) are within reach of open-cut mining methods. The "lateritic" type ore is also formed by the leaching action of acid rainwaters percolating through residual soils over the favourable olivine-rich rocks. Factors contributing to the formation of this type of ore are:

a) Petrology of underlying rocks

b) Topography

c) Climate

d) Vegetation.

(a) <u>Petrology of Underlying Rocks</u>

The underlying rock must be of a type capable of bearing nickel, for it provides the source of weathered concentrates. No primary nickel minerals have been identified in the nickel-bearing ultrabasic rocks, and it is believed that the nickel content of these rocks is contained within the molecular structure of the mineral olivine and possibly to a lesser extent in enstatite and other basic pyroxene minerals. Nickel-rich soils of Cuba and of Dutch New Guinea are formed over harzburgites, an olivine-enstatite rock. Harzburgite has been observed in the Papuan ultrabasic belt but investigations to date suggest that dunites (wholly olivine) and enstatite pyroxenites are more widespread.

The effect of * serpentinization within the peridotites and pyroxenites on the available nickel content of these rocks is at present unknown. Severe serpentinization which induces shearing adversely effects the availability of nickel in the nickel/cobalt prospect areas of Rhynauwen and Ifar near Hollandia in Dutch New Guinea. Serpentinization without shearing does not appear to effect the availability of nickel to the soils in the Ajura Kujara region of the Papuan ultrabasic belt.

b) <u>Topography</u>: The topography must be such that soil is retained to permit the leaching processes to proceed. On the other hand, the topography can be too flat, resulting in very deep weathering and leaching, thus producing very thick, mature lateritic profiles in which the nickel/cobalt content has been concentrated in zones near the base of the profile, leaving the upper section of the profile barren. Such deposits would require more selective and, consequently, more costly mining.

c) <u>Climate</u>: Rainwater is the essential concentrating agency. In areas of high rainfall the leaching processes acting on the soils will proceed faster than in areas of lesser rainfall. However, the same results may be achieved over a longer period with less rainfall. By corollary, the more rapid leaching processes in high rainfall areas will induce nickel/cobalt concentrations in the soils on medium to steep slopes where rate of chemical concentration exceeds the rate of removal of the residual surface soils (after leaching) by erosion. In areas of lesser rainfall, the rate of erosion

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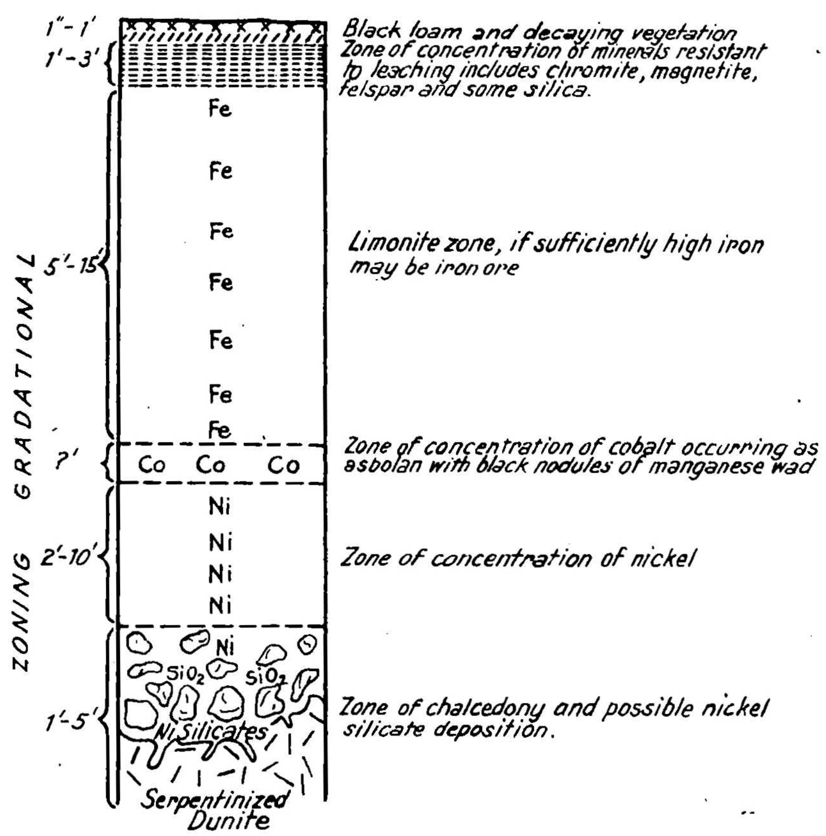
* Serpentinization is a process of alteration peculiar to ultrabasic rocks in which the magnesium-rich minerals alter to a variable mixture of hydrated magnesium silicates known as serpentine. This process is usually autometamorphic but may be induced by contact or dynamic metamorphism.

may exceed the rate of leaching and consequently the soils from the medium to steep slopes will be removed before advanced leaching. Thus, in high rainfall areas prospecting for nickeliferous soils should not be restricted to old peneplain or mature topography remnants, but should extend to all slopes which retain a leached soil mantle.

d) Vegetation: Most of the "lateritic" type nickel deposits which have been explored and exploited in other countries have a very sparse vegetation cover. These areas generally have less rainfall than the Papuan ultrabasic belt. Most of the Papuan ultrabasic belt supports thick rain forest of comparatively small timber. Although this rain forest cover hampers exploration and would add to mining costs, it has served valuable purpose in protecting the steeper slopes from erosion, thus retaining soils for leaching and also in maintaining the percolating rainwaters in a favourable acid condition. The classical conditions of alternating wet and dry seasons for the formation of laterites is not regarded as an essential requirement for the segregation of nickel/cobalt and iron concentrations within leached soil profiles in high rainfall areas with heavy vegetation cover. It is abundantly evident in the Papuan ultrabasic belt that these concentrations have been effected even though the soils are perpetually saturated.

Leaching and concentration by reprecipitation within the soils derived from dunites in the Ajura Kujara Mountains produce the following general zoning pattern:-



This is an idealized profile representing a well advanced stage of leaching. Often the zone of residual resistant minerals is removed by erosion and in other cases portion of the limonitic zone may also be removed. The thickness of the complete profile, as above, is known to range generally from 10 ft. to 30 ft., but it is expected that the profile will be much thicker in areas of gentler topography not yet examined. Only a few analyses for nickel are available and these represent only a small area of lateritic soils derived from serpentinized dunite near Kokoda. These results suggest that nickel values range from .6% at the top of the limonitic zone to 1.2% in the boulder zone near the limit of weathering. These values should provide incentive for more extensive testing.

Smelting of the "lateritic" type of nickel ore may permit the recovery of iron if the limonitic zone has high iron and low silica values. Iron and silica assays are not yet available on samples taken to date. Cobalt is also recoverable from the "lateritic" type ore by smelting.

(b) COBALT: Cobalt occurs with nickel in sulphide lode deposits. It is also invariably present in small amounts in nickeliferous lateritic ore and is recovered with nickel by smelting. The cobalt concentrations usually correspond with a horizon in the soil profile containing soft black nodules of manganese wad with which black cobalt oxide (asbolan) is associated. No quantitative information is available on the distribution of cobalt in the lateritic soil profiles of the Papuan ultrabasic belt, but black nodules have been observed low in most profiles. Cobalt values in similar soils in tested deposits elsewhere range from .02% to .25% increasing with depth, to a maximum located slightly above the zone of maximum nickel values.

Cobalt also occurs associated with nickel in silicate type ores, but its recovery by the silicate arc smelting process is low.

(c) PLATINUM-OSMIRIDIUM: Platinum and osmiridium are usually present with other heavy minerals concentrated in stream courses or in beaches by wave action in the vicinity of the major ultrabasic belts. These metals have been won in conjunction with gold in small scale alluvial (ground sluicing) operations in four of the major streams draining the Papuan ultrabasic belt, namely, the Waria River, the Gira River, the Mambare River and the Musa River. All these streams carry alluvial gold and warrant testing as dredging prospects where they emerge suddenly from the hills into the lowlands.

Platinum and osmiridium probably occur as disseminations throughout the peridotite and pyroxenite members of the ultra-basic suite. However, if any system of zoning of petrological types is detected within the ultrabasic mass, then prospecting for platinum-rich zones in the more basic members should be encouraged.

(d) IRON: Iron is being extracted from Cuban lateritic nickel ores, where it occurs in the limonitic zone that overlies the nickel zone in the lateritic profile. Lateritic soils containing more than 35% Fe are regarded as ore in Cuba. No quantitative results on the distribution of iron in the soils of the Papuan ultrabasic belt are available, but an iron-rich zone is qualitatively indicated. Silica has also been observed in the limonitic zones in the Papuan ultrabasic leached soils, but until quantitative information is available, the effect of this silica on the potential of the local limonitic zones as iron ore can not be assessed.

(e) CHROMIUM: Chromite is invariably associated with peridotites and pyroxenites. In all streams draining the Papuan ultrabasic belt it may be observed as a heavy natural concentrate. Chromite is also a heavy constituent of heavy mineral concentration in beach sands on the northeast coast of Papua. At Koreppa in the Waria Valley, lumps of chromite up to 3 inches across were found on the lateritic surface with the residual minerals which resist leaching processes. In all the known peridotite areas fine-grained chromite occurs as a residual concentrate on the surface of the soils.

Chromite commonly occurs as massive, pod-like segregations, as fracture-filling lode systems, and as stratified deposits in ultrabasic zones throughout the world. Chromite has not received serious prospecting attention in the Papuan ultrabasic belt and the current market price for this mineral does not provide the necessary incentive.

(f) ASBESTOS: Chrysotile asbestos may be expected to occur in association with serpentinized peridotite and dunite in the Papuan ultrabasic belt. Chrysolite veinlets have been observed in specimens of serpentinized dunite from the Didana Range, at the eastern extremity of the ultrabasic belt. Boulders containing chrysotile asbestos have been observed in the Waria, Mambare and Musa Rivers, but to date no interesting concentrations of asbestos have been located in situ.

(g) GOLD AND OTHER MINERALS: Alluvial gold has been won from all major streams draining the Papuan ultrabasic belt. A gold-bearing quartz-chalcopyrite vein with a maximum observed width of 3" has been seen in sheared enstatite pyroxenite bedrock exposed by the Waria River not far from the Koreppa nickel silicate locality. This occurrence is of no immediate importance, but it does indicate that both gold and copper mineralization has taken place along shear zones in the ultrabasic belt, and similar occurrences, yet to be discovered, may exist.

The source of alluvial gold in the Gira, Mambare, and Musa Rivers has not been recorded, but there is little doubt that it comes from late mineralization within the ultrabasic zone.

HYDRO-ELECTRIC POWER POTENTIAL:

Discussion of the economic potential of the ultrabasic belt would not be complete without reference to the availability of hydro-electric power potential.

Detailed statistics are not available on rainfall and water flow in the area, but major streams drain the Owen Stanley Range (average height 12,000 ft.) and the adjoining ultrabasic mountains (peaks up to 7,000 ft.) and spill on to the coastal alluvial flats within 40 miles. The principal streams which could be developed for hydro-electric power are the Waria River (New Guinea), the Mambare River (Papua) and the Musa River (Papua). Of these, the Musa River appears to provide the most economical scheme for large-scale power development, though it is not centrally located within the ultrabasic belt. The Mambare River is centrally located and has a large power potential, but its development may present engineering difficulties.

CONCLUSION:

The Papuan ultrabasic belt provides a good prospecting field for both lateritic and silicate type nickel ores. It also has possibilities of producing cobalt and iron as a by-product of lateritic nickel mining. Deposits of platinum, osmiridium, asbestos, chromium, gold, and copper may be located in the course of prospecting.

There are local difficulties, probably peculiar to Papua and New Guinea, which will adversely affect large-scale prospecting and development. These difficulties include, particularly, the high rainfall which would reduce the rate of coverage by prospecting parties, hinder open-cut mining operations, and increase road building and maintenance costs. Heavy vegetation cover also retards prospecting progress and geological mapping and, in the event of large-scale mining of lateritic soils, removal and disposal of rain-forest cover would increase mining costs.

Access to natural harbours from the Papuan portion of the ultrabasic belt would require at least 30-50 miles of road building in high rainfall country. In the New Guinea section of the ultrabasic belt, harbour sites are closer but access would still present difficulties.

However, despite these difficulties, this area is worth closer investigation for possible large-scale mining prospects which, with the advantage of nearby large hydro-electric power potential, might be economically developed.

ACKNOWLEDGEMENTS

The writer has benefited from discussions with Dr. D.R. de Vletter of the International Nickel Company of Canada during his recent visit to Papua-New Guinea. Dr. de Vletter readily provided much information on the occurrence, mining and treatment of Cuban lateritic nickel ores, beyond the scope of his published report.

Useful information was also obtained during a recent visit to the nickel/cobalt prospecting areas near Hollandia, Netherlands New Guinea, where Mr. C. Soutendam of the Mines Division of the Netherlands New Guinea Administration freely discussed the results of extensive nickel/cobalt prospecting.

Information from both these sources has been particularly valuable, as access to overseas literature on this subject has been difficult to obtain.

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APPENDIX I

Some Hints for Nickel Prospectors

The following brief notes may assist the prospector in the recognition of geological conditions favourable for the formation of superficial nickel deposits and in the identification of the important nickel supergene minerals.

The olivine-rich plutonic rocks are the principal donors of soluble nickel salts for concentration by groundwater movement within soil mantles. The olivine when fresh is green and glassy; under tropical high rainfall conditions it weathers rapidly to limonitic soils, which vary in colour from yellow to red. Most boulders of olivine-rich rocks where exposed to weathering action have a margin of light-brown decomposition products which grades inwards into the dark-green fresh colour of the rock. A process known as serpentinization alters fresh glassy olivine completely or partially to serpentine, which on a fresh surface is dull, greasy, light to dark green, and soft. Serpentinization does not usually adversely effect the nickel available for release to overlying residual soils, except where the serpentines are strongly sheared and faulted.

The nickeliferous residual soils are fine-textured mustard-yellow to dull red clays, and unfortunately, except under the microscope, are similar to residual soils derived from many other rocks under tropical conditions. The only sure method of determining the presence of significant nickel content in the soils is by qualitative chemical tests. A simple field test for nickel is described in Appendix II of this report. Outcrops are usually scarce in areas of thick soil cover and field nickel testing of the residual soils, below the surface loam horizon, is a good method of delineating underlying olivine-rich rocks.

In outcrops, excavations, or auger sampling in ultrabasic country a light green fracture filling or encrustation mineral may be observed at the base of the soil profile, or in partially weathered rock. This green mineral may be one of the nickel silicate group (garnierite) and its identification should encourage closer search for economic accumulations. All such green fracture fillings and encrustations should be tested for nickel by the field test recommended.

A dull brown amorphous mineral is often associated with the green nickel silicates. This may be a nickel-bearing serpentine such as the "chocolate ore" which is mined with garnierite in New Caledonia. This nickel-bearing serpentine has been noted in the Koreppa area in the Waria Valley.

In the course of sampling by augering through residual soils, one or more horizons containing soft bluish-black nodules may be traversed. These nodules are essentially manganese oxide with which cobalt oxide is often associated. Such zones may warrant assaying for cobalt.

APPENDIX II

Field Testing for Nickel

Field identification of nickeliferous soils and nickel minerals is a necessity for intelligent prospecting. The method for chemically identifying nickel, described below, has been used with success during prospecting in the Papuan ultrabasic belt. The time and trouble of carrying out chemical tests as prospecting progresses will not be wasted. It is impossible to distinguish barren from nickel-rich soils by any known physical features and green serpentine may easily be mistaken for nickel silicate minerals.

CHEMICALS AND EQUIPMENT:

In field testing for nickel the following chemicals are required:

Concentrated hydrochloric acid	These are dangerous corrosive liquids and care must always be observed in storage and handling.
Concentrated nitric acid	
Ammonia	

Alcohol

Dimethylglyoxime powder

Litmus paper

The minimum equipment necessary includes:

Pyrex test tubes

Filter funnel

Filter papers

A source of heat, either a primus or campfire

PROCEDURE:

A small quantity of "aqua regia" is first prepared by adding three parts of concentrated hydrochloric acid to one part of concentrated nitric acid. A small quantity of mineral or soil to be tested is added to about twenty times its volume of "aqua regia" in a pyrex test tube and boiled until brown fumes are no longer expelled. The solution and residue is then cooled and diluted to twice its volume with water. Litmus paper is inserted, then ammonia is added slowly with stirring until the litmus paper turns blue. At this stage, in the case of lateritic soils, a flocculent brown precipitate of ferric hydroxide will be formed. This may conceal the litmus paper, in which case ammonia should be added until the odour of an excess can be detected in the test tube. Any precipitates formed on adding ammonia are filtered off and discarded. The filtrate may now be tested for nickel by adding a small quantity of dimethylglyoxine solution in alcohol which has previously been prepared by adding the white dimethylglyoxime powder to alcohol and shaking until no further powder dissolves. If significant nickel (more than 0.5%) is present, then a bright red fluffy precipitate will form immediately.

Small quantities of samples and reagents should be used to conserve stocks of chemicals. The reaction is very sensitive and trace quantities will be indicated by a red colouration rather than a precipitate.

The silicate minerals are more difficult to dissolve in "aqua regia" than the lateritic soils and require fine crushing and possibly longer boiling in the acid.

With experience, and by using roughly constant amounts of sample and reagents, high nickel values (1.5% - 2.0%) may be distinguished from medium values (.05% - 1.0%) which in turn may be distinguished from trace or negative values. Such information in the field is of importance both in planning further prospecting and in deciding which samples warrant more accurate assay.

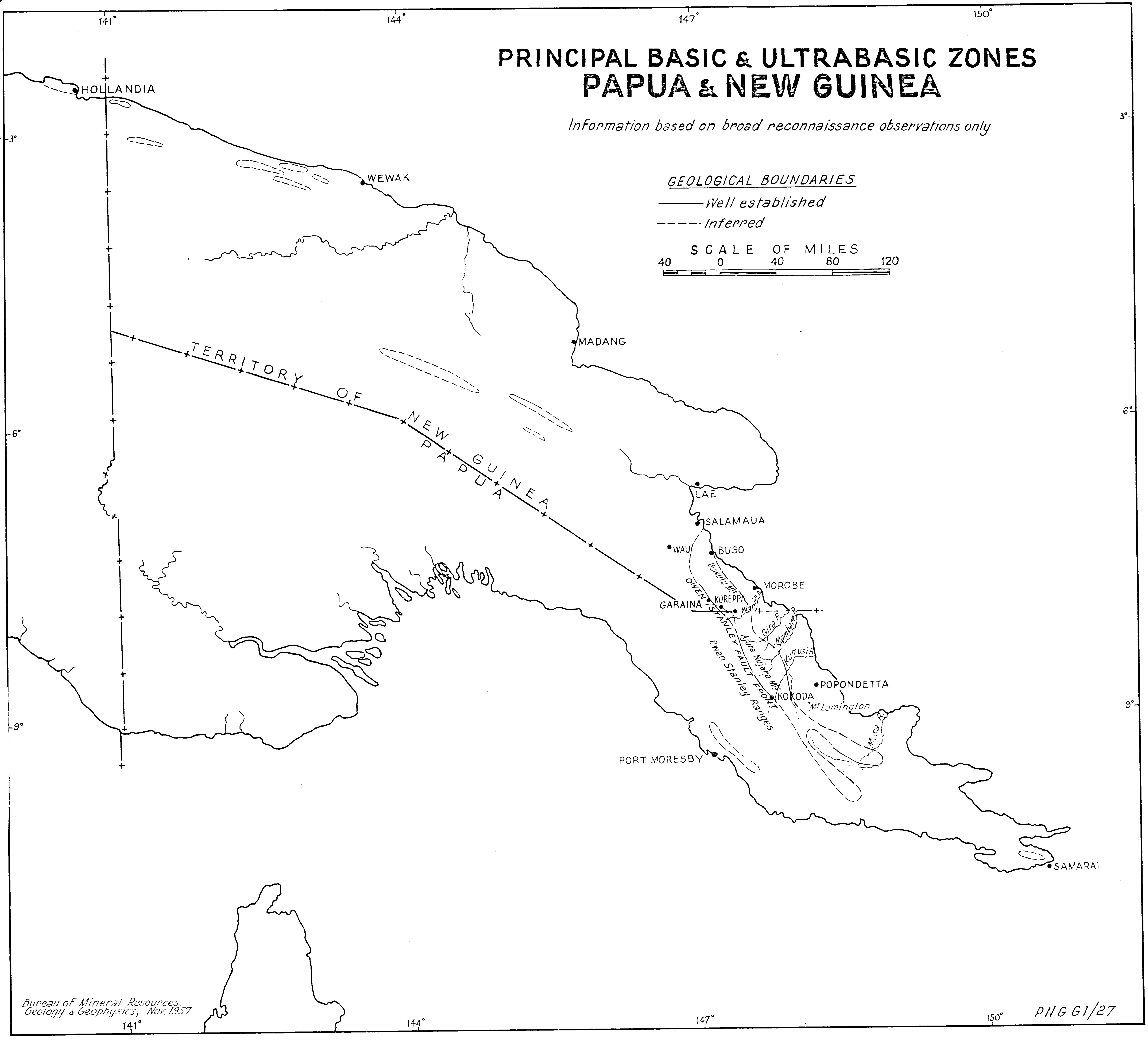
APPENDIX III

Sampling Equipment For Nickeliferous Soils

Manually operated 4 inch diameter soil augers of the "Jarrett" type, readily obtainable in Australia, have proved satisfactory for reconnaissance sampling of nickeliferous soils in the Wariā Valley and in the Ajura Kujara Ranges. This type of equipment is more effective than spiral augers in the wet clayey soils of these areas.

Detailed testing may require light-weight power-driven drilling equipment to penetrate partly decomposed boulders low in the soil profile and to enter into the zone of open fractures in the underlying rocks where nickel silicate accumulations may be expected.

Lateritic soil samples from the Papuan ultrabasic belt are usually water saturated. Wet samples should not be stored in cloth sample bags because of the rapid growth of mould which ultimately rots the bags. Plastic sample bags may be more effective. Ideally, samples should be dried and reduced by quartering in the field, thus reducing the volume of samples to be transported to base camps and ultimately to assaying centres.


PRINCIPAL BASIC & ULTRABASIC ZONES
PAPUA & NEW GUINEA
Information based on broad reconnaissance observations only
GEOLOGICAL BOUNDARIES
Well established
Inferred
SCALE OF MILES
40 0 40 80 120
141°
144°
147°
150°
3°
6°
9°
HOLLANDIA
WEWAK
MADANG
TERRITORY OF NEW GUINEA
PAPUA
LAE
SALAMAUA
WAU
BUSO
MOROBE
GARAINA
KOREPPA
OWEN STANLEY FAULT FRONT
Owen Stanley Ranges
Bowutu Mts
Waria R
Gira R
Mambare R
Kumusi R
Ajura Kujara Mts
POPONDETTA
KOKODA
Mt Lamington
Musa R
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SAMARAI
Bureau of Mineral Resources, Geology & Geophysics, Nov. 1957.
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