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A GEOLOGICAL RECONNAISSANCE OF THE UPPER SEPIK-AUGUST RIVER AREA SEPIK DISTRICT, NEW GUINEA

by

W.J. Perry.

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CONTENTS

SUMMARY

Reconnaissance geological surveys of the Enterprise of New Guinea Company's Permit No. 21 in the Sepik District in 1954 and 1955 have shown that the area is occupied for the most part by metamorphic rocks. The West and Landslip Ranges form a metamorphic-plutonic complex possibly of Palaeozoic age, and the rocks of the upper August, upper Sepik and Hoffnungs Rivers are low grade metasediments, predominantly slates, phyllites and quartzites which are tentatively correlated with the Mesozoic rocks near Telefomin.

The isolated outcrops of sedimentary rocks, largely impure sandstones or greywackes, and siltstones, are restricted to a narrow strip 200 square miles in extent on the western side of the permit between the West Range and the Dutch border. The southern part of this area is considered to be a fault trough. The sediments range in age from Palaeocene to Pliocene, but neither the total thickness nor the subsurface structure can be adequately assessed from the scattered outcrops.

Oil prospects are not encouraging owing to the lack of suitable surface structures, the unknown thickness of sediments and the fact that these rocks are probably of generally low porosity and therefore not particularly suitable as reservoir rocks. However if the Company wishes to do further work in the area, a geophysical investigation, preferably by gravitymeter, should be carried out to ascertain the configuration of basement and the sub-surface structure of the sediments.

INTRODUCTION

General

This report presents the result of a geological reconnaissance survey carried out in the Upper August-Sepik river area during the period from July to November 1955. It also incorporates the findings of the preliminary survey in 1954 (Perry, 1955). Work in the 1955 season was done by Company geologists Messrs. S.J. Paterson and D.H. Probert, and by the writer. Dr. E.K. Sturmfels, Consulting Geologist to the Company, visited the party for three weeks from the middle of October.

The Company intended to move in to the area in May, that is, after the wet season but before the time of very low water. Unfortunately the Company's new river-boat "Henrietta" was severely damaged in a cyclone off the northern N.S.W. coast while en route for New Guinea, and all cargo had to be off-loaded and sent on by coastal steamer to Madang. This caused considerable delay and it was August 7th before all cargo had been transported to the store camp at the mouth of the August River. An indication of the state of the river can be gauged from the fact that whereas last season the charter vessel "Winon" (draught when loaded 6 feet 6 inches) was able to proceed to the October River 7 miles upsteam from the August River, on this occasion the same boat had to discharge her cargo some 40 miles below the August mouth, necessitating a number of extra trips by the smaller Company boat "Tiare" (draught when loaded 5 feet 6 inches) to bring it to the store camp.

As the area under investigation is uncontrolled, the party was accompanied by Patrol Officer M. Brightwell of the Department of Native Affairs, and ten native police. About 100 native labourers were recruited from the Lower Sepik River and from Madang, and were under the supervision of Mr. E. Harridge. Maintenance and repair of outboard motors and other engines was carried out by Mr. J. McGrath, and Mr. W. Brelaz acted as caretaker on the "Tiare" which remained at the storecamp for the greater part of the survey. The transportation of stores to forward camps by powered canoe was carried out mainly by Messrs. McGrath, Paterson and Harridge, though all members of the party took part in this work at various times. Owing to the generally low water level obtaining, much difficulty was experienced, and powered craft could be used only immediately after the infrequent river rises, with the result that the Labin base camp site was not reached until September 28th.

For the sake of completeness a description of general conditions obtaining in the area, though dealt with in the preliminary report, is again included.

Situation and access

The Petroleum Prospecting Permit No.21 is a rectangular block whose north-western corner lies at the intersection of latitude 4 degrees South and longitude 141 degrees East; from this point the boundary extends 30 miles east, thence 55 miles south, thence 30 miles west to the 141st meridian, which forms the western boundary, the enclosed area being 1650 sq. miles.

Access to the area is difficult but can be gained by air from Wewak or by water from the mouth of the Sepik River. Norseman aircraft (pay load 1800-2000 lb.) from Wewak can land at Green River airstrip, about four hours walk from the Hauser-Sepik confluence. There is no regular service to the Green River Patrol Post, but aircraft can be chartered when required. Flying time from Wewak is approximately one hour twenty-five minutes. Heavy material can be shipped by coastal vessel to Angoram, thence by shallow draft work-boat up the Sepik to the August River which provides the access to the eastern and southern parts of the permit area. The journey from Angoram to the mouth of the August River takes about ten days.

This year it was found that more powerful outboard motors were necessary in the fast water of the upper August, and the most efficient rig for river transport was a broad single canoe about 35 feet long with a capacity of 2,000 lb., powered by one Johnson 25 h.p. motor. A special fibre-glass boat 18 feet long, powered by a 21 h.p. engine was bought by the Company especially for river work under difficult conditions, but unfortunately its performance was far below requested specifications and it could not be used with success south of Gwin Camp. Powered double canoes and dinghys and paddled canoes were also used in transporting stores and equipment and personnel to the Labin base camp.

Climate

The climate in the low lying parts is warm and wet, but near the southern foothills the nights are mild; the wetter months are from December to April. A record of daily rainfall, maximum and minimum temperature and humidity was kept during the 1955 field season. (Appendix 1). Humidity is fairly high, and optical instruments should be kept in airtight containers with a dehydrating agent to prevent the formation of fungus growths on lenses.

Vegetation

The whole area is thickly timbered, with the exception of the long grass-covered gravel strip on which Green River Patrol Post is situated. The plain country adjacent to the Sepik and August Rivers is subject to periodical flooding and is covered with swamp forest. This is characterised by fairly thick undergrowth of vines and rattans with sac-sac (sago) in places close to the rivers and pit-pit (bamboo-grass) along the banks generally on the side opposite to the river channel. Movement through swamp forest is greatly hindered by the undergrowth, and tracks have to be cut in most places. The foothills and higher country are covered with lowland and mid-mountain forest and again it is necessary to cut tracks except on the rare native pads.

Food Supplies

All European food has to be brought into the area.

Foodstuffs such as sago, bananas, taro and sugar cane are grown by the local natives in places, but are not plentiful and cannot be depended on to supply more than a small fraction of requirements for a labour line. Owing to the difficulty of river transport and the resulting delay in getting native rations to the base camp during the 1955 season, it was found necessary to have an air drop of about 4,500 lb. of rice in November at a site adjacent to the Labin camp.

Game is not plentiful, though wild pigs, possums, wallabies, pigeons, hornbills and crocodiles are found. Fresh water fish can be caught in the Sepik and its larger tributaries.

Natives

Population is sparse throughout the area and the local natives though friendly, are unreliable as carriers. Interpreters from the villages near Green River can be used throughout the August-Sepik plain but they cannot converse with the hill people of the West Range or the upper August River. Three Telefomin interpreters accompanied the party in 1955, but they also did not understand the language of the hill people. Despite this it was possible to trade with the bush natives, buying wild pigs and meagre supplies of taro for beads, matches, razor blades, tomahawks and the like. Other bush natives were seen in the Hoffnungs River valley, but no contact was made with them.

Communications

Several transceivers of various types were used to keep the forward parties in touch with store camp, Green River and Wewak. Mail from Wewak was delivered at Green River on the irregular charter flights, and contact between the party and Green River was maintained by sending a small party of natives when required.

Survey Method

Outcrops in the area are confined for the most part to stream courses which were mapped by pace and compass at a scale of 1:20,000. The navigable streams were mapped by the time and compass method and the scale of the plot adjusted in some places by reference to latitude-longitude determinations carried out by the Company Surveyor and in other places by comparison with the scale of Schultze's original survey.

Air Photographs

Two trimetrogon runs of the south-western part of the area were available. Vertical coverage afforded by these runs is indicated on the map by the centre points of the vertical photos. The quality of the prints is poor and at the time the photos were taken cloud obscured much of the ground; however a west-plunging syncline was mapped from the southern vertical run and the course of part of the August River was verified.

GEOLOGY

Previous Work

Before the Enterprise Company's surveys, no primarily geological work had been done in the area (with the possible exception of Hubrecht's work - Hubrecht 1913).

The first expedition to visit the area was led by Dr. Leonard Schultze in 1910 for the purpose of surveying the then German Territorial Boundary (Schultze, 1914); the party travelled up the Sepik River as far as the Drei Zinnen (Three Pinnacles) in latitude 4 degrees 48 minutes south. The few geological observations made were confined to rare outcrops and to boulders in the stream bed. Boulders and gravel of highly metamorphosed rocks were reported in the river west of 142 degrees east, and particularly between 4 degrees 15 minutes and 4 degrees 38 minutes south latitude.

A Dutch military expedition which explored the northern part of Dutch New Guinea during the years 1911-1913 appears to have reached the upper Sepik, coming from the west, but it is not known whether any geological work was done (Hubrecht, 1913).

Schultze's work was followed up in 1912-13 by Dr. Behrmann, who with a large and well organised expedition mapped most of the Lower and Middle Sepik and its tributaries, but did not penetrate beyond longitude 141 degrees 12 minutes east. Dr. Thurnwald, an ethnologist attached to the expedition, remained in the area until 1914 and went to the Middle and Upper Sepik, penetrating as far as the Telefomin valley in September 1914.

Zwierzycki (1927) published a geological map that shows Neogene, Jurassic, undifferentiated Mesozoic, and crystalline schist along the Upper Sepik River.

In 1927-28 Karius and Champion, Officers of the Papuan Administration, on their crossing of New Guinea walked down the Sepik from its source to a point on the Dutch border from which they started to raft. Karius (1929) reported that a metamorphic slate-like stone predominates in the upper reaches of the Sepik and also that diorite is present.

The next Europeans to visit the area were the personnel of the prospecting expedition led by J. Ward Williams in 1935-36 (Campbell, 1938). Besides examining the headwaters of the Sepik, they prospected the Brücken and Hoffnungs Rivers, but reported finding only limestone gravel and black shale. In the January (August) River about one mile north-east of the Sepik-Hoffnungs junction, good gold prospects were reported in surface wash, but no payable gold was discovered. The party followed the January to its head and crossed the divide of the Landslip Range into the south-west branch of the May River; no gold was found and no geological observations were made.

In 1950 a patrol from Telefomin led by Patrol Officer West reached the Nong River coming from the south, crossed the divide into the Sepik and returned to Telefomin up the Sepik River. West reports passing over limestone on the outward journey until he reached the Nong River where there was mudstone and shale; this predominated in the Sepik also, until limestone was again met with at a point several miles downstream from the Clear River junction.

Physiography

Broadly the area may be divided into three parts:- the plain of the Sepik and August Rivers on the west, the West Range and Landslip Range on the east, and in the south the foothills of the Star Mountains and the Thurnwald Range.

From east to west the plain ranges in width from over 20 miles in the north of the permit area to about 7 miles where the Sepik emerges from the foothills. The plain tract is characterised by swamp forest and much of it is inundated at times during the wet season from December to April. For about 20 miles downstream from its point of emergence from the foothills, the Sepik has a generally straight course with braided channels among extensive gravel banks characteristic of an aggrading valley plain. This course seems to have developed within the last 45 years for it is apparent from a comparison of Schultze's map with the air photographs that his survey party in 1910 came up what is now only an anabranch of the main river. Though this anabranch is now confined to a narrow channel, a photo study of the heights of surrounding trees indicates that it formerly occupied a much broader braided strip comparable in width to the present course. Downstream the main channel becomes well defined with shelving scroll gravel banks on the inside of bends and steep banks on the outside. The structural depression of the

Sepik was formed probably in the Pleistocene (Beltz, 1944) and the present swampy nature of the country indicates that slow sinking is still going on. Within the plain on the eastern side, volcanic rocks form low hills up to about 600 feet above the plain, isolated from the plutonic-metamorphic mass of the West Range. Horn Hill, about 1000 feet above sea level, is cone shaped and was probably a focus of eruption for the surrounding andesite. The plain south of this between the two rivers is traversed by stream channels through which water can pass from the Sepik to the August in times of high flood. This is thought to be the way in which fossiliferous limestone and siltstone pebbles found their way on to gravel banks in the August near Wogarabei Creek and further downstream. In the south-west of the plain in lat. 4 degrees 30 minutes South the sediments form low ridges separated from the high metamorphic hills further west by a strip of alluvium over a mile wide.

The West and Landslip Ranges constitute a much dissected area of high relief. According to the Four Mile Military Map, spot heights range up to 6,800 feet with many above 3,000 feet. So little is known about the main part of the Ranges that the relationship of the physiography to the structure is not clear. The air photos available extend only to the western part of the West Range, and the only structure visible is an anticlinal mountain probably composed of metamorphics round an igneous core at approximately 4 degrees 26 minutes south, 141 degrees 10 minutes east.

The foothills of the Star Mountains and Thurnwald Range constitute a rugged deeply dissected area drained by the Hoffnungs, Brücken and upper Sepik Rivers. These are rapidly flowing streams of great transporting power. Their pattern seen in the air photos suggests that they are strike streams subsequent on a west plunging syncline and its complementary anticline to the north. However, traverses up the Sepik and Hoffnungs Rivers showed that no anticline is present but that these streams cut through metamorphic rocks whose structure bears no obvious relation to the stream pattern.

STRATIGRAPHY

PRE-TERTIARY

Metamorphic rocks

The oldest rocks in the area are the metamorphics, which can be divided into two groups; the plutonic-metamorphic complex of the West and Landslip Ranges, and the tightly folded metamorphosed sediments of the upper August, upper Sepik and Hoffnungs Rivers. Further field work may make it possible to place a definite boundary between these units, possibly to the north of the upper August River, as indicated on the map by a colour boundary.

The West Range metamorphics are more highly metamorphosed than the rocks of the August, Sepik and Hoffnungs Rivers, and include biotite schist, sillimanite schist, garnet gneiss and gneissic granodiorite. The petrography of these rocks has been described by R.D. Stevens (1955).

No petrographic study of the rocks of the August, Sepik and Hoffnungs Rivers has yet been made, but field examination indicated that they derive from the low grade regional metamorphism of both pelitic and psammitic sediments. The dominant rock types present in the upper Sepik and upper August Rivers are blue-grey slates and phyllites, and these also occur locally in the Hoffnungs River. Bedding is shown here and there by thin layers of silt half and inch or so apart in the otherwise smooth slate surface; the foliation is at a slight angle to the bedding, giving the rock a banded appearance on foliation surfaces. In many places, barren white quartz veins ranging in thickness from a fraction of an inch to 12 inches, intrude the slate, usually parallel to the foliation, but in places transgressive, and some veins have been dislocated by subsequent movement. Much of the slate and phyllite contains small crystals of pyrite, probably an original constituent of the sediments.

Gravel banks in the upper August contain pebbles of white quartz, blue-grey phyllite and slate, green tuff, hornblende porphyry, rhyolite and slightly metamorphosed pyritic black siltstone. Careful search failed to reveal any limestone pebbles, and it is concluded that those found in 1954 close to Wogarabei Creek came from the Sepik River.

In the Hoffnungs River the dominant rock type both in situ and in stream pebbles is a light grey metaquartzite. Other rocks in place are chlorite schist, quartz-sericite schist, and graphitic slate. In one place quartzite was seen interbedded with black slate. The stream gravels are largely of quartzite with about ten per cent of granodiorite.

The age of the metamorphic rocks is not known. They are certainly pre-Tertiary, but apart from this fact there is no definite evidence of their age. On the basis of regional metamorphic grade, by comparison with the pre-Permian Omung Metamorphics (Rickwood, 1955), it is thought that the West Range rocks may be Palaeozoic and the low grade metasediments of the upper August, upper Sepik and Hoffnungs Rivers Mesozoic. If this is so, then the latter could be the metamorphosed equivalents of the Jurassic and Cretaceous rocks of the Telefomin area. Sykes (1954) mentions that the Mesozoic rocks are slightly dynamically metamorphosed in the vicinity of the Donner River and it is possible that the sediments were more strongly metamorphosed further west. Also the rocks exposed in the southern part of the permit area are some 3,500 feet lower relative to sea level than the Telefomin rocks and thus had so much more cover at the time of metamorphism. A situation that may be analogous to the above occurs in eastern New Guinea, where the unmetamorphosed Cretaceous sediments of the Wahgi Valley disappear under a Tertiary cover and are found further east in the Morobe district as the Kaindi Metamorphics.

On the other hand it is possible that the rocks of the upper August, upper Sepik and Hoffnungs Rivers are pre-Jurassic, and further field work is necessary before the correct relationship can be definitely established.

Igneous intrusive rocks

The schists of Tai Creek are intruded by grey biotite granodiorite dykes with finely gneissic structure, which possibly indicates post-emplacement metamorphism. (Stevens, 1955). Further south, east of Horn Hill is grey granodiorite that forms a spur of the Landslip Range. Its contact with the metamorphics was not seen, but it is probable that it is intrusive. It is not gneissic in the hand specimen so it may be later than the Tai Creek granodiorite.

One mile south of Labin camp diorite intrudes the sericite schist of Tsimo Hill; on either side of the diorite separated from it by soil cover are fine grained greenish rocks that may be marginal modifications of the diorite. If this is so, the intrusion is probably a broad dyke about 300 feet wide.

On the left bank of the Sepik four miles in a direct line north-north-east of the August River mouth is an isolated outcrop of a weathered porphyritic igneous rock (AA.120) that Behrmann (1917) described as a porphyritic quartz-hornblende diorite.

Isolated from the West Range in the alluvium three miles south-east of astro' station No.6 is a small hill of hypersthene gabbro (AA16). This shows no sign of metamorphism and it is therefore probably later than the Tai Creek granodiorite.

The age of the intrusive igneous rocks is considered to be pre-Tertiary.

TERTIARY

Palaeocene

Of the sedimentary rocks the oldest are found 8 miles west of Mountain Gate. Here there is a thickness of approximately 3,000 feet of calcareous fine to coarse greywacke, sandstone, pebbly sandstone, siltstone and mudstone. Exposures are poor and the section is probably affected by strike faulting. Two samples (AA.99,100) collected from the mudstone contain abundant derived Upper Cretaceous (Maastrichtian) foraminifera together with lower Tertiary (Palaeocene) forms; other samples contained only poorly preserved fossils, with the exception of a dark grey calcareous siltstone (AA.107) near the top of the section close to a postulated fault. This contains an assemblage characteristic of the Pliocene "h" stage and is probably faulted down into the older material. The foraminiferal assemblages have been described by Crespin and Belford (1956). The source of the derived Upper Cretaceous is not known, but it is probable that they come from the west; much of the section contains detrital material including rounded pebbles of igneous rock, schist, limestone, and black slate indicating deposition near the shore line. The sediments form a low range of hills about 1½ miles wide trending west of north; to the west they disappear under the alluvium. One mile further west is a higher range of metamorphic rocks. There is no direct evidence of the nature of the contact between the metamorphics and the sediments, but it is a fault contact further south-east, and is assumed to be the same here.

Lower Miocene Tf

At Mountain Gate, Schultze's anabranch cuts through a low range exposing calcareous greywackes on either side of the stream. On the west side fine calcareous greywacke can be seen in places around Worta Hill; the general dip is to the west at 40 degrees, the exposed thickness being 1750 feet. Near the stream is medium to coarse greywacke with patches of fine conglomerate grade containing granules of volcanic and possibly metamorphic rocks and in places coal fragments. In one place the greywacke contains fragments of cream limestone with derived "e" stage foraminifera (AA.44). Other samples yielded poorly preserved "f" stage foraminifera and the age of the rocks is probably "f" stage. A calcareous greywacke (AA.45) from the east side of the anabranch probably belongs to "f" stage. If this is continuous with the Worta Hill sediments the total thickness present is 3,150 feet. To the east the sediments are overlain by volcanic rocks and though no contact is exposed it is thought that the volcanics were extruded after the folding of the sediments.

Lower Miocene Tf_1-f_2

Half a mile down the Boye anabranch from its junction with the August River is Napsi Hill, an isolated cuesta composed of white to pale pink partly recrystallised foraminiferal algal limestone rising about 200 feet above the alluvium. The limestone beds are from six inches to one foot thick and dip 30 degrees in the direction 280 degrees forming a prominent dip slope. The eastern side of the hill has an almost vertical face trending about 30 degrees east of north; it is probably a fault line scarp. The thickness exposed is 105 feet and the age determined from foraminifera is "f_1-f_2" stage.

Middle Miocene Tf_3

In the banks of the West River there is a sequence of siltstone, calcareous siltstone, sandstone and fine to pebble conglomerate with metamorphic pebbles. The section is affected by strike faulting and no reliable estimate of the thickness exposed can be given. The sediments are characterised by arenaceous foraminifera which belong to the f_3 stage of the Indo-Pacific Classification. (Crespin and Belford, 1955).

Upper Miocene Tg

A probable thickness of nearly 3000 feet of grey siltstone dipping east and south-east is exposed in the banks of the October River about 13 river miles from its junction with the Sepik. The outcrops are not continuous though this has been assumed in computing this thickness. The siltstone in places is micaceous and contains carbonaceous fragments. Further upstream it is not certain from the attitude of the rocks whether the river cuts through a broad north plunging fold or through a number of fault blocks. Dips are normally gentle but in places range up to 70 degrees, so it is probable that faulting is present, though none was seen. On the other hand, the steep dips may be due to a pseudo-diapiric fold. Rocks present include interbedded siltstone and medium grained sandstone, pebble conglomerate with igneous pebbles, medium grained calcareous sandstone and calcareous siltstone. At the limit of the traverse the stream gravels were found to be predominantly of metamorphic and igneous origin, which may indicate that the October River heads in the Border Mountains where such rocks are known to outcrop. Of the samples collected only AA.176, 179 and 181 were fossiliferous and these contained foraminifera characteristic of the Upper Miocene "g" stage (Crespin and Belford, 1956).

Five miles west of Zweifel Gorge along the foot of metamorphic mountains conglomeratic greywackes containing lenses of coal, quartz sandstones and carbonaceous mudstones have been reported by E.K. Sturmfels, the Company's Consulting Geologist (personal communication). All the sediments are much folded and faulted, showing dips up to 60 degrees but they are not metamorphosed. Exposures are poor and the only formation that could be measured was 650 feet plus of black carbonaceous mudstone (AA.144), which contains a rich "g" stage assemblage. The mountains are of metamorphic rocks, mostly chlorite schists, graphite schists and quartzites, and in places the dip of the sediments is towards the metamorphics. Sturmfels considers that the sediments are separated from the metamorphics by a major fault, and that the sediments themselves are broken into fault blocks.

Four miles north of the Hauser-Sepik confluence at Dio Village, is approximately 120 feet of sub-horizontal greenish grey siltstone containing abundant pelagic foraminifera. This rock also belongs to the "g" stage of Indo-Pacific Tertiary stratigraphy.

Plio-Pleistocene?

Volcanics. Augite andesite outcrops in a steep narrow ridge up to 400 feet high trending south from Tai Creek Camp (astro' station No.6); the rock is massive, greenish, with radiating aggregates of small zeolite crystals in places; it is probably tuffaceous in part. In the right bank of the August River nearly half a mile north-north-east of Tai Creek Camp there is an outcrop of very weathered fine-grained greenish massive rock that may be andesite. About one mile east of Napsi Hill are low ridges that appear to be continuous with the Tai Creek volcanic rocks; two ridges were encountered on a traverse of Boye Creek; the rock on the western one was so weathered that it could not be positively identified but definite volcanics were found on the eastern ridge. Similar rock was found half a mile south-east of Gwin Camp.

The largest development of volcanics is found round Horn Hill. This is a cone shaped peak rising about 650 feet above the plain, surrounded by ridges of andesitic and basaltic lavas of a general level of 600 feet. At Mountain Gate boulders of andesite and porphyry are found deriving from above the west dipping Lower Miocene greywacke. No contact was seen but it is thought that the volcanics were erupted after the folding of the sediments. It is suggested that Horn Hill, probably the focus of eruption, is located on a north-trending fault.

Volcanics are found along the foot of the metamorphic hills to the west of Zweifel Gorge; they are thought to be associated with a west-trending fault. The boulders of basalt found in creeks draining east into Zweifel Gorge 200 to 300 feet above river level possibly belong to an earlier eruptive phase.

The Horn Hill volcanics are definitely post-Lower Miocene since they overlie "f" stage sediments at Mountain Gate. Similar volcanic rocks are found just west of Zweifel Gorge where they are thought to be associated with the continuation of a fault that disrupts Upper Miocene sediments further west. The faulting here and hence possibly the volcanics are post-Upper Miocene. West of Mountain Gate Pliocene has apparently been faulted down into the Palaeocene so it is possible that the main faulting and also the extrusion of volcanics took place at the end of the Pliocene. The volcanics may possibly thus be correlated with the "Young-Volcanic" formation of the Upper Digoel region (van Bemmelen, 1949, p.184).

Andesites at Tai Creek are isolated, and there is no definite evidence as to their age so they have been assumed to be of the same age as the Horn Hill volcanics.

Two samples (AA.121,122) of possible volcanic rock were collected from weathered outcrops in the banks of the Sepik River in the extreme north of the permit; their relationship to the other volcanics is not known.

STRUCTURE

The sediments of the southern portion of the permit area appear to lie in a fault trough between metamorphic mountains on the east and west. In the south-western part of the permit, Tertiary sediments are found along the foot of metamorphic hills. The sediments themselves are much folded and faulted, and are considered to be separated from the metamorphics by major high angle normal faults. The south-western boundary of the trough is formed by a major fault trending north-north-west; this may be continuous with a fault trending west along the southern boundary.

Field work has shown that the apparent dip slopes mapped from air photos on the east and west of Zweifel Gorge do not represent the direction of dips on the ground; it is thought that they are the topographic expression of the west striking fault referred to. Along the foot of the metamorphic hills on the west of Zweifel Gorge are outcrops of andesite and andesite porphyry that form a low ridge in front of the higher metamorphic hills. Volcanic boulders found in the streams draining east into Zweifel Gorge 200 to 300 feet above river level lend support to the idea that volcanic rocks capped the metamorphics, that is they were extruded prior to the faulting. However it is thought more likely that the volcanics at the foot of the scarp are associated with the faulting and that the high level boulders belong to an earlier eruptive phase.

A north striking fault later than the west trending fault has shifted the western side of Zweifel Gorge southward relative to the east side. This fault may continue northward to form the eastern boundary of the trough. There is no definite evidence of faulting along the front of the West Range, but the presence of volcanic rocks, probably from fissure eruptions, at Horn Hill and between Tai and Boye Creeks supports the idea. It is possible, however, that north of Horn Hill the contact between the Tertiary Sediments and the metamorphics is a normal transgressive one.

The width of the trough from east to west ranges from 7 miles at the southern end to well over 20 miles at the northern permit boundary; air reconnaissance of the mapped part of the October River and further west indicated that sediments outcrop for many miles into Dutch Territory. The predominantly metamorphic and igneous pebbles found in the October River indicate that the stream heads in basement rocks but how far away this is can only be guessed and consequently the configuration of the boundary of the sediments in this area is not known. Probably less than half the trough is within Australian Territory.

Within the trough the sediments are folded and faulted. On the West River meridional faults were mapped in 1954; Napsi Hill is a fault block dipping west and bounded on the east by a fault striking 30 degrees east of north; on the October River no faults were actually mapped, but dips normally gentle range in places up to 70 degrees so probably faulting is present. The sediments in the south-west are considered by Sturmfels (personal communication) to be broken into blocks by faults antithetic to the major normal fault, or by step faulting.

A west plunging syncline about 40 miles long and up to 8 miles wide, to the south of the permit area was mapped from the air photos. It was formerly assumed from the stream pattern shown by the Brücken and Sepik Rivers that there was a complementary anticline to the north; however this assumption was proved false when the area of the supposed anticline was visited during the 1955 field season and found to be occupied by tightly folded metamorphic rocks. The drainage pattern is difficult to explain unless it is inherited from broadly folded younger rocks that have been completely eroded, leaving superposed subsequent streams as the only record of their former presence. It may be that some of these rocks are preserved in the core of the syncline to the south.

Nothing is known about the structure of the plutonic metamorphic complex of the West Range apart from a structure visible in an oblique air photo at approximately 4 degrees 26 minutes south, 141 degrees 10 minutes east; this is thought to be an anticlinal mountain composed of metamorphics round an igneous core.

OIL PROSPECTS

No surface structures suitable for oil accumulation are present within the Permit, so that the area cannot be considered worth while testing for petroleum unless the presence of subsurface structural, stratigraphic, or combination traps can be established. This would require geophysical work, probably with control by core drilling.

The sediments present are largely impure sandstones or greywackes and siltstones probably of generally low porosity, and therefore not particularly suitable as reservoir rocks. However such characteristics as porosity and permeability are subject to lateral variation and can properly be determined only from subsurface investigations such as examination of cores, cuttings and well logs. The algal limestone of NAPSI Hill is probably the best potential reservoir rock, but only 105 feet is exposed at the surface. The maximum thickness of sediments exposed within the permit area, assuming continuity of outcrop, is of the order of 3,000 feet. It is not possible to predict from the limited surface exposures what thickness may be expected beneath the alluvium, and whether Palaeocene underlies the Lower Miocene at Mountain Gate. Again geophysical methods, are required to establish the depth to basement.

Assuming the sediments of the trough to contain oil and the westerly dip at Mountain Gate to continue in the subsurface, it is possible that oil could migrate toward the eastern part of the trough until either it escaped at the surface as a seepage or it met with some obstruction. The latter could be formed by a fault such as the bounding fault of the trough, or by a diminishing of permeability up dip, either obstruction resulting in a concentration of oil on its down dip side. At the north end of the permit the dip of sediments in the October River is to the east, so that any migration of oil within the trough would be towards Dutch Territory.

If step faulting within the trough is present to an important degree, as seems likely, then it is improbable that large scale migration of oil could have taken place.

It cannot be said from the geological evidence that there are no oil prospects, but they are certainly not encouraging. There is an unknown thickness of Tertiary sediments that may contain suitable sub-surface traps, but the remoteness of the area is probably its greatest drawback. Only a very rich oil find could result in commercial production.

POSSIBILITY OF THE OCCURRENCE OF MINERAL DEPOSITS

In the West Range, phyllite, schist and gneiss has been found intruded by granodiorite, quartz veins, and aplitic material; pyrite mineralization has been observed in hornfels, phyllite and unidentified weathered rocks in places but testing of stream wash and rock samples by dish and dolly pot failed to reveal any trace of gold. Many tributaries of the upper August, Sepik and Hoffnungs as well as the main rivers were prospected for gold unsuccessfully. The only intrusives into the slate and phyllite of the upper August and Sepik are barren white quartz veins; no mineralizing igneous rocks were seen. Magnetite is plentiful in the small creeks draining west into Zweifel Gorge, apparently deriving from volcanic rocks now found as rounded boulders.

No evidence has been seen in the upper Sepik area and the western side of the West Range to suggest the presence of economic mineral deposits.

CONCLUSIONS

The work of reconnaissance surveys during 1954 and 1955 has shown that the sedimentary rocks of the permit are restricted to a narrow strip of about 200 square miles on the western side between the Dutch border and the West and Landslip Ranges. It is probable, owing to the isolated nature of sedimentary outcrops that detailed geological mapping will add little to what is already known. Therefore if the Company intends to continue with the area, a programme of geophysical work will be necessary, primarily to determine the depth of basement rock below the surface and also to indicate the nature of the sub-surface structure. Probably the best way to obtain this information, or at least enough to decide whether further work is warranted, is by a number of gravitymeter traverses from the West Range west across the alluvium.

In any application for renewal of the permit the large areas of metamorphic rocks in the permit should be omitted and the new area restricted to the August-Sepik plain, with a possible extension as far north as Green River Patrol Post.

Although geological evidence is not encouraging, it cannot be said with certainty that there is no possibility of finding oil; there is thus no geological reason why the Company should not be allowed to do further work in the area if it so desires.

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APPENDIX 1

WEATHER INFORMATION

1955 SURVEY

Month - August

Location and Date	Rainfall in Points	Temperature 0900 hrs. Dry °F	Wet °F	Humidity 0900 hrs. %	Temperature 1500 hrs. Dry °F	Wet °F	Humidity 1500 hrs. %
Store Camp							
1st	32.5	75	73	89	86	77	66
2nd	12.0	74	72	89	87	78	66
3rd	1.0	75	73	89	87	78	66
4th	40.0	74	72	89	83	77	76
5th	0.0	75	74	94	88	79	67
6th	0.0	75	73	89	80	77	85
7th	30.0	75	74	94	85	79	76
8th	0.0	75	73	89	85	79	76
9th	7.0	76	74	89	89	78	61
10th	0.0	78	75	84	86	80	76
11th	3.0	75	74	94	85	78	72
12th	0.0	75	74	94	85	79	76
13th	0.0	75	74	94	85	76	74
14th	1.0	77	74	84	85	79	76
15th	0.0	78	76	89	90	85	82
16th	33.0	76	75	95	85	80	80
17th	120.0	78	76	89	90	85	82
18th	5.0	75	73	86	83	78	80
19th	265.0	76	73	80	84	78	76
20th	3.0	76	73	80	86	78	70
Stage Camp (Gwin) No. 1							
21st	5.0	76	73	80	86	78	70
22nd	53.0	77	73	80	84	78	76
23rd	75.0	75	73	89	86	78	70
24th	0.0	76	74	89	85	78	72
25th	0.0	76	74	89	83	80	87
26th	0.0	76	74	89	85	78	72
27th	19.0	76	74	89	85	78	72
28th	40.0	84	78	89	77	76	76
29th	2.0	77	76	94	84	78	76
30th	0.5	77	75	89	85	79	76
31st	0.0	77	75	89	85	75	76

Total Rainfall for month August 747 points.

Month - September

Location and Date	Rainfall in Points	Temperature 0900 hrs. Dry °F	Wet °F	Humidity 0900 hrs. %	Temperature 1500 hrs. Dry °F	Wet °F	Humidity 1500 hrs. %
Stage Camp (Gwin) No. 1							
1st	0.0	77	75	89	85	79	76
2nd	125.0	75	73	86	85	79	76
3rd	225.0	74	73	95	85	79	76
4th	0.0	76	74	89	84	80	84
5th	0.0	76	74	89	83	78	80
6th	0.0	79	74	75	84	80	84
7th	17.0	76	74	89	84	77	72
8th	72.0	76	74	89	86	78	70
9th	27.0	76	74	89	86	78	70
10th	2.0	76	74	89	86	78	70
11th	0.0	76	74	89	86	78	70
12th	1.0	75	73	90	84	78	76

Month - September (continued)

Location and Date	Rainfall in Points	Temperature 0900 hrs. Dry °F	Wet °F	Humidity 0900 hrs. %	Temperature 1500 hrs. Dry °F	Wet °F	Humidity 1500 hrs. %
Stage Camp No. 2							
13th	0.0	76	74	89	86	78	70
14th	0.0	76	74	89	86	78	70
15th	20.0	76	74	89	86	76	62
16th	5.0	76	73	85	84	79	80
17th	20.0	76	74	89	84	80	84
18th	0.0	75	75	100	81	76	77
19th	40.0	74	72	89	84	78	76
20th	140.0	74	73	95	85	82	88
21st	0.0	79	76	85	86	76	72
22nd	5.0	74	72	89	87	78	66
23rd	25.0	76	74	89	84	77	72
24th	350.0	74	73	95	84	78	76
25th	0.0	74	73	95	85	79	76
26th	80.0	80	76	81	85	78	72
27th	30.0	77	74	84	86	78	70
28th	40.0	75	75	100	90	75	49
29th	40.0	76	75	95	90	75	49
30th	70.0	76	75	95	86	79	73

Total Rainfall for Month September 1334 points.

Wet-Dry Bulb Thermometer lost early October

Month - October

Location	Date	Rainfall in Points
Stage Camp No. 3 (Wogarabei)	1st	0.0
	2nd	100.0
	3rd	0.0
	4th	0.0
	5th	0.0
	6th	0.0
	7th	50.0
	8th	0.0
Base Camp (Labin)	9th	20.0
	10th	0.0
	11th	250.0
	12th	150.0
	13th	200.0
	14th	0.0
	15th	60.0
	16th	70.0
	17th	30.0
	18th	0.0
	19th	70.0
	20th	0.0
	21st	0.0
	22nd	280.0
	23rd	130.0
	24th	40.0
	25th	0.0
	26th	0.0
	27th	30.0
	28th	0.0
	29th	50.0
	30th	0.0

Total Rainfall 1530 points.

Month - November

Location	Date	Rainfall in Points
Base Camp	1st	60.0
	2nd	150.0
	3rd	30.0
	4th	0.0
	5th	0.0
	6th	20.0
	7th	10.0
	8th	0.0
	9th	30.0
	10th	350.0
	11th	0.0
	12th	175.0
	13th	250.0
	14th	300.0
	15th	100.0
Store Camp	16th	80.0
	17th	100.0
Sepik	18th	25.0
Traverse	19th	30.0
	20th	50.0
	21st	200.0
Store Camp	22nd	250.0
	23rd	100.0
	24th	5.0
	25th	100.0
	26th	50.0
	27th	100.0

Total Rainfall 2565 points.

Summarized Rainfall for 1955 Survey

Month		Rainfall
August	.....	747 points
September	.....	1334 points
October	.....	1530 points
November	.....	2565 points

Rainfall Records for Green River Patrol Post for the year 1953

Month		Rainfall
January	.....	2185 points over 25 days.
February	.....	1389 points over 23 days.
March	.....	2195 points over 31 days.
April	.....	2189 points over 29 days.
May	.....	836 points over 14 days.
June	.....	231 points over 7 days.
July	.....	877 points over 11 days.
August	.....	973 points over 13 days.
September	.....	1152 points over 15 days.
October	.....	982 points over 14 days.
November	.....	938 points over 12 days.
December	.....	1685 points over 13 days.

Rainfall Records for Telefomin Patrol Post for the year 1953

Month		Rainfall
January	.....	1710 points
February	.....	1965 points
March	.....	2184 points
April	.....	1100 points
May	.....	843 points
June	.....	1083 points
July	.....	1473 points
August	.....	1746 points
September	.....	1362 points
October	.....	1275 points
November	.....	927 points
December	.....	417 points


GEOLOGICAL MAP
PERMIT No.21
SEPIK DISTRICT, NEW GUINEA
HELD BY
ENTERPRISE OF NEW GUINEA GOLD
AND PETROLEUM DEVELOPMENT. N.L
Scale
1:100000
MILES
LOCALITY MAP
NEW GUINEA
PAPUA
NEW IRELAND
NEW BRITAIN
SCALE
100 0 100 200 300 MILES
SEPIK RIVER
AUGUST RIVER
INTERNATIONAL BOUNDARY
WEST RANGE
LANDSLIP RANGE
THURNWALD RANGE
Reference
QUATERNARY
? Plio-Pleistocene
TERTIARY
Pliocene
Upper Miocene
Middle Miocene
Lower Miocene
Palaeocene
PRE-TERTIARY
? Mesozoic
? Palaeozoic
undifferentiated
Qa Alluvium
Pv Volcanic rocks
Th Siltstone
Tg Siltstone, sandstone greywacke, conglomerate, mudstone
Tf3 Siltstone, calcareous siltstone, sandstone, conglomerate
Tf1-f2 Limestone
Tf Calcareous greywacke
Tl Greywacke, sandstone, pebbly sandstone, siltstone, mudstone
?Mm Metamorphic rocks
gb Gabbro
gd Granodiorite and diorite
?Pzm Metamorphic rocks
m Metamorphic rocks
Boundary of Permit Area
Established geological boundary, position approximate
Inferred geological boundary,
Strike and dip of strata
Strike and dip of foliation, inclined
Strike and dip of foliation, vertical
Synclinal axis, position approximate, showing direction of plunge
Inferred anticlinal axis
Established fault, position accurate
Inferred fault
" " concealed
Trend line, from air photographs
Dip slope
Sample numbers, prefix AA.
Native village
Clearing, probably native garden
Astronomical station
Principal point of air photograph
Dyke
Gravel banks
Vegetated islands
Streams; broken lines indicate streams not traversed, or
not visible in air photographs
· 120' Spot height from aneroid, approximate only
× 370' Spot height, after Schultze
Camp site
ASTRONOMICAL DATA
Station 1 Latitude 4° 03' 56·4" S
Longitude 141° 05' 55·7" E
2 4° 10' 13·8"
140° 59' 05"
3 4° 06' 13·6"
141° 07' 57·8"
4 4° 08' 54·3"
141° 07' 13·8"
5 4° 11' 28·4"
141° 05' 44·4"
6 4° 21' 35·7"
141° 03' 03"
7 4° 29' 28·92"
141° 04' 39·07"
W. J. Perry
March, 1956
SECTION A.B
SECTION C.D
PNG 4-11