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A GEOLOGICAL RECONNAISSANCE OF THE JIMI AND SIMBAI RIVERS TERRITORY OF PAPUA AND NEW GUINEA.

by

D.B. Dow.

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A GEOLOGICAL RECONNAISSANCE OF THE JIMI AND SIMBAI RIVERS.

TERRITORY OF PAPUA NEW GUINEA

SUMMARY

A geological reconnaissance was made on three separate surveys from June 1958 to March 1961, of parts of the watersheds of the Jimi and Simbai Rivers. Probably the oldest sediments in the region are arkose and arkosic conglomerate named here the Herbert Beds, which can possibly be correlated with the Permian Kuta Group (Rickwood 1955). Triassic Jimi Beds and Jurassic Maril Shale are conformably overlain by Lower Cretaceous Kondaku Tuff: these sediments are separated by faults from an apparently conformable sequence comprising the following newly named formations: the Genjinji Beds of probable Middle Cretaceous age, the Kumbruf Volcanics of probable Upper Cretaceous age, and the Eocene Asai Beds.

In the southern half of the region, there are unmetamorphosed beds as old as Triassic, but in the north probable Eocene sediments have been metamorphosed to sericite schist. The metamorphism was probably caused by large shearing stresses with small confining pressure along the Ramu Graben.

An orogeny which began in Tertiary time and which has continued to the present day, caused major, predominantly transcurrent faulting, accompanied by moderate folding.

Alluvial gold has been mined at Maramp River and Kumbruf Gold Prospect, and the writer confirmed minor gold occurrences in the Pint River and the head of the Jimi River. No other minerals of economic importance were found.

INTRODUCTION

The following report is the result of three short reconnaissance geological surveys carried out by the writer in conjunction with inspections of Kumbruf Gold Prospect. The first reconnaissance was made between the 4th. and 26th. June 1958. The writer flew into Simbai Patrol Post, mapped the Kumbruf Gold Prospect, and then walked to Aiome Patrol Post by way of the Middle Simbai River and the Ramu fall of the Schrader Range.

Between the 18th December 1958 and 6th. January 1959, the writer walked from Mala in the Wahgi Valley, across the lower Jimi River to Kumbruf, then proceeded to Aiome by way of the middle Asai Valley. The third reconnaissance was made between 24th. February and 30th. March 1961 when the writer visited Kumbruf after flying to Simbai Patrol Post, and then walked to Kerowagi by way of the Jimi River.

LOCATION AND ACCESS

The area mapped lies within the Ramu, 1:250,000 Sheet. Only the area north and east of the Jimi River is covered by vertical air photographs (Magin, Ramu, Obulu, Toro, and Kerowagi 1 mile areas), and most of the mapping was confined to this area. Between the Jimi River and the Wahgi River, a sketchy patrol map on a scale of one inch to four miles is the only one available.

The accompanying map (Plate 1), was made from an uncontrolled compilation of air photographs, which was then reduced to 2 miles to one inch with a pantograph and details from the patrol map added. The scale is not accurate because of the lack of airphoto control.

Airstrips have been constructed at Aiome (DC3 aircraft) and Simbai, Tabibuga, and Kol (Cessna aircraft). Access to the rest of the map area is by walking tracks which are rough and not graded. Most of these tracks are now being replaced by graded Administration tracks and by February 1961, this work was well advanced.

POPULATION AND INDUSTRY

The area supports a large native population which is generally confined to the upper parts of the Jimi, Simbai and Asai Valleys. There are two large areas without population, one being between Mt. Herbert and the Ramu River, and the other along the lower Jimi River.

The Simbai, Asai, and Lower Ramu Rivers are part of the Madang District and there are patrol posts at Aiome and Simbai. The rest of the area, with the exception of the Koro River, is part of the Western Highlands District, and there is a patrol post at Tabibuga in the Jimi Valley. The Koro River and the Kerowagi Patrol Post are part of the Eastern Highlands District. There are mission stations at Tabibuga, Simbai, Kol, and Ambulua.

Gold mining is the only industry in the area; Mr. J.C. MacKinnon is mining alluvial gold (April 1961) at Kumbruf, and native miners are working in the Maramp River, a tributary of the Jimi River.

PREVIOUS INVESTIGATIONS

D.W.P. Corbett of the Bureau of Mineral Resources, when member of a C.S.I.R.O. Land Research Party, visited Kumbruf in 1958 and sampled the rocks in the Simbai and Asai Rivers and localities along the north fall of the Schrader Range. Morgan (1960) described the petrography of these specimens (Appendix 1).

TOPOGRAPHY

Figure 1 shows the region divided into six well-defined physiographic units : the Ramu Graben, the Bismarck - Schrader Horst, the Jimi Valley, the Wahgi - Jimi Divide, the Wahgi Valley and the Wilhelm - Herbert Massif.

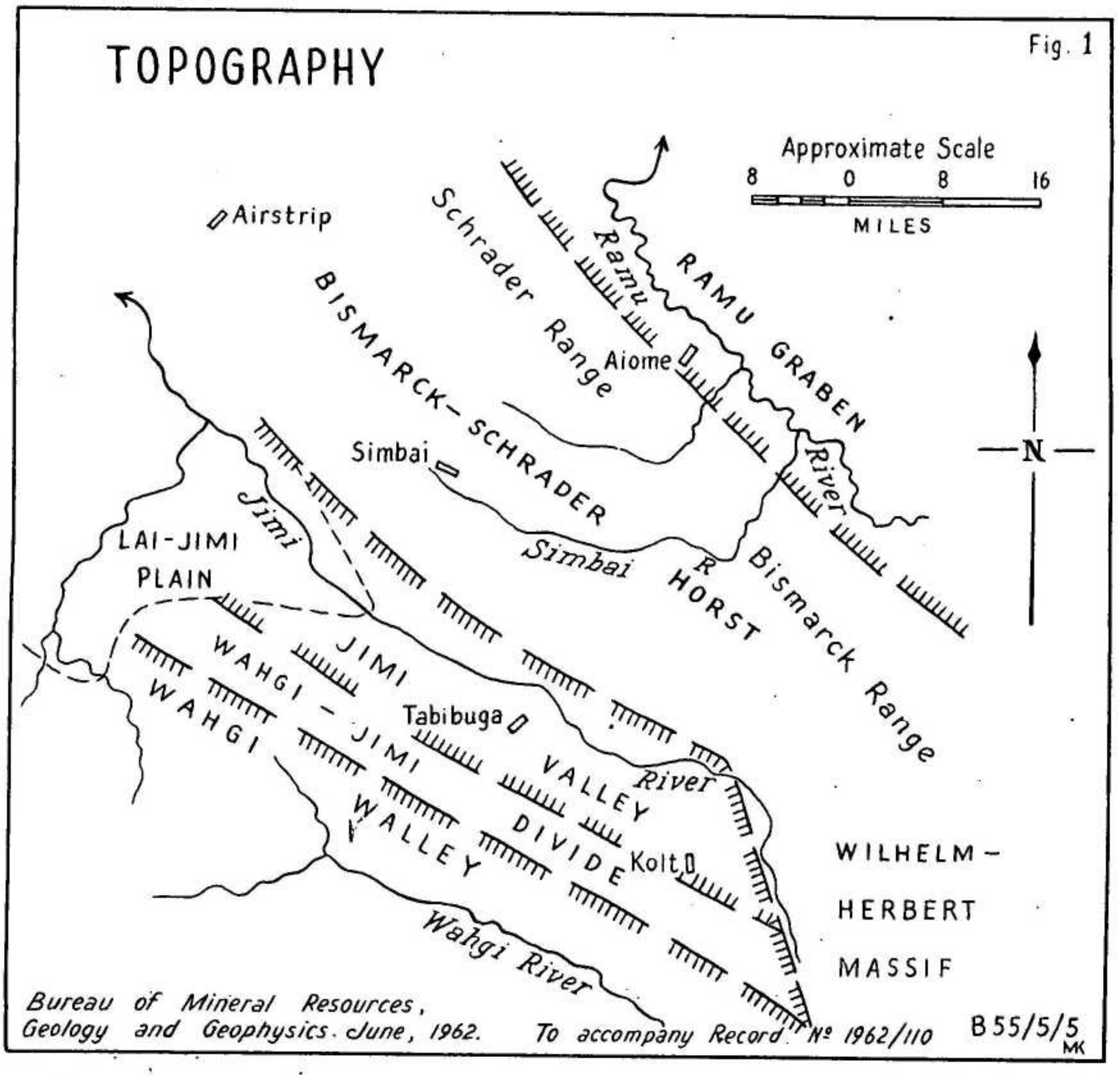

Figure 1: Map showing the main topographical units and the location of airstrips.

Figure 2: Wilhelm - Herbert Massif taken from Bubultunga Rest House near the head of the Jimi River. Looking south-east up the Kana River.

Figure 3: Mount Wilhelm from near Ambulua Mission Station looking north-east. Shows U-shaped glacial valley notched at its base by the subsequent stream.

RAMU GRABEN:

On the north-eastern margin of the map area, the Ramu River flows north-westwards along a flat-floored valley called here the "Ramu Graben." The floor of the valley averages about 300 feet above sea level, and is composed of recent alluvium derived from the flanking ranges. The Simbai, Asai, and Tigenans Rivers are the main streams supplying debris from the Bismarck - Schrader Horst in the map area, and they have deposited gently-sloping piedmont plains where they debouch from the mountains.

BISMARCK-SCHRADER HORST:

The map area is the junction of two mountain ranges, the Bismarck Range in the south-east, and the Schrader Range in the north-west, which form the south-western boundary of the Ramu Graben. The horst includes the whole area between the Ramu and Jimi Rivers; it is very rugged, with deeply incised rivers and has several peaks over 9,000 feet. The two major rivers draining the horst, the Simbai and Asai Rivers, flow south-east parallel to the main range for most of their length, before swinging sharply north to join the Ramu River. These two rivers run through deep gorges over much of their courses.

The Bismarck Range is dominated by the "Wilhelm - Herbert Massif" (Figure 2), which is part of the range at the head of the Jimi River. The massif covers an area of about four square miles, most of which is over 12,000 feet above sea level. There is little vegetation above 10,000 feet and as the rocks are subject to frosts, the ridges are sharp. Deep U-shaped valleys, and many cirques at the heads of these valleys (Figure 3) are evidence of glaciation.

JIMI VALLEY:

The Jimi River and its major tributary, the Tagan River, flow north-west along a lowland called the "Jimi Valley" (Figure 4). The valley is bounded on the north by the Schrader-Bismarck Horst (7,000 feet to 8,000 feet above sea level), on the south by the Wahgi - Jimi Divide (8,000 feet to 13,000 feet), and on the east by the Wilhelm - Herbert Massif (12,000 feet to 15,000 feet). To the west the Jimi Valley merges with the Lai-Jimi Plain (Dow 1961).

Figure 4: Looking down the Jimi River from Kwiop Village. The hill on the left rises to 4,800 feet at Tabibuga Patrol Post (out of picture to the left), and is part of the Jimi Valley. The range to the right (obscured by cloud), is part of the Bismarck - Schrader Horst, and rises to over 8,000 feet.

There is sharp relief at the eastern end of the valley where the rivers are incised 3,000 feet below the level of the surrounding hills; the hills are commonly flat-topped, and rarely exceed 6,000 feet in height.

WAHGI-JIMI DIVIDE

The Wahgi-Jimi Divide is a narrow west-north-west trending range of mountains separating the Wahgi and Jimi Valleys. It culminates in the rugged bare-topped Mount Udon, which is 12,000 feet high.

STRATIGRAPHY

The Herbert Beds, a sequence of arkose, arkosic conglomerate, and feldspathic greywacke, are tentatively correlated with the Permian Kuta Formation (Rickwood op. cit.). Thick-bedded Triassic greywacke and minor overlying basic volcanics, called here the Jimi Beds, conformably underlie Upper Jurassic Maril Shale and Lower Cretaceous Kondaku Tuff (Rickwood op.cit.). Also present in the region, but separated from these rocks by faults, is a thick sequence of shale and marl, the Genjinji Beds, tentatively correlated with the Middle Cretaceous Chim Group. These rocks are conformably overlain by Upper Cretaceous Kumbruff Volcanics (new name), and probably conformably by Eocene Asai Beds (new name). The latter are siltstone, shale, and limestone, which are metamorphosed to quartz sericite schist to the north.

HERBERT BEDS

These beds were examined only in the headwaters of the Jimi River, but they probably also occur on the western slopes of Mt. Herbert and Mt. Wilhelm. On the west they are faulted against Triassic Jimi Beds. The Herbert Beds are medium-grained green greywacke, arkose, and arkosic conglomerate with minor siltstone and shale.

The greywacke constitutes about 40 percent of the sequence examined in the Kana River. It is bedded, highly indurated, and generally medium to fine-grained. The feldspar content of the arkose is variable but salmon-pink feldspar is a dominant constituent.

The most common arkose is medium-grained, bedded, and consists of subangular fragments of pink and white feldspar, and quartz, in a fine-grained green matrix. The conglomerate is made up of scattered pebbles of granite, acid volcanic rocks, hornfels, silicified greywacke, and quartz, in an arkose matrix.

Black and red siltstone and shale are sheared in places, and where sheared contain ramifying calcite veins. Floaters of acid volcanics and vesicular basalt were found in several localities on ridges in the Kana River area, but could not be found in outcrop. They could be interbedded with the Herbert Beds, but more likely belong to a recent volcanic phase, and are possibly related to the Hagen Volcanics (Dow op.cit.).

The Herbert Beds are at least 2,000 feet thick and may be much thicker. Their age is unknown, but they are lithologically distinctive, and similar to the Permian Kuta Formation of Rickwood (1955), with which they are tentatively correlated.

JIMI BEDS:

'Jimi Beds' is the name proposed for a sequence consisting mainly of greywacke with interbedded shale and siltstone, overlain by basic volcanics. The beds crop out along the Jimi Valley and the type area is the area surrounding the Tabibuga Patrol Post between the Tagan and Jimi Rivers. The rocks are faulted against Gahjinji Beds to the north, and Herbert Beds to the east. On the west they are covered by sediments of the Lai-Jimi Plain (Dow op.cit.), and to the south they underlie Jurassic and Cretaceous rocks.

The Jimi Beds are mainly greywacke with interbedded shale and siltstone; conglomerate is common in the lower part of the sequence.

Figure 5: South-westerly dipping Jurassic Maril Shale in the Kawn River near Ambulua Mission Station. Boulders are medium-grained granodiorite from Mount Wilhelm.

Figure 6; Easterly dipping greywacke of the Jimi Beds in a tributary of the Kawn River near Bubultunga Village.

Greywacke constitutes about 60 percent of the sequence: it is indurated, fine to coarse-grained, and coloured black to dark blue and, rarely, green. Calcareous greywacke and light grey feldspathic sandstone occur in places. Bedding is medium to massive, and graded or current bedding can be seen in most good exposures. Poorly preserved plant impressions were found near the top of the formation in the eastern part of the map area. Intraformational conglomerate beds up to one foot thick, which consist of sub-angular shale fragments in a green greywacke matrix, were noted in several places.

The siltstone and shale were seen mostly in weathered outcrop where they are brown and fairly friable. They break readily into near-cube-shaped fragments in contrast to the finer members of the Genjinji Beds which, on weathering, break into thin platy fragments. The fresh shale and siltstone are generally dark-blue and black though red varieties were noted. These fine clastic rocks in most places occur as beds up to one foot thick, interbedded with the coarser clastics.

Conglomerate is common in the bottom half of the Beds. It consists of well-rounded components ranging in size from pebbles to small boulders, set in a dark grey or blue greywacke matrix. The larger components are all indurated fine-grained greywacke and fine-grained basic igneous rocks.

Near Ambulua Mission, the uppermost part of the sequence consists of basic volcanic rocks. These are green vesicular basalt and fine-grained basalt agglomerate. The agglomerate contains rare, poorly preserved, marine fossils.

Triassic fossils were found in several localities along the Jimi River in the lower half of the sequence. In an unpublished preliminary report, on the fossils, Dr. L.R. Cox (British Museum) says:

"Some of the fossils retain their original shell, but where decalcifiction has taken place they are in the form of external and internal moulds. Three species, belonging to the Bivalvia, are identifiable generically and may be recorded as Gervillia cf elongata Mansuy, Gervillella sp nov., and Costatoria sp.nov..

One or two other forms are represented in the material but only by ill-preserved and genetically indeterminate specimens.

"The presence of a representative of the myophoriid genus Costatoria (the most abundant species in the material), establishes the age of the formation as Triassic. The relatively large size of this shell suggests that it is Upper Triassic age, as species of comparable size do not appear to be known from earlier beds. A second species seems to be closely comparable to Gervillia elongata Mansuy, which occurs in the Upper Triassic of Tonkin."

The thickness of the beds was not measured but it is greater than 2,000 feet.

MARIL SHALE:

Beds referred to the Jurassic Maril Shale (Rickwood op.cit.), were examined only at the head of the Jimi River in the vicinity of Ambulua Mission. Here the rocks are fine-grained greywacke and siltstone which overlie the Jimi Beds. Owing to poor exposure, the contact was not seen, but it is probably conformable.

The Maril Shale in this locality consists of black fine-grained greywacke with interbedded siltstone. The rocks are thin to medium-bedded and have a distinctive outcrop with resistant greywacke alternating with less resistant siltstone (Figure 5). Towards the top of the sequence the beds become coarser-grained and pass upwards into quartz sandstone and then into tuffaceous greywacke of the Kondaku Tuff.

The thickness of the beds was not measured. Jurassic fossils were found in weathered shale in two localities two miles south of Ambulua. Inoceramus sp. was abundant, including one species with very coarse concentric sculpture, the folds of which are nearly one inch apart. Fragmentary Buchia malayomaorica was also noted.

Rickwood (op.cit.) has shown that the Mesozoic sediments in the Wahgi Valley thicken from west to east. Thus near Mt. Hagen, Lower Cretaceous rocks disconformably overlie Permian Kuta Formation, and 25 miles to the north-north-east near Banz over 1,000 feet of Upper Jurassic Maril Shale conformably underlies the Lower

Cretaceous and disconformably overlies the Permian rocks.

Further evidence of this thickening is shown by the section in the Kawn River, 25 miles farther to the north-north-east. Here the conformable Mesozoic sequence includes Triassic Jimi Beds underlying Maril Shale. The Herbert Beds can probably be correlated with the Permian Kuta Formation and therefore may underlie the Jimi Beds (Figure 7).

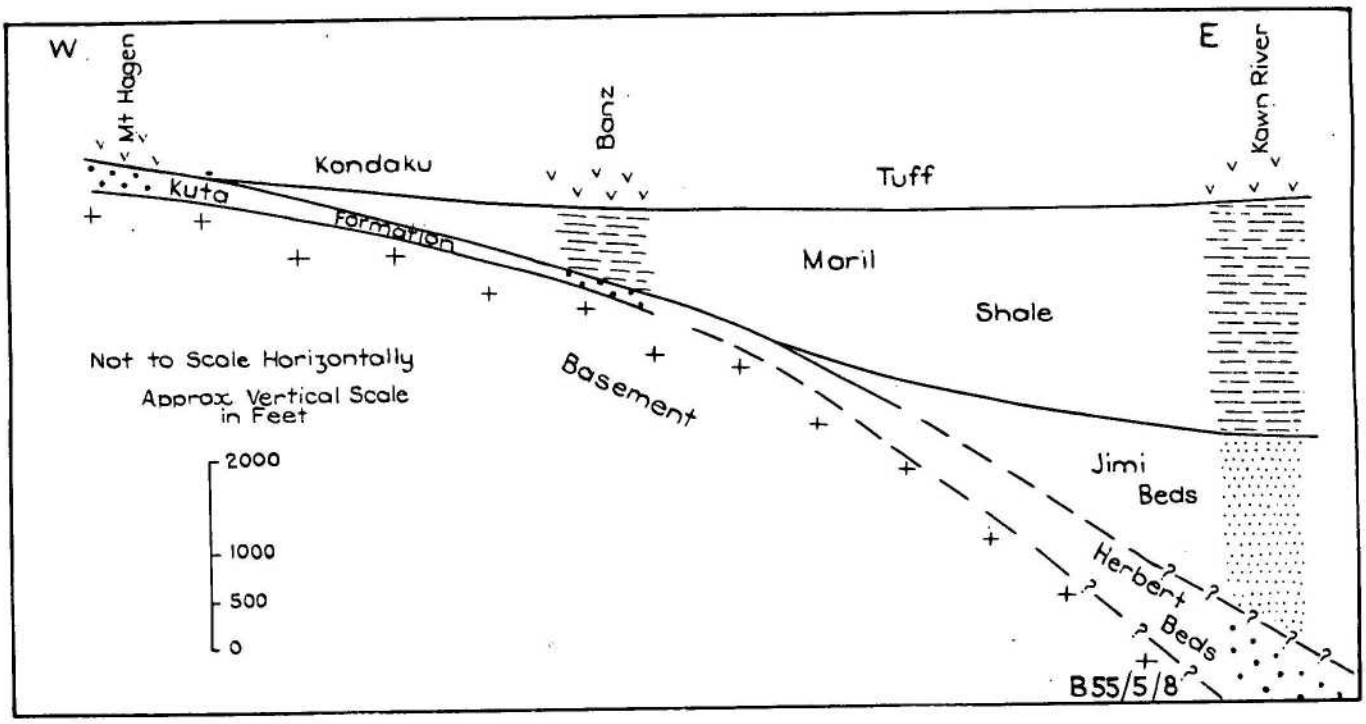

Figure 7: Diagrammatic section of the Mesozoic sequence between the Wahgi Valley and the Jimi Valley.

KONDAKU TUFF:

Tuffaceous greywacke and basaltic volcanics overlying the Maril Shale between the head of the Jimi River and Koro River are included in the Kondaku Tuff (Rickwood 1955).

They were examined only in track cutting and as boulders weathering from hillsides. Coarse to medium-grained tuffaceous greywacke is prominent near the base and passes upwards into basaltic scoriaceous agglomerate and vesicular basalt. In this upper part, tuffaceous greywacke and conglomerate containing basalt pebbles and boulders, make up about half the sequence.

GENJINJI BEDS

A large area of the Bismarck Range between the Jimi River and the Simbai River is composed of shale and siltstone named here the 'Genjinji Beds'. These rocks are overlain to north apparently conformably by the probable Upper Cretaceous Kumbruf Volcanics: to the south they are faulted against the Jimi Beds.

The Genjinji Beds consist of fine-grained shale and siltstone and minor fine-grained greywacke. The shale and siltstone varies from light grey and green, to dark blue and black, and darker rocks being the most common. Distinctive banded green and reddish-purple shale occurs in Kunun Creek, and appears to be confined to one stratigraphical position. Steeply dipping incipient slaty cleavage is almost invariably present, and commonly obscures the bedding. Bedding, where seen, consists of laminations or thin lenses of black shale in a lighter coloured siltstone. The fine-grained sediments have a phyllitic sheen, which may be due to recrystallisation, or to detrital micaceous material. The green varieties have a talcose appearance. The greywacke is black, indurated, and fine-grained, and occurs as beds up to three feet thick. Calcareous nodules occur throughout the sequence.

A thick lens of limestone estimated at 300 feet thick was seen from a distance in the Kunun River, interbedded with rocks of the Chim Group, but the locality was not visited.

The Beds are best exposed to the southwest of Kumbruf, on the north-eastern flank of the Jimi Anticline. The section exposed is not complete, and is estimated from the airphotos to be about 4,500 feet thick. Belemnites were found near the top of the sequence, and the rocks underlie, apparently conformably, the Kumbruf Volcanics. Their age is tentatively given as Middle Cretaceous, and they can probably be correlated with the Chim Group of Rickwood (op.cit.).

<u>KUMBRUF VOLCANICS</u> (New Name)

The type locality for the Kumbruf Volcanics is at Kumbruf Gold Prospect on the south side of the Simbai Valley, located approximately 5°20' south and 144°30' east. The formation crops out as a west-north-west trending belt along the south side of the Simbai Valley between Simbai Patrol Post and Terengi Village. The formation probably extends to the north-west, as spilitic volcanics were collected by D.W.P. Corbett from the Aunga River. The southeastern extent of the formation is unknown. The formation conformably overlies the Genjinji Beds, and underlies the Eocene Asai Beds, apparently conformably.

A chain and compass survey was made of Tunonk and Nanoi Creeks which bound Kumbruf Prospect. The Kumbruf formation is almost continuously exposed in these creeks which flow at right angles to the strike of the beds. The following section was measured:

		Top
ASAI BEDS	2,450 feet.	Indurated black siltstone and phyllite, calcareous in places with crystalline limestone beds up to 200 feet thick.
KUMBRUF VOLCANICS	200 Feet	Basaltic agglomerate, some pillow lavas.
	350 feet	Indurated calcareous siltstone with slump structures.
	550 feet	Mainly basic pillow lavas with some siltstone interbeds.
	600 feet	Black indurated siltstone, tuff, tuffaceous sandstone and rare basaltic pebble conglomerate beds.
	4,400 feet	Mainly basaltic agglomerate with minor lava flows, some basaltic conglomerate and red banded siltstone.
Total	6,100 feet	Bottom

Products of submarine vulcanism make up about 80% of the formation. The agglomerate is green, highly indurated, and consists of angular and sub-angular basalt fragments in a medium-grained tuffaceous matrix. The basalt fragments commonly contain spherical vesicles filled with zeolites or calcite and calcite patches are common throughout the rock. In many places, the sub-rounded fragments are almost indistinguishable from the matrix, and have probably resulted from hot eruptions, with subsequent welding of the components. Pillow lavas are common, particularly in the upper part of the section. The pillows range in diameter from two feet to six feet, and have interstices filled, either with green or red siltstone, or else an indeterminate white mineral, probably a zeolite.

Medium-grained andesitic tuff and tuffaceous greywacke makes up about 10 percent of the section; these rocks are light-coloured, thin to medium-bedded, and are interbedded with siltstone. The siltstone is dark blue to black, and is laminated and thin-bedded. Slump structures are common.

Samples of the volcanics were collected by D.W.P. Corbett from the Krumbruf area during a short visit in 1958, and a petrological report of the specimens was made by W.R. Morgan. (Appendix 1). The basic pillow lavas and agglomerate are with one exception classed as spilite, and are mostly porphyritic and amygdaloidal. Phenocrysts of olivine are common and the amygdales are filled with chlorite, calcite, epidote, and zeolite. The tuff sample was classified as andesitic, crystal tuff.

The only fossils found in the formation were near the top of the formation in a small tributary of Soi Creek. They occur in boulders of indurated siltstone and fine-grained greywacke but an adequate collection was not possible. The only form recognised by the writer was a species of Belemnite. About 2,000 feet stratigraphically above the top of the formation a limestone member of the Asai Beds contains Eocene microfossils. Field relations indicate a conformable contact and the Kumbruf Volcanics are probably Upper Cretaceous.

Rickwood (op.cit.) notes olivine basalt near the top of the Chim Group in the Chim Valley and the Kumbruf Volcanics are probably a lateral equivalent of these, but warrant separation as a new formation.

Upper Cretaceous rocks were mapped by MacMillan & Malone (1960) in the Bundi area about 50 miles south-east of Kumbruf. In this locality the rocks are mainly grey shale with limestone lenses, but vesicular basic igneous rocks in the sequence may be correlated with the Kumbruf Volcanics.

ASAI BEDS:

The Asai Beds crop out over a large area between the Simbai and Ramu Rivers. The name is derived from the Asai River, which drains a large area of these rocks.

The formation overlies, apparently conformably, the Kumbruf Volcanics in the Simbai River area and consists of siltstone, calcareous siltstone, fine-grained greywacke, and limestone. North of the Simbai River the rocks appear to grade into fine-grained quartz serecite schist.

A section of the Asai Beds, 3,350 feet thick overlying the Kumbruf Volcanics was measured in Tunonk Creek and is given below:

		Top
	900 feet	Sheared phyllitic siltstone (about 20% of the siltstone is calcareous) with minor limestone lenses.
	150 feet	Fine-grained recrystallised limestone, massive, though laminations ans thin-bedding were seen. Eocene foraminifera.
	200 feet	Calcareous phyllite 50% of sequence, small limestone lenses.
	30 feet	Fine-grained marble.
	200 feet	Black phyllite, about 50% calcareous. Many calcite nodules. Much shearing evident.
	20 feet	Fine-grained marble.
	450 feet	80% Black phyllitic siltstone, 20% calcareous phyllitic siltstone. Sheared contorted and brecciated. Pyrites nodules up to three inches in diameter in places.
	900 feet	75% Siltstone, 20% calcareous siltstone, 5% fine-grained greywacke. Laminated and thin-bedded also with thin lenses of black siltstone in finer-grained matrix. Finer-grained beds tending towards phyllitic; zones of silicification.
	500 feet	60% laminated and thin-bedded siltstone, 40% calcareous siltstone, calcareous nodules common. Many sub-aqueous slump structures.
Total	3350 feet	Bottom

The thick limestone lens near the top of the section, though mostly recrystallised, contains thin foraminiferal lenses from which Eocene Discocyclina and Operculina were determined by Belford (1960).

In the Kumbruf locality, the Simbai River follows a large shear zone, but the Asai Beds are again exposed on the north side. They are in distinguishable from the rocks of the fault, and Belford also determined Eocene Nummulites and Discocyclina from a sample of limestone interbedded with phyllitic siltstone.

Most of the rocks north of the Simbai River were called "sub-schist" in the field. In hand specimen this rock is fine-grained, black or dark blue, and has a regional schistosity consisting of many small, closely-spaced shear planes. It is difficult to find unsheared fragments of any size, but where they are preserved, they are similar in composition to the phyllitic siltstone at Tunonk Creek. The rocks in this area invariably contain ramifying calcite veins, and the bedding has been obliterated by the schistosity.

Near the Ramu River, the beds have been metamorphosed to quartz sericite schist.

The writer considers that these sub-schists were formed by large shearing stress with small confining pressure, acting on a fairly homogeneous sequence of fine-grained sediments.

Figure 8: Mount Oipo (left), and Mount Wilhelm (right), taken from Tabibuga Patrol Post. The Jimi River flows from right to left in a deep gorge between the dark ridge in the centre foreground, and Mount Oipo.

IGNEOUS INTRUSIONS

BISMARCK GRANODIORITE

The Bismarck Granodiorite was seen only as boulders in the Kawn and Koro Rivers which drain the Wilhelm-Herberton Massif. The rock is light coloured, generally redium-grained, and composed of white feldspar, quartz, hornblende, and some biotite. Coarse-grained boulders are rare.

Rickwood (op.cit.) and MacMillan and Malone (op.cit.), correlated the Bismarck Granodiorite with the pre-Permian Kubor Granodiorite, which crops out about 35 miles to the south-west.

Rickwood (op.cit.) mapped all the Wahgi-Jimi Divide as Bismarck Granodiorite but granodiorite is not as extensive as shown by Rickwood and some of it is almost certainly younger than pre-Permian. North of Mala a fairly large body of medium and coarse-grained granodiorite intrudes shale tentatively referred to the Jurassic Maril Shale, and appears to intrude beds mapped as Miocene by Rickwood (op.cit.), though this could not be confirmed. Mount Udon appears from a distance to be composed of another body of granodiorite.

OIPO INTRUSIONS

"Oipo Intrusions" is the name proposed for the predominantly gabbroic rocks that intrude the sedimentary rocks of the Bismarck and Schrader Ranges. The name is derived from Mount Oipo, a prominent mountain on the Jimi-Simbai divide (Figure 5). In addition to the larger intrusions shown on the map, there are many areas, particularly along the Bismarck Range between the Jimi and Simbai Rivers, where the sediments are intruded by many small irregular dolerite and gabbro dykes.

The Oipo Intrusions range in composition from pyroxenite and serpentinite to porphyritic microdiorite and granodiorite. The ultramafic rocks crop out in the Middle Simbai River, in the Kumun River, and at Mount Oipo. The porphyritic microdiorite occurs at the head of Tunonk Creek and near Kompiai Village. Fine and medium-grained granodiorite, which grades into gabbro, intrudes the Jimi Beds between Koenambi Village and Tabibuga Patrol Post.

The Oipo Intrusions intrude the Eocene Asai Beds and are possibly co-magmatic with the Pliocene Timun Intrusions. (Dow 1961).

STRUCTURE

In the map area, beds of Eocene age and older are folded into large, fairly tight folds, with the exception of the Jimi Beds which are only gently folded. Major faulting affects all the rocks of the area but possibly do not cut the more recent alluvium.

FOLDING

The Herbert Beds dip fairly steeply to the north-east in the Kana River; near the Kawn Fault the structure of the Beds is very irregular, apparently as a result of drag on the fault.

An anticline, named here the 'Jimi Anticline', trends north-north-west along the north side of the Jimi Valley; it is symmetrical with flanks dipping between $40^{\circ}$and 60°, has a sub-horizontal axis, and folds Cretaceous and Eocene rocks. On the south flank there is a minor syncline with an outlier of Upper Cretaceous rocks in the core. The north flank is cut by the Simbai Fault and the south flank by the Jimi Fault.

The Mesozoic rocks on the south side of the Jimi Valley are folded into a broad syncline which was mapped only on its eastern end. Jimi Beds occupy most of the Jimi Valley and these are mostly only gently folded with dips rarely exceeding 30°, except near the major faults of the area. Along the north side of the Valley the beds are commonly horizontal.

North of the Simbai Fault, bedding in the Asai Beds is obscured by schistosity and the structure is not known.

FAULTING

The major physiographic units of the area were formed by faulting in the late Tertiary. The faulting broke the area into parallel linear troughs separated by up faulted blocks (Figure 1.).

Four major faults were mapped: Jimi Fault, Bismarck Fault zone, Kawn Fault, and the Simbai Fault. The southern margin of the Ramu Graben is almost certainly faulted, though recent alluvium obscures the probable trace of the fault.

There is insufficient information to determine the total movement on these faults. Rickwood (op.cit.p.80, states "the faults in the Bismarck Fault Zone are high-angle over-thrust faults", but gives no evidence to support this contention. Vertical movements on the faults in most places are obvious; some of the faults also have transcurrent components, the total magnitude of which is not known. As the fold axes are parallel to the faults in most cases, large transcurrent movement could have taken place leaving little record, and it is possible that the faults may be predominantly transcurrent.

Bismarck Fault Zone.

The Bismarck Fault Zone was mapped by Rickwood (op.cit.), as comprising several west-north-west trending faults which he regarded as high-angle thrust faults. The fault traces as mapped are straight or slightly curved, and their direction is apparently not affected where they traverse areas of marked relief: the fault planes must be vertical or nearly vertical.

Kawn Fault.

The Kawn Fault trends north-west and branches off the Bismarck Fault Zone in the head of the Koro River and faults Jimi Beds to the west down against the probable Permian Herbert Beds.

The fault was seen only in the Kawn River near Mami Village where a sheared zone 100 feet wide is exposed. The shear zone is vertical and probably occupies the whole of the stream bed which is 400 feet wide in the locality. The fault affects mainly the less competent arkosic sandstone and siltstone of the Herbert Beds. There has been plastic flow of the sediments with rafting of lenses of the sediments along the shear zone. Several well-defined faults within the shear zone dislocate siltstone bands which have been contorted by earlier faulting. The fault planes are vertical and where the dislocation is small (i.e. up to ten feet), it is transcurrent, the west block moving south.

Two small faults were seen in greywacke of the Jimi Beds close to the main fault. These are parallel to the main fault and dip westwards at about 45° and have normal vertical displacement of up to 10 feet. These faults reflect the vertical component of the main fault which on stratigraphic evidence is downthrown to the west. The vertical throw is greater than 2,000 feet, but the magnitude of the transcurrent movement is unknown.

Jimi Fault.

The Jimi Fault trends west-north-west along the north side of the Jimi Valley. It was mapped near Koenambi Village where it shows on the air photographs as a lineament. Exposures on the line of traverse were not good, and the fault trace was not seen, but the fault brings sub-horizontal Jimi Beds against steeply dipping Genjinji Beds of probable Cretaceous age. Close to the fault, the Jimi Beds dip at 25° to 30° away from it, but within 300 yards, they are nearly horizontal.

On its eastern end the fault probably joins the Kawn Fault, and the Mount Oipo igneous rocks probably were intruded along a line of weakness caused by the faulting. To the west the fault can be seen on the airphotographs continuing along the north side of the Jimi Valley.

Movement on the fault is downthrow to the north.

Simbai Fault.

The Simbai Fault is a major fault, which trends between 280° and 300° along the upper part of the Simbai Valley. The fault is well-exposed along the Simbai River near the Tunonk Creek junction.

Most of the shearing is in a vertical zone about 400 feet wide. Rocks in this zone have flowed plastically and large blocks of limestone have been rafted along the fault and streaked out horizontally into lenses up to one hundred feet long. Zones of shearing associated with the main fault occur up to half a mile to the north and south of the fault.

The movement along the fault appears to be largely transcurrent as Eocene limestone is exposed on both sides of the fault.

To the east the fault passes south of Tembium Village where exposures are not good, but some shearing was noted. The fault can be clearly seen on the air photographs trending eastwards across the Mamp River to join with the fault system mapped by MacMillan & Malone in the Baia River north-east of the Willhelm - Herbert Massif. On its western end the Simbai Fault passes to the north of Simbai Patrol Post.

Indirect evidence of fairly recent transcurrent movement on the fault is given by the anomalous courses of several tributaries of the Simbai River when they cross the fault. However these streams give no idea of the direction of movement. The auriferous terrace at Kumbruf and the alluvial flats at Simbai Patrol Post probably also result from recent movement on the Simbai Fault.

ECONOMIC GEOLOGY

Gold has been found in economic concentrations at Kumbruf and Maramp Rivers, and uneconomic gold occurrences are known at Pint River, and the head of the Jimi River. No other minerals of economic importance were seen by the writer.

Kumbruf Gold Prospect (Dow 1962)

The Kumbruf Gold Prospect is a ridge flanked by Tunonk and Soi Creeks, tributaries of the Simbai River. The ridge is capped by a remnant of an elevated and weathered auriferous terrace. The terrace was probably formed by blocking of the ancestral Tunonk Creek by movement along the Simbai Fault, which crosses the mouth of Tunonk Creek.

Tunonk and Soi Creeks have progressively cut down through the auriferous gravels and have left a series of terraces down the side of the ridge, some of which the lessee has worked for gold. The beds of the two creeks and Nanoi Creek, a tributary of Soi Creek, were also worked.

Gold is at present shedding from the vicinity of porphyritic microdiorite intrusions in the head of Tunonk Creek, and it is undoubtedly this shed which supplied the gold in the terrace. However the shed is neither rich nor extensive, and testing recently done by the writer on the old terrace, show that it is not an economic proposition. A forty-foot deep section of the terrace from the bottom of the old channel of Tunonk Creek was tested, and gave an average value of fourpence per cubic yard. The younger terraces were enriched by concentration of the gold by downcutting of the flanking creeks, but most of these were worked out at the time of the writer's latest visit, and further work on the deposit must shortly cease.

Pint and Kunun Rivers

The porphyry intrusions at the head of Tunonk Creek extend to the headwaters of the Kunun and Pint Rivers which are tributaries of the Jimi River. The writer confirmed the presence of gold in these rivers, but the values are poor. A recent terrace of the Pint River, which was considered the most likely prospect, was tested by means of a portable sluice box but the results were disappointing, and only 0.01 ounce of gold were recovered by four labourers for one days boxing. The gold from both this shed and the Tunonk shed is between 870 and 900 fine.

Maramp River

Gold has been worked by European miners in the Maramp River, a tributary of the Tagan River, for moderate returns. The best gold is worked out, but the river and terraces are still being worked by natives who are content with smaller returns than Europeans. The occurrence was not visited by the writer.

Upper Jimi River

The Kana and Kawn Rivers both contain gold which appears to be derived mainly from arkose and granite conglomerate of the Herbert Beds. The Wilhelm Granodiorite has possibly also contributed some of the gold, but no gold was found in the head of the Kawn River which contains many granodiorite boulders. The Jimi River has a fairly flat gradient below the junction of the Kana and Kawn Rivers, and the recent terraces in this locality may carry sufficient gold to warrant working by the local natives.

RECOMMENDATIONS

It is recommended that a field officer of the Administration Mines Division visit the Upper Jimi River area to test the gold values in the recent terraces with a view to initiating the local natives into gold mining. The best access is by way of Kolt Airstrip followed by one day walk to Bubultunga Village.

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APPENDIX 1.

The Petrography of Specimens Collected from the Lower Ramu - Atitau Area T.P.N.G.

by
W.R. Morgan.

A.29: Slide number 4659. Tunonk River (possibly from Oipe Intrusions)

The hand specimen is a pale greenish-white, apparently weathered and friable igneous rock with abundant phenocrysts enclosed in a fine-grained, seemingly quartz-free groundmass. Phenocryst plagioclase forms tabular white crystals up to 9 mm. long; some of them have a thin border of ferruginous material. Other phenocrysts are composed of prismatic, somewhat acicular greenish black amphibole, up to 4 mm. in length.

A.29. Slide number 4659 (cont.)

In thin section, the rock is seen to be far more fresh than may be supposed from examination of the hand specimen. The groundmass is hypidiomorphic-granular, with an average grain-size of 0.06mm. The abundant phenocrysts are idiomorphic, and plagioclase ranges from 1 mm. to 6.25 mm. in size, and hornblende rnages from 0.1 mm. and 2.25 mm..

The groundmass is composed of granular-tabular sodic plagioclase, prismatic green hornblende, and rare granular quartz. Minute flakes of brownish biotite, or (?)nontronite, are present. Granular black iron ore, some of it altering to leucoxene, may be seen.

The phenocrysts consist of andesine and hornblende Andesine forms tabular crystals which commonly have a very thin rim of hydrated iron oxide. The borders of andesine crystals appear to have been altered to somewhat kaolinised potash felspar, in which are enclosed granules of epidote. In some places, an anti-perthitic relationship of potash felspar lamellae to host andesine may be seen, the lamellae originating from the potash felspar borders. In one crystal it was noted that andesine and potash felspar were both twinned on the same Carlsbad plane. Rarely, tabular crystals of felspar now consist entirely of potash felspar.

Hornblende phenocrysts are euhedral and prismatic, and are commonly clustered. The hornblende is pleochroic, with X = very pale green, Y Z = olive green. Some crystals are zoned, having a paler green border. Hornblende phenocrysts commonly have a thin rim of minute flaky biotite or (?)nontronite crystals stained by hydrated iron oxide.

Rare amygdales are seen, one of which was 1 mm. in diameter, and consisted of a rim of small acicular hornblendes, the interior being filled with quartz.

A visual estimation of the percentages of minerals present is: - andesine anti-perthite: 50, hornblende: 40, quartz: 5, accessories: 5. The rock is a porphyritic quartz - bearing hornblende andesite.

A.31. Slide number 4660, and A.36. Slide number 4662.
Both specimens from Tunonk River. (From Kumbruf Volcanics)

The hand specimen of A.31 is a somewhat weathered and friable, pinkish-brown, fine-grained and apparently porphyritic igneous rock studded with coarse crystals of dull green pyroxene. Little evidence of the fragmental nature of the rock can be seen. The hand specimen of A.36 is less friable, and consists of small fragments of dull red-purple fine-grained volcanic material. Adjoining this is a layer of laminated sedimentary or tuffaceous matter.

In thin section, specimen A.31 is seen to be composed of fragments of porphyritic, fine-grained igneous rock and of isolated crystals. The angular to sub-angular, poorly sorted fragments are from 0.35 mm. and 7 mm. in size. The sparse groundmass to the fragments consists of fine grains of felspar, augite and black iron ore: some shard-like grains of felspar were noted.

The fragments themselves are dominantly seriate microporphyritic; the microphenocrysts being up to 0.3 mm. in size. More rarely, macrophenocrysts, up to 1 mm., or more, in size, are present. The phenocrysts are (?)andesine and colourless to pale green augite: rare hornblende, pleochroic in green is almost invariably surrounded by a rim of hydrated iron oxide. The groundmass is partly very fine-grained, and almost indeterminate even under a high power lens: it is apparently holocrystalline, and consists of fine felspathic and (?)chloritic material. Accessory black iron ore, granular epidote and prismatic apatite may be seen. A few haematite-impregnated grains of olivine were noted. In texture, the rock fragments are commonly pilotaxitic, and only one or two show any pronounced flow orientation of the microphenocrysts. The fragments appear to be of augite-andesite, and hornblende-augite-andesite.

The groundmass of a few of the fragments is nearly opaque because of large amounts of hydrated iron oxide which is present.

The individual crystals present are mainly plagioclase and greenish augite.

The thin section of A.36 shows a very similar fragmental rock, except that here, hornblende is more common, and occurs as both micro- and macrophenocrysts. A brownish serpentinous mineral is seen to pseudomorph rare crystals of olivine.

A.31. Slide number 4660, and A.36 (cont.)

A somewhat fibrous, yellow, epidote-like mineral is seen to occupy uncommon amygdales.

Both rocks are andesitic lithic and crystal tuffs.

A.35. Slide number 4661. Tunonk River. (From Kumbruf Volcanics)

The hand specimen is a fine-grained, porphyritic igneous rock: it has a purple groundmass that encloses numerous flow-oriented tabular white phenocrysts of felspar, and some prismatic ferro-magnesian minerals.

In thin section, the euhedral phenocrysts are seen to be enclosed in a fine-grained hypidiomorphic inequigranular andinterstitial groundmass with an average grain size of 0.05 mm. A slight flow-texture is present. The size of the phenocrysts is 0.5 mm. to 2 mm..

The groundmass consists of tabular plagioclase and interstitial green chlorite: some tabular areas are composed of flaky aggregates of chlorite. Hydrated iron oxide commonly forms highly irregular grains, often in aggregates.

The phenocrysts consist mostly of tabular, sometimes corroded, crystals of albite, commonly somewhat altered to epidote, sericite, chlorite and quartz: some crystals enclose aggregates of hydrated iron oxide. Rarely, albite is almost entirely replaced by quartz. The other phenocrysts consist of olivine and augite. The olivine is a relatively iron-rich variety; it has 2Vx = 70° - 80°. It is also stained brown by hematite. Olivine is commonly altered to a serpentine material, and is replaced by hydrated iron oxide or hematite along its margins and cracks. These alteration products occur particularly where quartz is present. Augite forms euhedral crystals partly, and sometimes almost entirely replaced by quartz and showing some alteration to greenish chlorite along cracks.

One or two thin veins are composed of granular quartz: where they cut albite phenocrysts, part of the felspar is replaced by quartz.

Accessory apatite is enclosed as fine needles in albite.

An estim[illegible] ercentages of minerals present is:- albite: 60, ch[illegible] ivine: 5, augite: 3, hydrated iron oxide: 12. T[illegible] saussuritized, silicified porphyritic olivine [illegible]

A.39. Slide number 4663. Tunonk River (from Kumbruf Volcanics)

The hand specimen is a dark greenish-grey basic igneous rock in which a very fine-grained groundmass encloses small prismatic phenocrysts of a ferromagnesian mineral. Thin veins of calcite cut the rock.

In thin section the rock is seen to be fine-grained and seriate glomeroporphyritic. The groundmass has a pilotaxitic, intergranular and interstitial texture. The specimen is amygdaloidal. The groundmass has an average grain-size of 0.04 mm. and sizes of the porphyritic crystals range between that of the groundmass and 1.75 mm..

The groundmass is composed of lean laths of flow-oriented (?)albite, prismatic augite, and interstitial pale green chlorite. Granules of black iron ore are present. The phenocrysts consist almost entirely of clustered prismatic crystals of colourless augite. Some of them have been replaced by pale green chlorite and subordinate calcite. Chlorite also occupies interstices between clustered augite phenocrysts.

The amygdales range from 0.2 mm. and 5.8 mm. in size, and are elongated in the direction of the flow structure. They are composed of minute spherules and part spherules of pale green chlorite, or granular calcite; - those containing the latter mineral have a thin rim of chlorite. Around some of the calcite-bearing amygdales the groundmass is enriched in chlorite, and contains a few granules of epidote, pleochroic in yellow, and abundant pumpellyite, pleochroic from colourless to bluish-green. Aggregates of pumpelleyite and chlorite are also present in these amygdales.

The rock is cut by an irregular net-work of thin veins containing granular epidote, and, more rarely, pumpellyite. Small amounts of granular sphene are present.

An estimation of the percentages of minerals present in the rock is : - Albite: 55, augite: 23, chlorite: 20, black iron ore, etc.: 2. The rock is a porphyritic amygdaloidal spilite.

A.42. Slide numbers 4664, 4665, and 4986. Tunonk River (Fine-grained rocks apparently from Kumbruf Volcanics, granodiorite from Oipo Intrusions).

These two specimens are composite. In onę, a pale cream rock is in irregular contact with a dark grey rock: some mixing of the two is apparent, and small fragrents of the darker material are found enclosed in the cream rock, as though the latter has intruded the former. In the other specimen, the cream, fine-grained rock is in sharp contact with an acid porphyritic igneous rock. This rock has a fine-grained groundmass enclosing coarse phenocrysts of rounded quartz, tabular felspar, and prismatic, amphibole-like minerals. The porphyry is said by Dr. Corbett to be from a dyke which intrudes the fine-grained rocks.

In thin section, the two fine-grained rocks (4664 and 4986) are rather similar to one another, except that the darker rock has a fair amount of leucoxenic matter present. In each, rounded to angular grains of quartz, and tabular crystals of (?)albite, whose average size is 0.035 mm., are scattered through a finer groundmass of average grain-size 0.007 mm. The groundmass apparently consists of sericite, chlorite, felsic material, and rare nontronite. Some (?) zeolite occupies apparent cavities, and, in places, cubic pseudomorphs of hydrated iron oxide may be seen commonly associated with sericitic veins. Some veins and irregular aggregates of carbonate are present.

The micaceous minerals have a preferred orientation which continues through the light and dark materials alike, but, the tabular fellspars have random orientation. The micaceous lineation is broken by apparent lines of shear. From this, it seems possible that both rocks are acid ashstones that have suffered some low grade metamorphism, and subsequent shearing.

The porphyry has a fine-grained (average size 0.014mm) hypidiomorphic-granular groundmass enclosing numerous phenocrysts which range from 0.1 mm. and 3.5 mm. in size.

With regard to the phenocrysts, albite (An9) forms tabular, somewhat sericitized and kaolinized crystals. One albite phenocryst appears to be antiperthitic, as it has a rim of apparent potash felspar from which exsolution almellae of this mineral extend across the crystal. The potash fellspar has a low refringence and a low negative optic axial angle.

Amphibole is pseudomorphed mostly by fine flakes of green chlorite and small amounts of nontronite, sericite and leucoxene. Two kinds of chlorite are present, one having anomalous brown, and the other anomalous blue interference colours. Quartz forms anhedral, rounded grains which show corrosion.

The groundmass contains granular to tabular felspar, rounded to poikilitic quartz grains, chlorite pseudomorphing amphibole prisms, and flakes of sericite. Accessory apatite and leucoxene are present. Hydrated iron oxide forms rare cubic grains and may pseudomorph pyrite.

A visual estimation of the amounts of minerals present is:- albite: 63, chloritized amphibole: 15, quartz: 15, sericite: 5, others: 2, The rock is a chloritized amphibole granodiorite porphyry.

A.44. Slide number 4666. Tunonk River (From Kumbruf Volcanics)

The hand specimen is seen to be a dark greyish-green, somewhat basic amygdaloidal and porphyritic igneous rock, in which the phenocrysts are enclosed in a dark, fine-grained groundmass. The phenocrysts consist mostly of tabular white felspar, measuring up to 1.5 mm. in size. Some euhedral phenocrysts of pyroxene are present ranging up to 4 mm. in size. The amygdales are roughly spherical, and measure up to 5 mm. in diameter.

In thin section, the rock is seen to be glomeroporphyritic, with a fine-grained holocrystalline hypidiomorphic and ophitic groundmass that encloses subhedral to euhedral phenocrysts of albite and augite. The groundmass is amygdaloidal.

Albite phenocrysts form tabular, frequently clustered, crystals that range in size between 0.2 mm. and 1.0 mm. The mineral shows slight sericitization, and some alteration to granular epidote. Augite forms euhedral to subhedral colourless to very pale green prismatic crystals, ranging, in size between 0.3 mm. and 5.0 mm. Their margins are somewhat corroded and fine granules of pyroxene, mixed with hydrated iron oxide dust, occur there. Slight alteration to chlorite has taken place, and the larger augites are cut by thin veins of quartz and pale green penninite.

Granular-prismatic crystals of epidote may be assiciated with augite phenocrysts. Some ferromagnesian mineral, possibly pyroxene, has been completely pseudomorphed by fine-grained chlorite and subordinate calcite.

The groundmass is composed of albite, chlorite and augite, with leucoxene and some hydrated iron oxide. Lean tabular laths of albite, 0.1 mm. in length, are in ophitic relationship to plates of interstitial, pale green chlorite. Augite forms minute granules, 0.01 mm. in size, and, more rarely, larger grains 0.06 mm. to 0.1 mm. in size, ophitically enclosing albite. Some granular leucoxene and more rare hydrated iron oxide are present. Small amounts of granular epidote may be seen.

Several amygdales are present in the slide, ranging between 0.5 mm. and 2.75 mm.. They consist mostly of aggregates of minute spherules and part spherules of pale yellow-green chlorite, which grow more coarse towards the amygdale centres. Some amygdales have a discontinuous rim of sub-spherulite-like tabular crystals of colourless to pale yellow epidote. One amygdale has a thin rim of chlorite, its centre being filled with black iron ore.

The specimen is cut by several very thin veins that are composed of green penninite and some quartz. A vein 1 mm. to 2 mm. broad is composed partly of a mosaic of sub-amoeboid grains which enclose flakes of sericite and prisms of apatite. In places, the vein is almost completely filled with sericite, mixed with sub-spherulite-like growths of prismatic apatite. Yellowish, granular epidote may be found along the veins margins, and around incorporated phenocrysts.

An estimation of the amounts of minerals present is:- albite: 45, chlorite: 30, augite: 20, others 5. The rock is a porphyritic amygdaloidal spilite.

Plate 1

THE GEOLOGY OF THE JIMI AND SIMBAI RIVERS

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