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EXPLANATORY NOTES TO ACCOMPANY A GEOLOGICAL SKETCH MAP OF PART OF THE WESTERN DAGA RANGES, PAPUA.

by

J.H. Latter

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EXPLANATORY NOTES TO ACCOMPANY A GEOLOGICAL SKETCH MAP OF PART OF THE WESTERN DAGA RANGES, PAPUA.

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ABSTRACT

The author made two short journeys into the area, which lies to the south of Collingwood Bay, Papua, and extends from the northern foothills to the crest of the Owen Stanley Range. The first, in early October, 1961, was a direct result of a report that volcanic activity was taking place. For several weeks in August 1961 dense smoke was seen emanating from a mountain-side close to the summit of the range some miles to the westward of the sharp peak of Mount Maneo*. These reports came from Mr. A.A. Imlay at Wanigela, 20-30 miles distant to the north-north-west, who also reported seeing a fluctuating glow over the mountain at night. Since it was believed that the area was a Pleistocene Volcano, an aerial reconnaissance was carried out from Port Moresby to confirm the activity. Bad weather made this inconclusive and a second one was made by Cessna aircraft from Lae. This established that there was no crater in the area, the wide expanse of burnt country attributed, correctly, to the result of an extensive grass fire.

The author, who was shortly afterwards visiting Mount Victory and Goropu (Waiowa) volcano, climbed Mount Maneo from Biniguni, on the north side of the range, and penetrated as far as Mount Aniata. The burnt area was located on Mount Kwankwai.

In August 1962 he again visited this part of the Daga Ranges, in company with the Rev. N.E.G. Cruttwell, of the Anglican Mission at Menapi.

GEOGRAPHICAL LOCALITY OF THE AREA

The Daga Ranges may be defined as the western half of the Gwoira Range, or, as it is sometimes known, the Gwoina Range, in south-eastern Papua.[X]

The Gwoira Range proper constitutes that part which lies well to the north of the crest of the Owen Stanley Range, in the vicinity of the villages of Biman and Danawan, Mount Gwoira itself being the mountain, forested at the summit but surrounded by extensive kunai grassland, which lies three miles north of Biman and about twelve miles west of the inner extremity of Goodenough Bay.

The name, Gwoira Range, has, however, been extended to cover the whole region from the west of Goodenough Bay to a little beyond the summit of Mount Aniata, thirty miles to the west, on the crest of the Owen Stanleys. This is therefore the

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* Also spelt Manaeo, Maneau or Manaeao, and sometimes referred to as Mount Dayman (see later discussion).

X Figure 1 illustrates the location of the area with respect to Collingwood and Goodenough Bays.

name that appears on the Department of the Interior photo index mosaic.

The name, Daga Ranges, originates from the Daga tribe, who are the indigenous people inhabiting the northern and central part of the Goropu Range from Biniguni to within a few miles of Goodenough Bay. The western Daga people inhabit the villages on the north side of Mount Maneo, their centres being Biniguni and Mayauman. The eastern Daga inhabit the area defined by the villages of Biman, Bonenao and Agaun, and have settlements that extend east towards Goodenough Bay.

The greater part of the area included in this report is uninhabited. On the north side the closest villages to Mount Maneo are Biniguni and Ginum, and on the south-east side Bonenao and Munimun (see map accompanying these notes). The area is virtually inaccessible from the western and southern sides, which are uninhabited.

The part covered in this report extends south about fifteen miles from Biniguni to Mount Aniata and about twelve miles in a south-easterly direction from there to Mount Garatun near Bonenao.

TOPOGRAPHY

The area described in this report rises from the faulted northern boundary of the foothills of the Owen Stanley Range at a height of about 500 feet above sea level, to the southern scarp of the Range at a height of over 9,300 feet.

The mountains do not form isolated peaks but are more in the nature of crests on the ridges. The main range itself follows the south facing scarp from the cliffs west of Mount Aniata through Mount Manaman and Mount Donana to Mount Biau. This scarp is the dominant feature of the region. Below the Mount Aniata cliffs the country falls rapidly to the south, dropping an estimated 6,000 feet in about four miles.

Within the area studied, the nature of the surface has been chiefly determined by the drainage, which, following planes of weakness in the rocks, has deeply incised the mountains forming gorges with relict terraces high up on their flanks.

The Kwasi River system, which comprises the rivers from the Gwariu on the east to the Kwankwai on the west, has determined the configuration of the northern part of the area, by cutting out a radial series of gorges around Mount Kwankwai. The central part of this area from Mount Kwankwai to Mount Igit has been left as an extensive plateau, swampy in parts, which extends up to the crest of the scarp near Mount Aniata.

Outside the circular pattern of the headwaters of the Kwasi River system, which empties through the narrow and deep Kwasi Gorge, the drainage to the north is consequent upon the steep but regular slope of the foothills, forming a series of nearly parallel water courses, precipitous in their lower part. These empty into the easterly flowing Mau'u River along the still active part of the northern boundary fault, and cross this fault in other places to flow out across the plains and ultimately into the Rakua River.

On the eastern side of the area the rivers flow in deep valleys between nearby parallel ridges. One, the Nowandowan, flows in a deep gorge from between Mounts Aniata and Manaman, where its headwaters have pushed back the line of the scarp some distance to the south-west.

The greater part of the country is forested. As one ascends, the rain forest of the plains north of the northern boundary fault gives way to the Oak and Castonopsis forest of the middle slopes. At about 5000 feet this gives way to Nothofagus forest in which moss is abundant and the trees are generally smaller. It is the upper parts of the Nothofagus forest, where moss particularly flourishes, that are loosely described as Moss or Cloud Forest.

At about 6,000 feet in this part of the Daga Ranges open patches of grass are found on which bracken grows very plentifully. The grass is short and bears no similarity to the Kunai grass which is encountered in so many parts of New Guinea. In it grow alpine plants in great profusion with various species of rhododendron and other high altitude shrubs, and through it and in the neighbouring forest are to be found Hoop Pines, (Araucaria cunninghamii).

At about 8,200 feet the grass gives way to a still more alpine flora with abundant sedges, and the country takes on the appearance of tundra. Hoop pines persist up to a height of about 7,500 feet. On the summit of the range, at about 9,000 feet, are patches of dwarf or 'elfin wood', in which the trees are small and heavily overgrown with moss, and in which many species of rhododendron flourish. On the tundra country between Mts. Aniata and Kwankwai grows a remarkable species of tree fern.

During the two periods in which the writer visited the area the weather was generally good. At 6,000 feet or more one is commonly above the daily cloudbursts that occur on the middle and lower mountain slopes and the days were pleasantly warm. At night the temperature dropped as low as 43°F. On several occasions, however, cloud rose from the valleys and completely blanketed the heights, and a cold drizzle set in.

DETERMINATION OF HEIGHTS

Heights were determined as accurately as possible by aneroid readings. Although heights given on the accompanying map have been corrected in accordance with the best evidence available at the time, they are still inaccurate. They represent the best fit between results obtained in August 1961 and those of October 1962.

Comparison with earlier maps of the region will show that they do not agree with previous measurements. In particular they disagree with the heights shown on the aeronautical map, which gives 9,800 feet for a mountain marked in the position of Mount Maneo, called Mount Dayman. W.M. Strong's map of 1916 gives the height of Mount Maneo as 9137 feet and that of Aniata, which he calls Dayman as 9305 feet. The latter is in good agreement with that quoted on the map accompanying this report. There are also disagreements between heights determined by the Rev. Cruttwell and mine, Cruttwell's being generally higher.

NOMENCLATURE

There is great confusion and disagreement over the correct identification of Mount Dayman. This mountain was named by Captain Owen Stanley during a survey voyage in the "Rattlesnake" along the south coast in 1849. The writer does not know whether Mount Maneo is visible from the south coast, as on the day that he climbed it there was thick cloud and no view could be obtained. Mount Aniata, however, is undoubtedly visible (not however from the north coast in all areas as it is obscured by Mount Igit). Since it is the highest peak in the area the evidence appears to be strongly in favour of its being the true Mount Dayman.

Mr. L.J. Brass in his 'Summary of the Fourth Archbold Expedition to New Guinea' refers to Mount Dayman as the group of peaks around the head of the Gwariu River (and marked on the accompanying map as Maneo, Donana, Manaman and Aniata). The name has accordingly been dropped on my map in favour of the native names on which there is better agreement.

Discrepancies between names on my map and those quoted by Mr. Brass can be explained by the fact that his are the names by which the mountains are known to the Biniguni or western Daga people, whereas mine are the names by which they are called among the Eastern, Bonenao people.

Equivalents are as follows :-

European	Western Daga	Eastern Daga
? Dayman	Maneo	Maneo
-	Gadmarau	Donana
-	Manaman	Manaman
? Dayman	Kakatun	Aniata
Kakatun Ridge	-	Igit

NOTE ON THE METHOD OF MAP CONSTRUCTION

The map presented with this report is completely uncontrolled. It was made simply by constructing overlays for individual airphotographs and filling these together without any kind of framework, using the Gwoira Range westerly tie as a guide to orientation.

Accordingly in those parts of the map where the relief is high, such as the Kwasi and Nowandowan Gorges, and on the south of the Aniata - Donana Scarp, there is likely to be considerable error in positions of the rivers.

In particular, angular directions measured between areas of high and low topography on this map are likely to be in error by a few degrees.

GEOLOGY

The following rough section was deduced for the succession in the area:-
NB :- Rocks that have been examined in this section by Mr. W. Morgan, marked*.

	Rock-type	Maximum Thickness (feet)		Age
	Tufa and Travertine	about 20		Recent
	Alluvium	about 15		Recent
	MIOCENE OROGENY?			
Volcanic Rocks	Vesicular Basalt*	?	about 5000	?Oligocene or lower Miocene
	Fine grained Basalt*, and some spilite*, often sheared,	4400		
	Tuffaceous Claystone*	about 400		
	Fine-grained Basalt*	?		
	UNCONFORMITY			
Calcareous Rocks	Slate*	about 350?	about 600	?
	Sheared marble* and thin calcareous slate*	about 200?		
	Faulted, thrust contact			
	Brown micaschist* (including phyllonite*)	about 1800	about 4000	?
	purple schist*			
	purple-green schist	about 2000		
	green schist			
	grey-purple sheared andesite*			

Dolerite*intrudes the schists, but is not seen intruding the calcareous or volcanic beds.

(a) The Schists.

Basement in the area is represented by schists. They vary somewhat from locality to locality, in appearance and grain size, but in all places are highly foliated. In a few outcrops minor quartz augen structure can be seen.

Since the rocks have been affected by widespread thrusting the succession is hard to establish.

The oldest rocks in the area are probably the grey-purple sheared andesites which appear to underlie fissile green schist on the north side of Mount Garatun.

The green schist is found exposed in the Magut River and near Bonenao, and it appears to form the lower slopes of Mount Mon. It occurs in the Gwariu River about a mile from Yogom, underlying purple schist. The purplish-green epidote schist (macroscopic determination), which is found in situ at the head of small streams leading down to the Duiri River, is probably a variant of either the green or the purple schists at the head of the Gwariu River.

Unfortunately no time was available for a traverse down the Gwariu River, where outcrops are said to be good and it is probable that a succession in the schists could be established.

Good exposures of schists are to be found near Vitanen, on the east side of Mount Donana. Here, although thrusting has occurred and the rocks are tightly folded, the upper part of the succession can be distinguished. A strikingly purple quartz-muscovite schist apparently overlies the purple-green schist, and is overlain by brown mica schist and phyllonite. Boulders of this purple quartz-muscovite schist are found in the Siau River at the point where the path from Bonenao crosses it, and in the Nowandowan Gorge below Yauyama.

The summit ridge of Donana is formed of the brown mica schist, which is apparently the top member of the schist group. Similar rocks, deeply weathered, occur on Airok and Wapuna mountains, north of Mount Maneo, and on the west side of Mount Aniata.

(b) <u>The calcareous rocks</u>.

Sheared marble with very thin bands of calcareous slate (1-3 inches thick), and hard grey-black calcareous slate up to about 375 feet thick, is found in the summit area of Mount Aniata. The rocks occur as thrust masses in the volcanics and schist sequence, and the relationships are somewhat hard to interpret. The true summit of Mount Aniata is a complex thrust block composed of highly sheared greenish basalt, much decomposed. Under it, on the south side, is a thrust block of interbedded sheared marble and slate, which also forms the upper part, at least, of the massive cliffs that extend from Mount Aniata westwards for more than six miles.

The calcareous rocks usually have travertine deposits formed on their exposed surfaces. This material, which is very soft, and grey white in colour, has a thin hard weathered crust which protects it against further weathering so that large masses resembling upraised coral reefs have been built up in places. Particularly good examples are to be found at the summit of Mount Donana, which is formed of a thrust block of interbedded slate and sheared marble. No fossils have been found in the sheared marble and slate.

Other outcrops of these rocks are to be found in the Pingai River near the head of the Gwariu River, near Yauyama, and in the Magut River to the south of Munimun. Contacts are either not exposed or are seen to be faulted.

At Yauyama Rock an excellent exposure shows marble overthrust from the south-east on tightly foliated grey mica schist.

(c) The volcanic sequence.

An unconformity probably exists between these rocks and the schist group. Contacts, however, are not well exposed (for example the contacts on Mount Mon are completely obscured by moss forest). Many are seen to be faulted, and it is possible that the apparent unconformity running east and south of the Gwariu River from near Mount Maneo to near Mount Kwankwai is faulted over much or all of its length. Similarly the contact on Mount Pema is not exposed and may be faulted. Thus the field evidence for the younger age of the volcanics rests chiefly on the fact that these rocks usually occur topographically above the schists, without actual evidence of faulting (cf. Mount Mon, Mount Maneo), while the calcareous group seems to be associated with the schists.

The volcanic beds are dominantly basalt. Minor spilites are found, and claystones, which from microscope evidence appear tuffaceous, are abundant.

The basalt is fine-grained, greenish and partly silicified. It is commonly cut by veins of quartz, epidote and chlorite, and in many outcrops it is strongly sheared, epidotized, and kaolinized.

In outcrops close to the major northern boundary fault the basalt appears in hand specimen to be a greenish fine-grained mylonite. Microscopic evidence shows that it is crushed, brecciated, hornfelsed and silicified. The crushing and brecciation occurred first, followed by the hornfelsing. Secondary silica was emplaced last.

Outcrops of vesicular basalt were found in the Burai River where it enters the Nowandowan River.

Structures are comparatively easy to map in the volcanics, compared with the schists, which have been much more heavily sheared and thrust, so that a fairly reliable succession was derived for this sequence.

Field evidence suggests that the whole of the area eroded by the Gwariu River may have been covered by volcanic outpourings, and that these probably originated from Mount Maneo or some centre of which Mount Maneo is a remnant. Clearly the original volcano cannot have been Pleistocene and it is suggested that it was Oligocene or early Miocene. Deformation of the rocks has certainly taken place, and this can only have been caused by the Miocene orogeny.

(d) The intrusive dolerite

Medium-grained, generally hornfelsed, dolerite is seen to have intruded the schists in a number of places, notably Mount Naip near Aininupineniwa, in the upper Gwariu River, and near Bonenao.

Its relationship with the calcareous group and the volcanics is not seen.

On Mount Manaman a quartz-grossularite-epidote hornfels is closely associated with the dolerite, which apparently intrudes it. Microscopic evidence shows that small amounts of probable phlogopite are present in the rock. At this locality the dolerite itself is also hornfelsed.

Near Bonenao the dolerite is strongly kaolinized. Although actual evidence is lacking, the writer is of the opinion that the dolerite is probably an intrusive member of the volcanic sequence.

STRUCTURE

The dominant structure, which marks the effective northern limit of the area mapped, is the great northern boundary fault along the margin of the northern foothills. This feature has been mapped well beyond the area covered by the writer (see J.W. Smith and D.H. Green, "The Geology of the Musa River area, Papua"); it is probably of the same age as the Owen Stanley Fault.

A second major fault follows the course of the Nowandowan River to the south side of Mount Aniata, and has a possible extension, not shown on the map, parallel to the southern cliffs of Mount Aniata.

The Kwasi River follows the line of a probable fault, and a number of others, for which the evidence is mainly from airphotograph lineations, are shown on the accompanying map.

Dominant directions range from north/south to north-east/south-west, and east-north-east/west-south-west to east-south-east/west-north-west.

Evidence of thrusting from the west has been observed near Vitanen and from the east near Yauyama. Almost horizontal thrust planes are to be seen near the summits of Mounts Aniata and Donana.

Apart from the Nowandowan Fault, the only observed faults in the area were those in the Magut River, and on the summit of Mount Aniata, and the Yauyama Fault near Dontoat.

Unfortunately insufficient evidence was obtained for conclusions to be drawn from the few structures that were mapped.

Hematite-rich quartz material with minor chlorite is found commonly associated with faults in the area.

The remarkably straight trace of the Mau'u River over a length of more than 5 miles provides a remarkably good illustration of fault control of river courses. The position of tributaries of the Mau'u River suggests that transcurrent movement took place along this fault (see Plate).

HOT SPRINGS

No hot springs or thermal areas were found in the Daga mountains themselves. A visit was, however, made to the Amunam River hot springs, which are about 2 miles to the east of Biniguni No.2 village, and almost on the trace of the Northern Boundary Fault.

Seven temperature readings were made of the water over a length of 690 yards along the river. Temperature was found to vary from 34°C at the furthest point measured downstream to 55°C at the source, 690 yards upstream. Immediately above the source the temperature of the stream water was 25°C.

The water at source emerges from an outcrop of carbonated lithic tuff. Under the microscope most of the fragments were found to be composed of fine grained altered basic igneous material, enclosed in a matrix formed of interlocking calcite grains*.

Ferruginous travertine has been deposited over the rocks where the hot water flows, and the water itself is orange-red in colour. It has a fresh, somewhat salty taste and no smell, and is quite well aerated. Some 300 yards downstream from the source a very slight odour of hydrogen sulphide could be detected.

According to local villagers, the water was colder than usual at the time of the writer's visit on account of recent heavy rains. In dry weather the whole riverbed is said to have hot pools in it, which even at the point measured furthest downstream (34°C) are too hot to put one's foot in.

A determination of the amount of acid insoluble residue and the sulphate content of the acid soluble part of samples of the travertine from the source rock and from 690 yards downstream was made by Mr. N.W. Le Roux at the Bureau of Mineral Resources Laboratory in Canberra. Results were as follows :-

Sample	Acid insoluble residue	SO_4 content of acid soluble part.
XIL (690' downstream from source)	1.8%	<0.03%
X3L (at source of hot water)	0.46%	<0.03%

It was hoped that this might give an indication of whether the flow of hot water could be derived from an underground volcanic source (such as Mount Maneo, some 9 miles to the south). The result of the analyses suggests that this was not so, since a higher sulphate content would have been expected.

Thus it is probable that the origin of the thermal area is to be correlated with the Northern Boundary Fault near which it lies, rather than with any ancient volcanic activity at Mount Maneo.

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* A sample of the "country rock" boulders in the river was identified as veined glomeroporphyritic and variolitic spilite, with veins containing quartz and chloritic matter.

It should be noted that the Goropu volcano (or Waiowa as it is sometimes called), which lies on the north side of the ranges some 16 miles to the west, is situated very close to the probable continuation of the Northern Boundary Fault, by which its position was probably controlled. This centre erupted, apparently for the first time, in 1943-44. See Plate.

ACKNOWLEDGEMENTS

The author wishes to thank Mr. W. Morgan of the Bureau of Mineral Resources who kindly undertook to cut and examine the specimens. The descriptions of the rock types are entirely his and without him no more than a very meagre account of this area could have been given, since the rocks are extremely hard to identify in hand specimen.

Acknowledgement is also due to Mr. N.W. Le Roux who carried out the analyses of the travertine samples in Canberra, to Messrs. G.A.V. Stanley, J.E. Thompson, J.W. Smith and D.B. Dow, who gave the author the benefit of their experience of New Guinea geology, and to the Department of Forests in Port Moresby for prolonged loan of airphotographs.

The author wishes to thank Mr. L.J. Brass, Associate Curator, Archbold Collections, the American Museum of Natural History, for his assistance in correspondence, and in particular the Reverend N.E.G. Cruttwell of the Anglican Mission, Menapi, for his very cheerful company in the field.

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Plate 1: Mount Manoo in the east and Mount Kwankwai in the west separated by the gorge of the Gwaniu River, looking east,

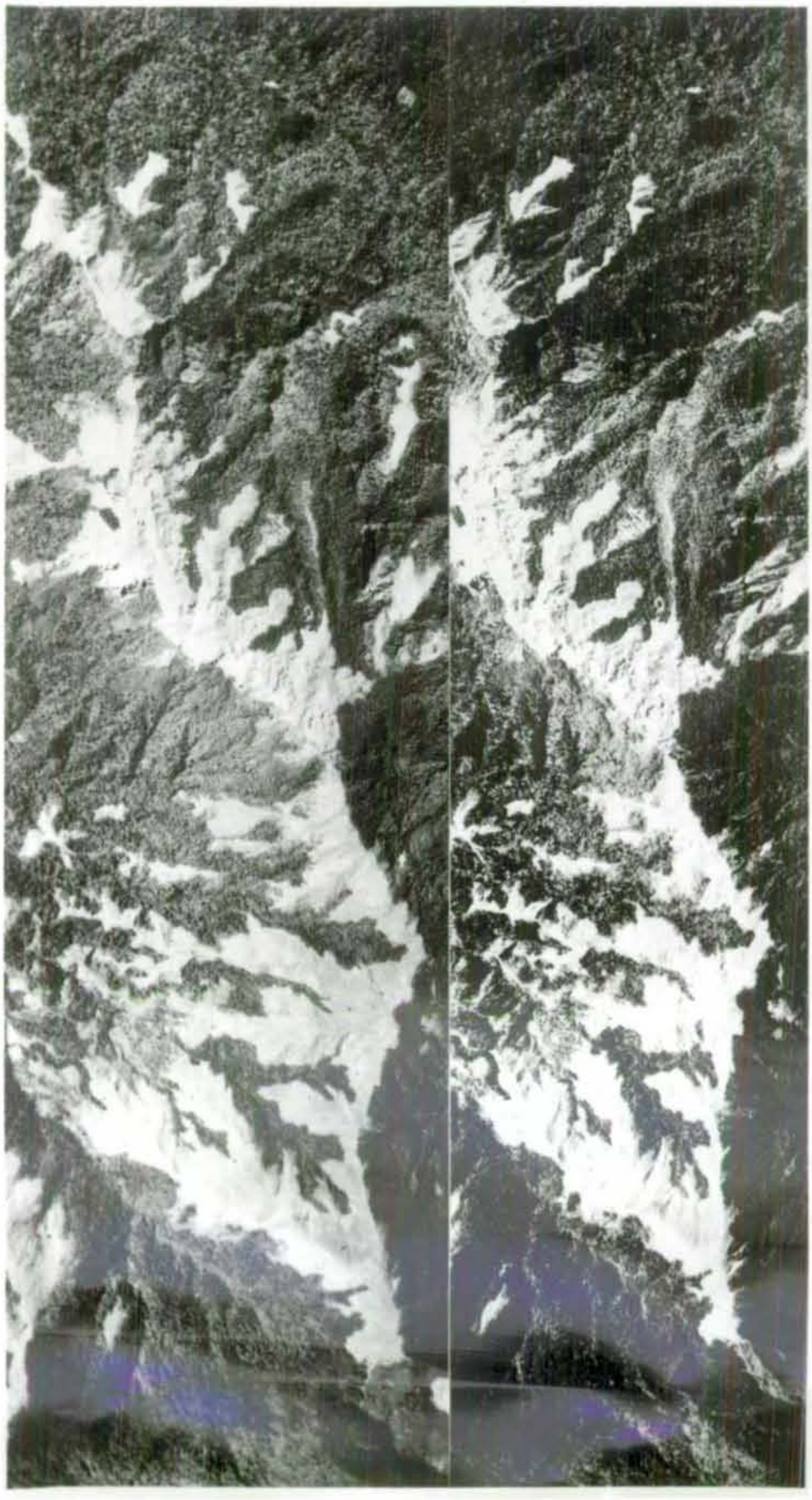


Plate 2: Mount Donana, looking east.

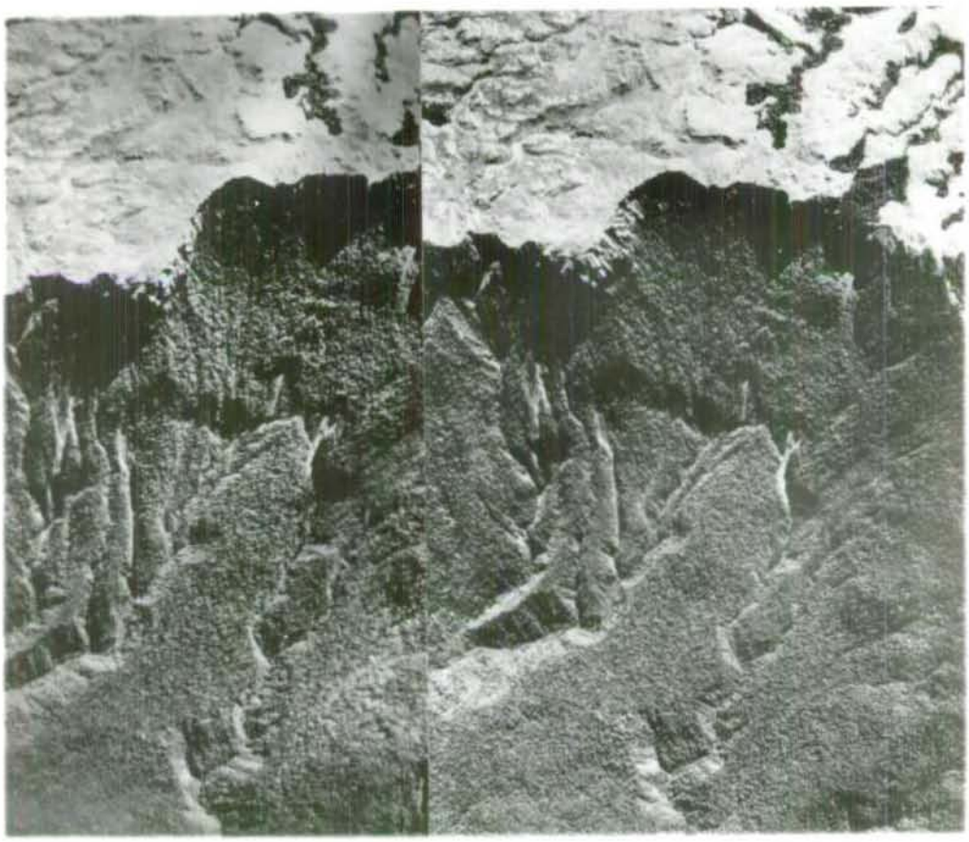


Plate 3: Mount Aniata, from the south.

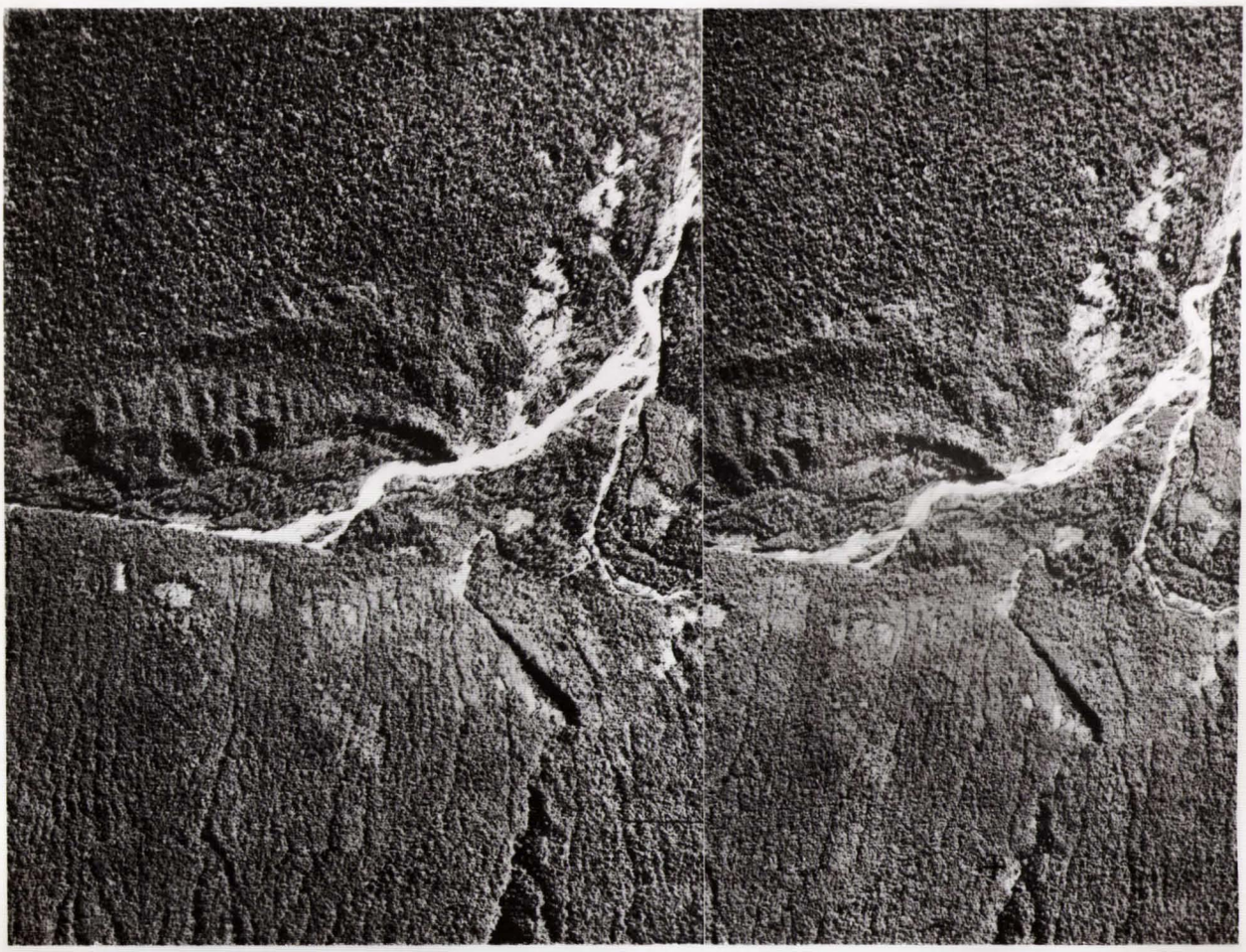


Plate 4: Mau'u River at Biniguni: the northern boundary fault, looking north.

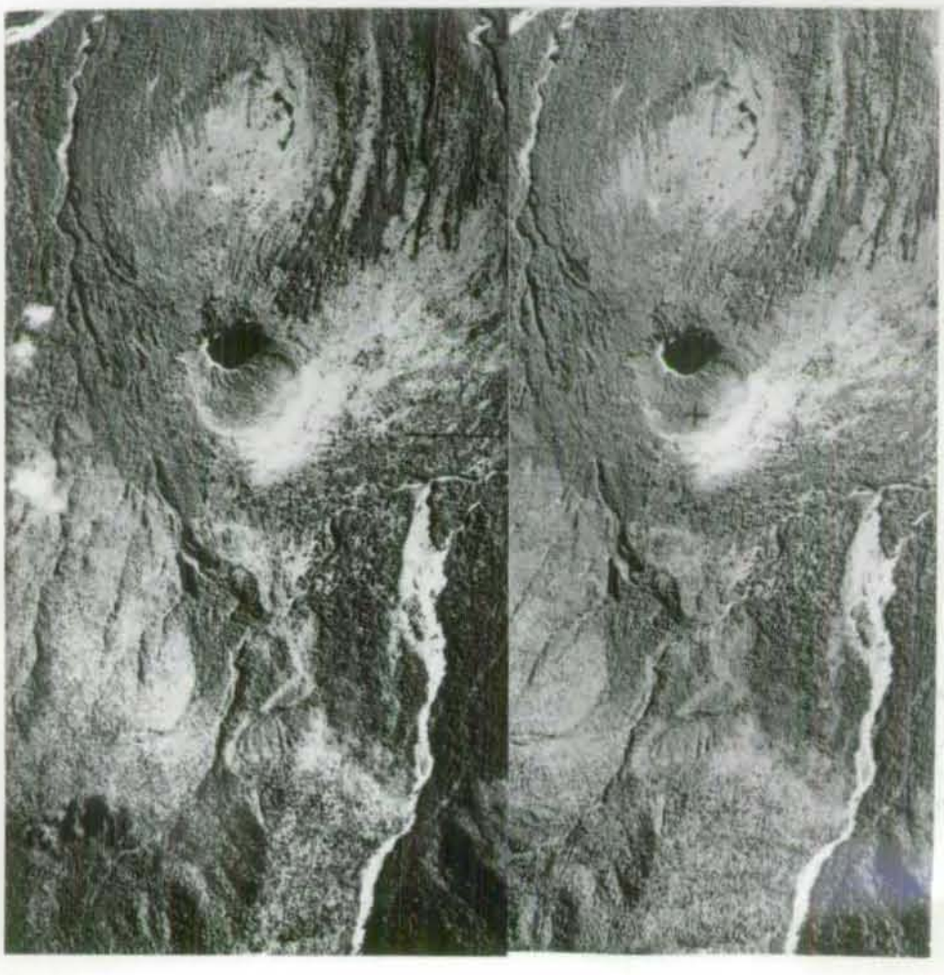
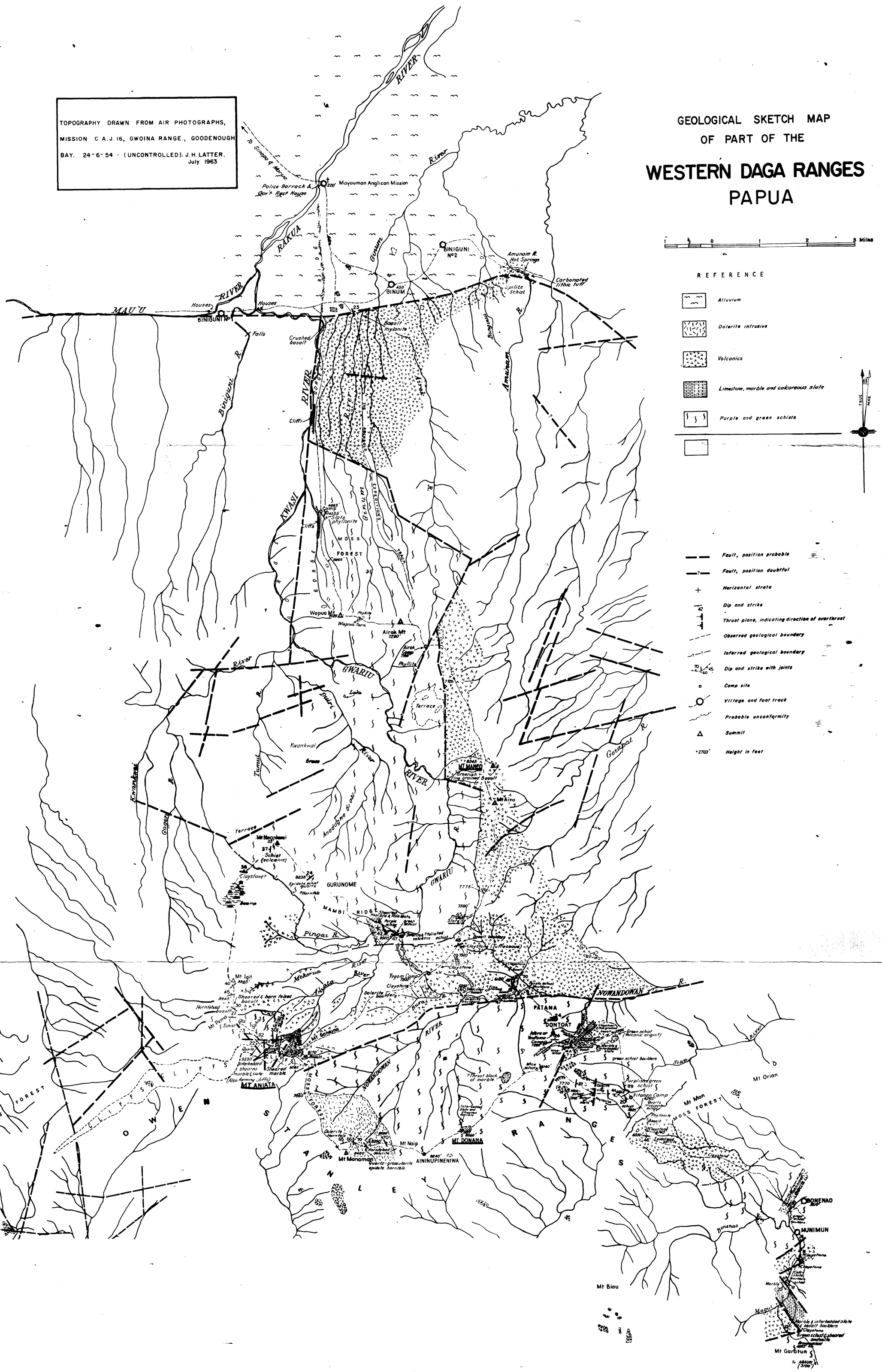


Plate 5: Goropu Volcano on the westerly extension of the northern boundary fault, looking north.

TOPOGRAPHY DRAWN FROM AIR PHOTOGRAPHS, MISSION C.A.J. 16, GWOINA RANGE., GOODENOUGH BAY. 24-6-54 - (UNCONTROLLED). J.H. LATTER. July 1963

GEOLOGICAL SKETCH MAP OF PART OF THE WESTERN DAGA RANGES PAPUA



Bureau of Mineral Resources, Geology & Geophysics. Oct., 1963.

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