COMMONWEALTH OF AUSTRALIA

DEPARTMENT OF NATIONAL DEVELOPMENT

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

REPORT No. 107

REPORT TPNG 2

Short Papers from the Vulcanological Observatory, Rabaul, New Britain

BY

C. D. BRANCH

Issued under the Authority of the Hon. David Fairbairn
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MINISTER: THE HON. DAVID FAIRBAIRN, D.F.C., M.P.

SECRETARY: R. W. BOSWELL, O.B.E.

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

DIRECTOR: J. M. RAYNER, O.B.E.

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CONTENTS

MOUNT BALBI VOLCANO COMPLEX, BOUGAINVILLE, T.P.N.G.

SUMMARY

The Mount Balbi volcano complex, 8500 feet high, on Bougainville Island, consists of six well preserved ash craters (A to F) surrounding an amphitheatre containing a solfatara field 1 mile in diameter. A prominent spine of augite andesite tuff has been extruded at the southern end of the volcano complex. The volcano is located at the intersection of three fault-controlled valleys; one trends south-west, one north, and one east.

The most recent eruption was probably from crater B, between 1800 and 1850, and many were killed by nuées ardentes. Present activity is confined to moderate fumarole activity in crater B, and strong fumarole activity on the southern slopes of crater C, where temperatures ranging from 76°C to 145°C were measured, and a large volume of vapour containing steam, hydrogen chloride, sulphur dioxide, and some hydrogen sulphide is issuing under high pressure.

INTRODUCTION

Mount Balbi lies in the centre of the northern third of Bougainville Island, in the Territory of Papua and New Guinea (Fig. 1). It is the northernmost volcano in Bougainville: the others are Bagana, Numa Numa, and Lake Billy Mitchell near the centre of the island, and Takua, Taroka, and Lake Loloru towards the southern end of the island (Blake & Miezitis, 1967). Bagana is active, Balbi and Lake Loloru dormant, and the remainder extinct.

The summit of Mount Balbi consists of a number of dormant volcanic cones, the highest point of which is about 8500 feet above sea level. Tropical rainforest covers the lower slopes of the mountain up to an altitude of about 4000 feet. Between 4000 feet and 7000 feet bamboo is the dominant vegetation. Casuarina trees grow above 4500 feet and moss becomes more abundant above 6000 feet. Stunted moss-covered forest is common at altitudes greater than 7000 feet, but in the Mount Balbi area, above 7500 feet, the forest is replaced entirely by a tough-cutting alpine rush (Fig. 6). The area above 2000 feet is uninhabited.

A report by an airline pilot of increased volcanic activity from the summit of Mount Balbi led to a ground investigation by J.H. Latter and C.D. Branch between 6 and 15 February 1963. The ascent of Mount Balbi was begun from Wakunai Patrol Post on the east coast of Bougainville. The route followed was along the Wakunai River to Togarau village on the first day, from Togarau to the lower camp (Fig. 1) on the second day (no water available), and the upper camp was reached by midday on the third day (good drinking water but very little firewood). Four days were spent examining the craters. The descent was made in the same stages as the ascent, with time taken, at the end of the first day, to recover from the effects of chlorine poisoning, and on the second day to examine a thermal area near Togarau village.

Black sand is abundant on the beaches at Wakunai, associated mainly with boulders of micromonzonite. Spilitized pillow lava crops out in the Wakunai River about 4 miles from the mouth: some outcrops are traversed by thin veins of clay containing pyrite. Six miles inland, limestone crops out in the Wakunai River.

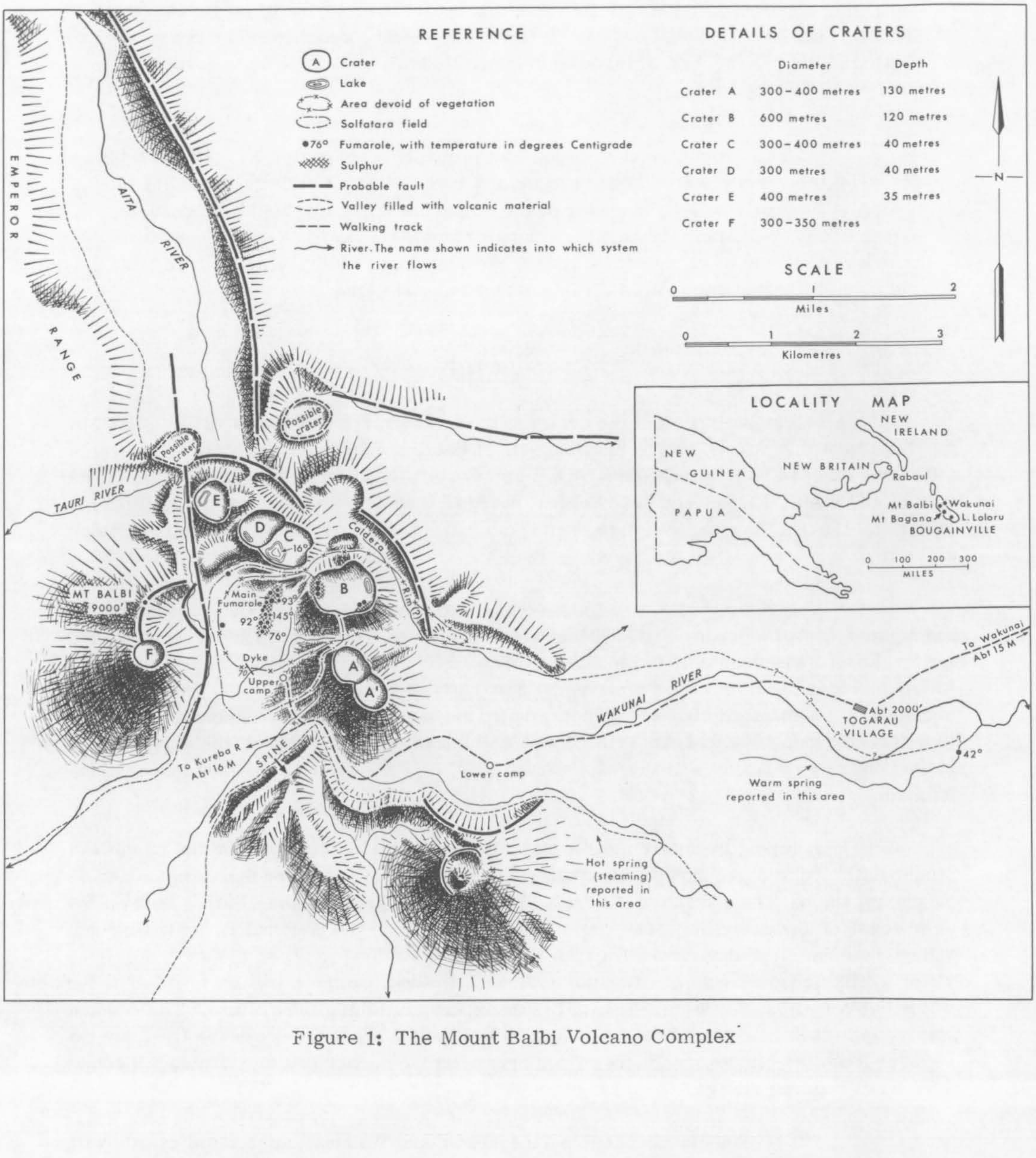

Figure 1: The Mount Balbi Volcano Complex

MOUNT BALBI VOLCANO COMPLEX

Topography

Viewed from the coast, Mount Balbi appears as a broad dome rising several thousand feet above the general level of the Emperor Range - part of the backbone ridge of Bougainville. The volcanic complex constitutes the upper part of the dome, and is 2000 to 3000 feet high. The summit area consists of an amphitheatre about 1 mile in diameter containing a solfatara field, ringed on three sides by six well preserved cones (A to F) 300 to 500 feet high, a partly collapsed cone - the top of which is the highest point in the area - and a volcanic spine (Fig. 1). To the south-west the amphitheatre opens into a broad valley that falls steeply to the coast 8 miles away. Two other valleys drain off the volcanic complex; the one to the north contains the headwaters of the Aita River, and the one to the east, towards Togarau village, contains the Wakunai River.

Previous and present activity

The last eruption of Mount Balbi is reputed to have taken place sometime between 1800 and 1850, and the inhabitants claim that many people died as a result of it.

The present activity is only at the fumarole level, and is confined to two areas; one area is inside crater B (apparently the focus of the last eruptive activity), and the other is on the southern slopes of crater C near the centre of a solfatara field. The presence of chlorine in the gases exhaled from the fumaroles indicates that the volcano is potentially active.

Craters A to F

Craters A to E form a lineament 2 miles long trending north-north-west and slightly convex to the north-east. Crater F is slightly more than 1 mile south-south-east of crater E and almost at the focus of the arc joining craters A to E. The craters have been described briefly by Fisher (1957) mainly from air-photo interpretation, and his descriptions are repeated here with some elaboration; the dimensions of the craters are listed in Figure 1.

Crater A is a well preserved pit crater 400 feet deep and 1200 feet in diameter; it is covered by vegetation on the outside (Fig. 2). A specimen of finely porphyritic augite basalt was collected from near the lip of the crater. On the outer, south-east side of crater A is another crater of similar dimensions (designated A1), but it is not as well preserved as Crater A. Crater A is the highest of the craters, and is joined to crater B by a sharp ridge.

Crater B is 380 feet deep and ranges from 1750 to 2200 feet in diameter. The crater and a considerable area to the east and west of it are devoid of vegetation (Figs 1, 3, 7). Active fumaroles steam steadily on the south-eastern (Fig. 4) and western (Fig. 3) faces of the crater. The fumaroles were inaccessible, but sulphur deposited beside them suggests that the temperature is not much above 100°C. The bottom of the crater is covered by agglomeratic material derived from the crater walls. Fisher (1957) reports fumarolic activity from the floor, but none was visible in February 1963. Irregularly bedded blocky ash (the blocks are flow-banded hypersthene-augite andesite) is exposed in the crater walls (Fig. 3), and similar material covers the outer slopes of the cone.

Crater C is 130 feet deep and 1700 feet in diameter. A brilliant blue lake with a water temperature of 16°C covers about half the bottom of the crater (Fig. 5). Alpine rush grows inside and outside the crater.

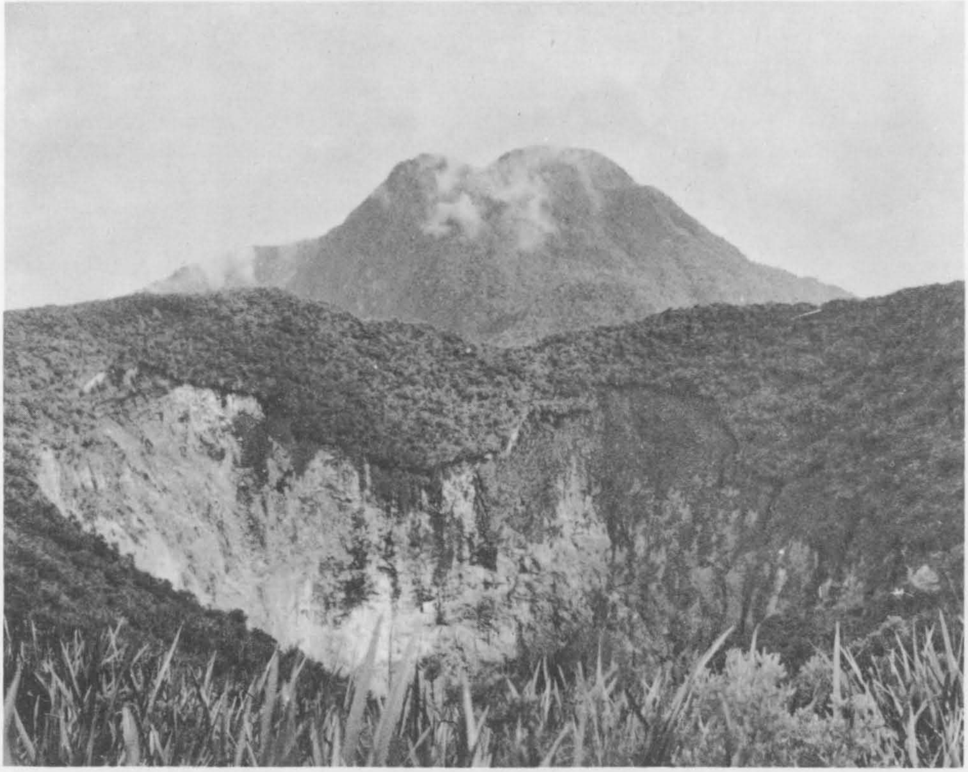

Figure 2: Crater A in the foreground, looking south-east to the spine.

Crater D is 130 feet deep and 1200 feet in diameter, and contains a small brown lake. The ridge dividing crater D from crater C is about 50 feet high and encroaches on crater C. This suggests that crater D is younger than crater C. There are small low-pressure fumaroles and solfataras in both craters at the north-eastern end of the dividing wall. Alpine rush grows inside and outside the crater. A plateau 2000 feet long and 800 feet wide on the south-western side outside the crater may be a lava flow from crater D.

Crater E was not visited. An attempt was made, but thick alpine rush slowed progess so much that the attempt was abandoned. The crater is about 120 feet deep and (from air-photographs) 1300 feet in diameter. It is breached on the eastern side, and is possibly joined to a small irregular crater outside the main crater.

Crater F was not visited; it is located in the summit of a well preserved ash cone about 500 feet high, which is joined on to the northern side of the wall of another crater that constitutes the highest point in the area (Fig. 6). It is separated from craters A to E by a solfatara field three-quarters of a mile wide. On the air-photographs, the crater is seen to be a fairly deep dish 1000 feet in diameter, covered by patchy vegetation on the inside and outside.

Crater B appears to be the youngest, then follow craters D, C, F, A, E, and the oldest is a remnant crater north of crater F.

Figure 3: Crater B in the foreground, looking towards crater A, with the spine in the right background.

Figure 4: Crater B, with Mount Bagana in the central background.

Figure 5: Crater C with the blue lake and craters D and E beyond.

Figure 6: Looking west from the upper camp to crater F on the left and Mount Balbi on the right.

Figure 7: View from the lip of crater B over the main fumarole towards Mount Balbi and crater F.

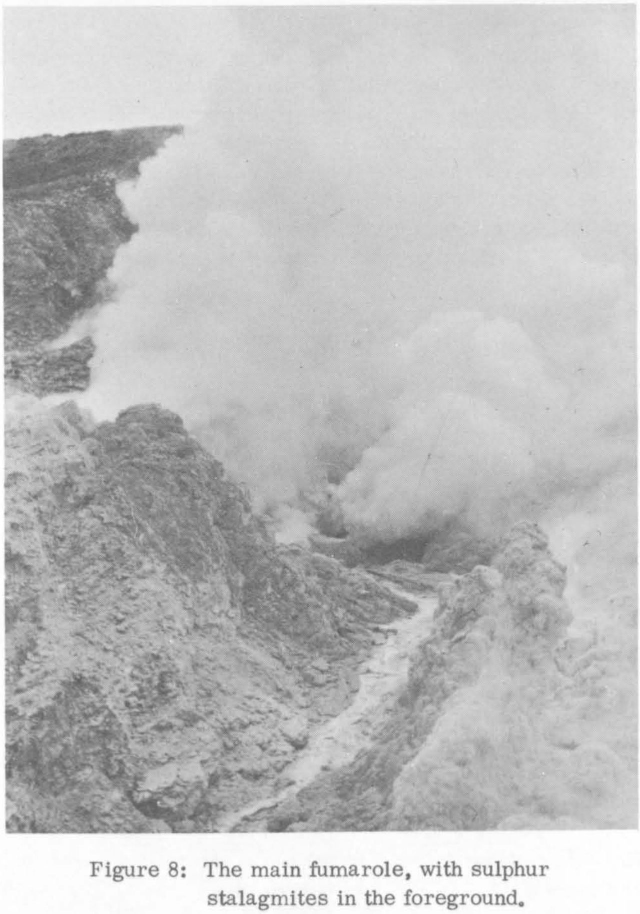

Figure 8: The main fumarole, with sulphur stalagmites in the foreground.

Other craters

The ridge to the north of crater F represents the western half of what originally must have been the highest cone in the area. The eastern half of this cone has subsided about 600 feet along two arcuate faults, revealing good exposures of bedded ash constituting the cone in the main fault scarp (Fig. 6).

Topographical features resembling craters were observed on the air-photographs, one to the north of crater E, and a complex group 1-3/4 miles south-east of crater A.

Spine

A possible spine is preserved half a mile south of crater A; it forms a peak 500 feet high, bounded by sheer rock faces on the eastern and western sides (Figs 1, 2, 3).

Rock specimens collected from creeks draining the north-eastern end of the spine are kaolinized augite-andesite tuff; the tuffaceous texture may have resulted from autobrecciation of massive andesite while it was being extruded as a spine.

Two other possible spines are associated with the crater complex south-east of crater A.

Solfatara field and fumaroles

A large solfatara field, 1 mile in diameter, occupies an amphitheatre between the craters (Figs 7, 8). Thermal activity is now mainly confined to a zone 200 feet wide and 2000 feet long trending north from near the centre of the field along the southern slopes of crater C. However, activity must originally have been widespread because rocks exposed in gorges in the solfatara field show evidence of alteration, and many are contorted and brecciated where fumaroles used to exist. Some fumaroles must have persisted until quite recently, because siliceous sublimation products can be found adhering to ledges on the brecciated rocks (for example, near the edge of the fumarole field west of the dyke marked in Fig. 1).

A section exposed in gorges at the southern end of the solfatara field consists of (from the top):

	Thickness (ft)
Crystal tuff with andesite blocks	10-15
Blocky agglomerate	50-60
(Both are nuée ardente deposits probably erupted from crater B between 1800 and 1850)	
Andesite flow (lens-shaped)	15 (max.)
Blocky agglomerate containing fragments of the underlying flow	10-40
Vesicular augite andesite flow - possibly an early flow from crater C - intruded by a dyke of labradorite-augite-biotite andesite (Fig. 1).	10-30
Bedded ash	50+

The nuée ardente deposits at the top of the section cover the solfatara field. The surface of the field is cemented to form a crust 1/8 to 1/4 inch thick, underlain by unconsolidated crystal tuff and blocky agglomerate. The crust is scoured by erosion into small valleys a few inches or feet deep exposing the soft tuff underneath, separated by ridges where the crust is intact. Percolating water cements the valleys. The ridges are then eroded and the topography inverted. As a result, the blocks in the tuff tend to be concentrated at the surface, commonly perched on tuff pillars 1 to 2 feet high. Amongst the blocks are some true bombs, and a few huge boulders 5 to 10 feet across.

Temperatures measured in fumaroles within the solfatara field are shown on Figure 1. They range from $75^{o}C$ to $145^{o}C$; the highest temperature was measured in a fumarole that pulsated with a loud roar every 1.5 seconds. Some fumaroles have built sulphur stalagmites up to 4 feet high. The main fumarole (Figs 7 and 8) could not be approached close enough to measure the temperature; steam, hydrogen chloride, sulphur dioxide, and some hydrogen sulphide are emitted continuously at high pressure and with a loud roar as a nearly horizontal jet from beneath the vesicular augite andesite flow (in section). The gases from the fumarole swirl around the small valley in which the fumarole is situated before sweeping upwards as a prominent white column that can be seen clearly from the north-western coast of Bougainville.

Hot springs

A temperature of $42^{o}C$ was measured in a spring issuing in the bed of a tributary of the Wakunai River, half a mile east-south-east of Togarau village (Fig. 1). The augite basalt surrounding the spring is ironstained, and the air is foetid.

Two other areas of hot springs were reported from farther west, and their approximate locations are shown on Figure 1.

Structural environment

Three large valleys drain the rock debris from the Mount Balbi volcano complex: the first trends slightly west of north; the second east; and the third south-west. Faults parallel to or coincident with these valleys are suggested on air-photographs of the area, and it is probable therefore that the volcanic complex is located at the intersection of three major lines of weakness.

FUTURE VOLCANIC ACTIVITY

It is evident that nuées ardentes have erupted from the Mount Balbi volcano complex; the presence of chlorine in gases from the main fumarole in the solfatara field indicates that the volcano is only dormant. Hence future eruptions must be expected, with the possibility that nuées ardentes will be produced.

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MOUNT BAGANA AND LAKE LOLORU, BOUGAINVILLE, T.P.N.G.

Helicopter and ground inspections of Lake Loloru and Mount Bagana, S.B. 56-8 Sheet area, were made from 3 to 9 October 1964. Mount Balbi was not revisited because the supercharger on the helicopter was unserviceable and it could not climb above 6000 feet. The co-operation of the members of the Forestry Department field camp at Jaba, who were using the helicopter at this time, is gratefully acknowledged.

Lake Loloru crater

Three days were spent examining the thermal areas at Lake Loloru and comparing them with the details in Reynolds (1955). Generally, all thermal areas are more overgrown by a vine-like bracken that makes access difficult, and the temperatures are little changed.

In Zone A in the valley between the dome and crater wall on the north-western side, dimensions of the area have not changed noticeably since 1955. However, most temperatures are lower. Reynolds reported temperatures of 88°C and 90°C in the central and south-eastern parts of the zone, but the present temperatures range from 40°C in bubbling springs to a maximum of 88°C in a loud steam vent. The spring at the north-eastern end of the zone is 60°C, 2 degrees warmer than before. About 100 feet upstream from the thermal zone, cold sulphur dioxide bubbles through the bottom of the creek, and the stream water is 32°C.

Vegetation is encroaching on Zone B on the northern slope of the dome (Fig. 11), but the thermal activity is similar to that present in 1955. The sibilant escape of steam can be heard from half a mile away, and the smell of sulphur dioxide is strong as one approaches. In the zone the steam is escaping mainly from the sulphurous areas, commonly from sulphur stalagmites 6 inches high. Temperatures range from 93°C to 97°C.

Zone C near the summit of the dome was not visited, but from the air it appeared little changed from Reynolds' description.

No temperatures were measured by Reynolds in Zone D, located on the dome between Zone B and the northern end of Lake Loloru. The area is almost entirely overgrown by bracken, and activity is restricted to the uphill end of the zone. Temperatures in the western part of the zone range from 58°C to 66°C, and in the eastern part from 54°C to 76°C. Only a trace of sulphur remains in the area, and the smell of sulphur dioxide is faint.

Zone F, on the south-western flank of Lake Loloru crater, was inspected only from the air, and no sign of thermal activity was seen.

Mount Bagana volcano

The most prominent activity from Mount Bagana is the continuous, voluminous emission of steam from the whole summit area. The volume increases markedly in the early morning after heavy rain during the night, but decreases to normal about 0800 hours. Every 10 minutes a mild steam explosion, sometimes containing a little brown ash, is ejected from a small crater on the western side of the summit area and ascends rapidly to 2000 feet above the summit. A deep red glow is seen above the summit at night.

The summit area was inspected closely from the helicopter at 0600 hours on the 7th, and the height above sea level determined as 5800 feet. The area resembled a

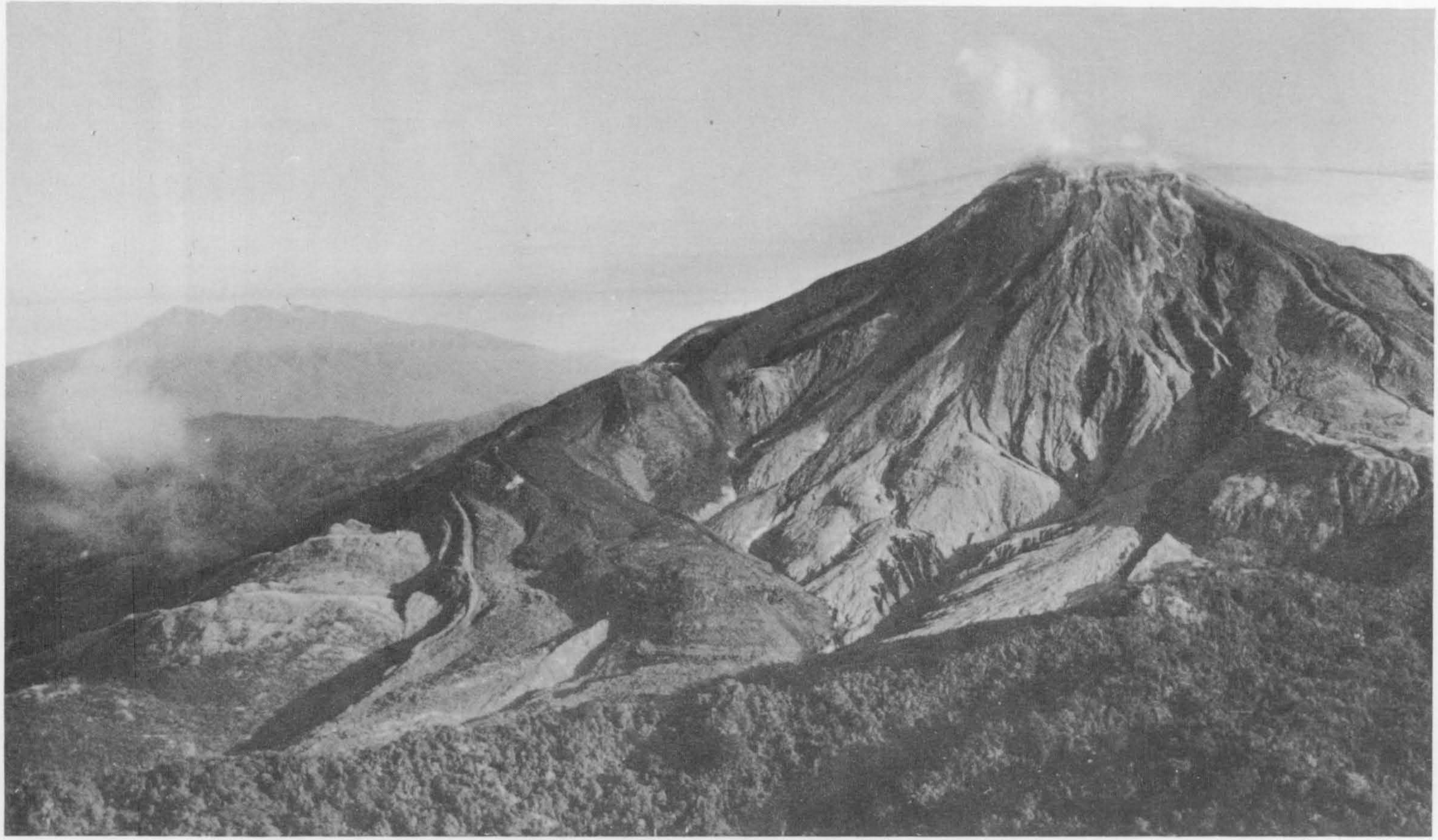

Figure 9: Bagana from the south. One tongue of the flow erupted in 1952 extends into the foreground. The summit of the Mount Balbi volcano complex is in the background.

Figure 10: Southern side of Lake Loloru crater, showing the steep crater wall on the right and the lower slopes of the central dome on the left.

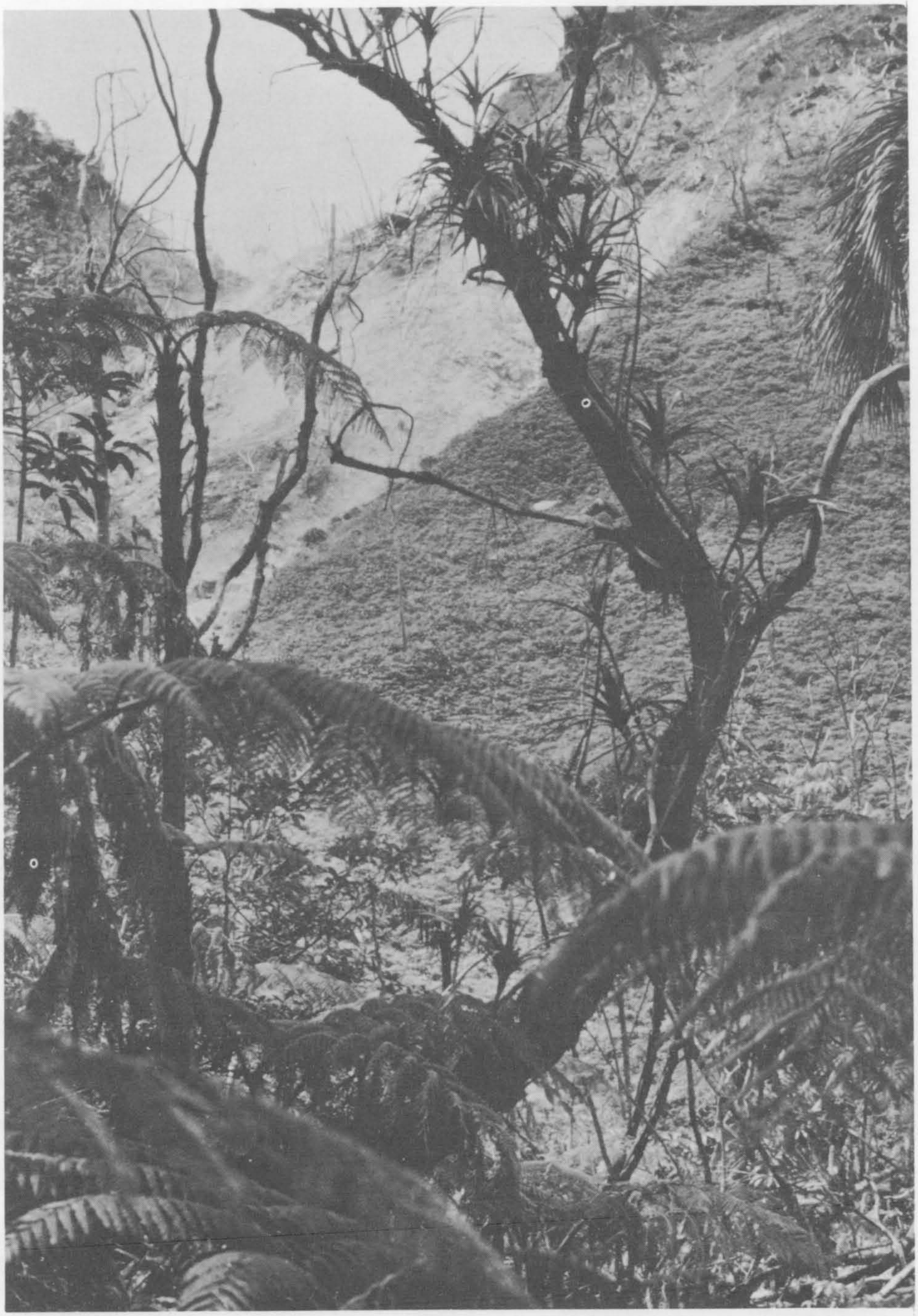

Figure 11: Thermal zone B on the northern slope of the dome in Lake Loloru crater. The area now covered with thick bracken was bare in 1955.

strong solfatara field, with thick sulphur deposits common around the margin. Steam is emitted at only a low pressure and the temperature is probably between 150° and 200°C.

The 1952 lava flow down the western flank of the volcano (Best, 1956) is a prominent topographical feature and the whole flow is still steaming strongly. In one part it is 150 feet thick and is probably only partly crystallized. The slopes of the volcano adjacent to the flow are also steaming, and temperatures measured at about 3000 feet above sea level are 89°C and 99°C.

A new lava flow is slowly advancing along the northern side of the 1952 flow and the snout is about 3200 feet above sea level. The flow is blocky, about 100 feet thick, and advancing a few inches per hour.

In addition to the thermal area on the western slopes of the volcano, the other main thermal area is the snout of a blocky flow low on the north-eastern slope of the volcano, above where the flow has dammed a stream to form a small lake. The flow appears to have been the most recent from the volcano in the air-photographs taken in 1947, and the area is now covered by a cane-like grass. It was not visited. A specimen from the upper part of the flow is a green andesite.

A small camp was established for two days at 4000 feet above sea level on the eastern slope of the volcano. During this time no noises or earthquakes emanated from the volcano. A tectonic earthquake on 7 October felt widely over southern Bougainville, and as intensity 2MM on Bagana, appeared to have no effect on the volcanic activity. An attempt to climb Bagana to measure the temperature of the fumarole at the crater was abandoned 400 feet below the summit.

There is no evidence of any recent nuées ardentes from Mount Bagana, and the present activity appears mild and stable.

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EFFECT AT RABAUL OF SEISMIC SEA WAVES GENERATED BY THE GREAT ALASKAN EARTHQUAKE OF 28 MARCH 1964

SUMMARY

A seismic sea wave generated by the great Alaskan earthquake of 28 March 1964 arrived in Rabaul at 0125 L.T. on the 29th. The initial wave height was 4 inches. A possible second seismic sea wave arrived at 0723 and a wave at 0933 had a crest to trough height of 16 inches. A maximum double amplitude of 24 inches was recorded at 1330, possibly caused by oscillations from the first and second seismic sea wave groups coming in phase. Oscillations of sea level due to this earthquake lasted four days. The velocity of the first seismic sea wave was calculated to be 480 miles per hour, and the average ocean depth between Alaska and Rabaul as 15,500 feet.

EARTHQUAKE AND WARNING DATA

At 0336 12.7 G.M.T. on 28 March 1964, an earthquake of magnitude 8.5 (CGS) occurred at latitude 61.1°N, longitude 147.6°W, at a depth of 20 kilometres. A seismic sea wave was generated which caused extensive damage throughout the Gulf of Alaska, along the west coast of North America, and in Hawaii.

A telegraphic bulletin advising that a seismic sea wave had been generated was issued from the Honolulu Magnetic Observatory to all stations in their seismic sea wave warning network in the Pacific. The bulletin also advised the expected arrival time of the wave at the various stations. Rabaul is not in the warning network, but the bulletin was overheard by the duty officer at the Overseas Telecommunications Station, Rabaul, and passed to the Vulcanologist at 2000 L.T. (1000 G.M.T.). The Rabaul harbour master was also notified, and on his own initiative advised all boats to move into midstream.

The first warning bulletin gave the expected arrival time of the wave at Guam as 1315 G.M.T. and at Samoa as 1430 G.M.T.. Later bulletins told of wave heights between 8 and 16 feet at Hawaii. The wave arrived half an hour later than expected at Guam and succeeding arrival times were changed accordingly.

EFFECT OF SEISMIC SEA WAVES AT RABAUL

The first wave arrived at 1525 G.M.T. (0125 L.T.). No withdrawal of water preceded the wave, and it boiled in over mud flats around the head of Simpson Harbour. A wave height of 4 inches was recorded on the tide gauge at the Main Wharf (Fig. 12). Succeeding waves arrived at 30 to 35 minute intervals and the fourth wave at 0315 L.T. had a trough to crest height of 10½ inches. It was concluded that a destructive wave would not arrive at Rabaul and warning of the seismic sea wave was withdrawn.

ANALYSIS OF TIDE GAUGE RECORD

Wave activity due to the first seismic sea wave was recorded from 0125 L.T. until 0645 L.T. and forms the first seismic sea wave group (Fig. 12). At 0723 L.T. wave activity recommenced with a sudden withdrawal of three inches, and at 0805 L.T. the ensuing smooth pattern of wave oscillations was abruptly disrupted. It is thought that one or other of these two times represents the first arrival of a second seismic sea wave group, generated by an aftershock of the main Alaskan earthquake. The recorded trace of following waves is irregular, indicating interference between the first and second seismic sea wave groups. Possibly because of the interference the amplitude of some waves was increased, and at Rabaul a maximum crest to trough height of 16 inches was recorded at 0933 L.T.

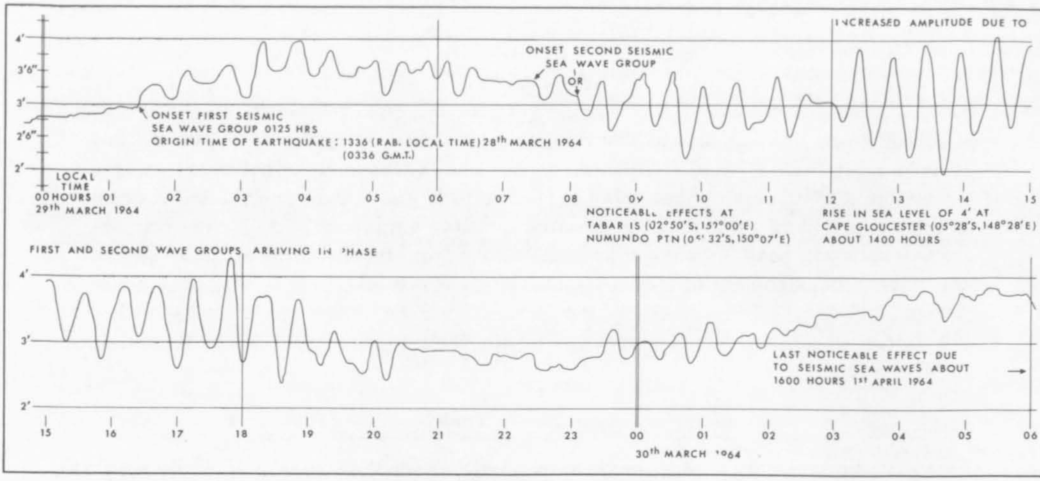

Figure 12: Tide gauge record at Rabaul of seismic sea waves generated by the great Alaskan earthquake of 28 March 1964.

The second seismic sea wave group caused noticeable effects at Tabar Island (02°50'S., 152°00'E.), where a rise and fall of sea level of about 12 inches commenced at 0830 L.T. and continued with a period of 15 minutes for some hours. Numundo plantation (05°32'S., 150°07'E.) reported that at 0845 L.T. the sea level rose about 12 inches and took about 15 minutes to fall to normal. This phenomenon occurred a further four times during the day.

About 12 noon on the 29th the wave motions due to the first and second seismic sea wave groups appear to have come in phase. A series of symmetrical oscillations were recorded, with a period of 30 to 33 minutes, which increased in double amplitude from 13 inches at 1220 L.T. to a maximum of 24 inches at 1330 L.T., then decreased in amplitude and became increasingly irregular during the next six hours. A rise in sea level of 4 feet was reported from Cape Gloucester (western end of New Britain) about 1400 hours. Irregular small oscillations caused by the seismic sea waves continued until about 1600 L.T. on 1st April.

TRAVEL TIME AND OCEAN DEPTH

Assuming that the first seismic sea wave group was generated at the same time as the earthquake, the wave took $11\frac{1}{2}$ hours to travel the 5550 miles from Alaska to Rabaul. This is an average velocity of 480 miles per hour.

The average ocean depth between Alaska and Rabaul may be calculated using the following formula:

$$h = \frac{V^2}{g}$$

where h = average depth of ocean
V = velocity of wave
g = acceleration due to gravity

Therefore, the average ocean depth between Alaska and Rabaul is 15,500 feet.

It is of great importance to know the travel times for seismic sea waves so that if waves are generated by future earthquakes in the same area, their arrival time may be calculated reasonably accurately. This is particularly so for the Alaskan area, which is highly seismic and from where more seismic sea waves must be expected. In the case of the March 1964 earthquake it was impossible to predict the arrival time of the wave within one or two hours, but with the data presented here, future predictions will be far more precise.

The Chilean area is another from which seismic sea waves may be expected. Earthquakes in that area in May 1960 generated seismic sea waves which reached Rabaul. For reference and comparison, the data calculated by Taylor & Barrie (1960) are included here: velocity of wave 385 m.p.h., and an average ocean depth of 9900 feet along the wave path.

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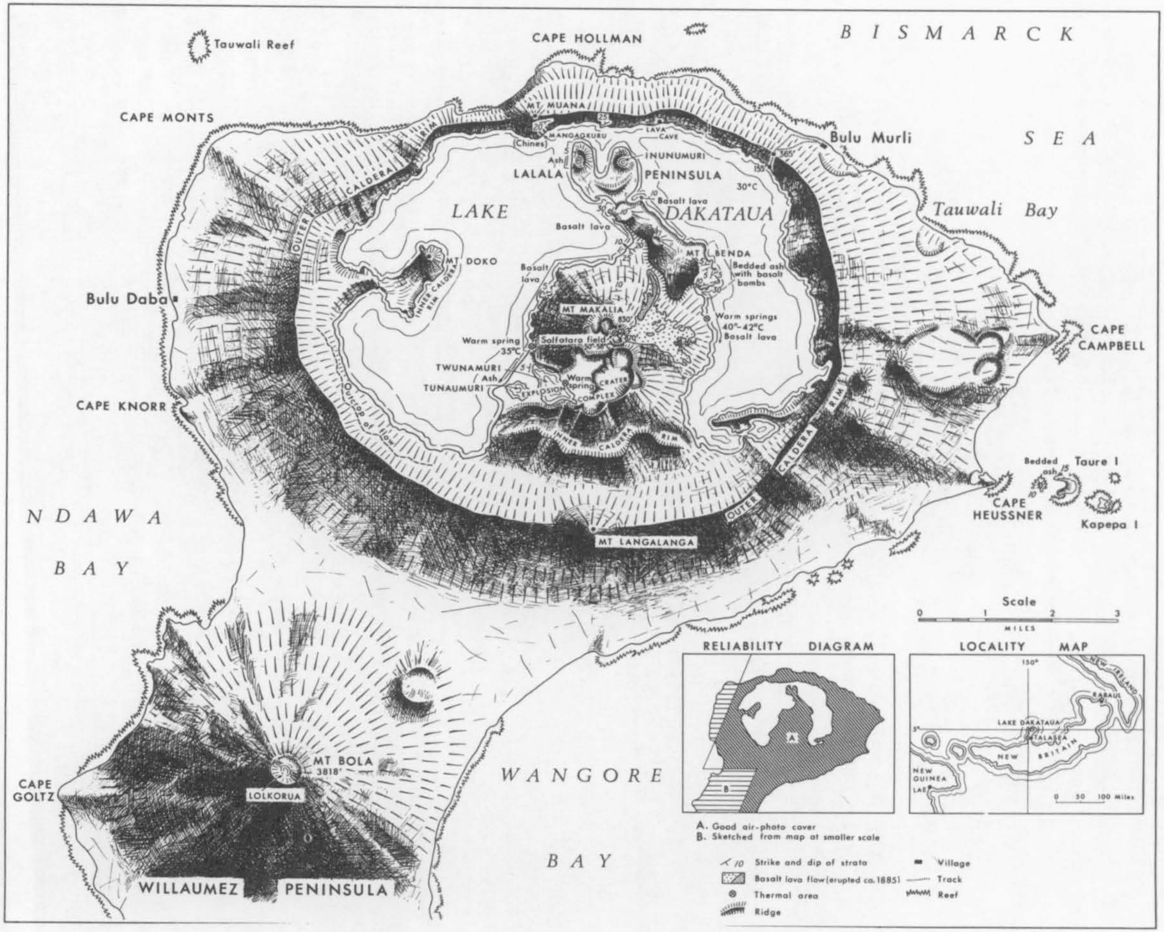

Figure 13: The Lake Dakataua Caldera.

VOLCANIC ACTIVITY AT LAKE DAKATAUA CALDERA, NEW BRITAIN

SUMMARY

Lake Dakataua, at the northern end of Willaumez Peninsula, New Britain, is a complex volcanic area consisting of an outer caldera about 7 miles across, an inner caldera 4 miles across, and a basaltic shield volcano, Mount Makalia. An explosion crater complex of at least eleven craters has torn out the south-western side of the shield volcano. The most recent eruption, 70 to 80 years ago, was a lava flow from an apical ash crater on Mount Makalia. Thermal areas in the crater range in temperature from $50^{o}C$ to $58^{o}C$, and thermal areas at the foot of Mount Makalia range from $35^{o}C$ to $42^{o}C$.

INTRODUCTION

Location

Lake Dakataua is a freshwater caldera lake about 7 miles in diameter, at the northern end of the Willaumez Peninsula on the central north coast of New Britain (Fig. 13). The Peninsula is built of overlapping volcanic cones, of which Mount Garbuna, near the base of the Peninsula, is the only one showing clear signs of activity, but the activity is mild and restricted to fumaroles with a maximum temperature of $101^{o}C$ (Fisher, 1957). Boiling mud pools and fumaroles are found around Garua Harbour, particularly at Talasea, and have been described by Reynolds (1954) and Branch (Vulcanological Observatory Monthly Report, October 1963).

The Lake Dakataua area was examined from 22 to 25 October 1963.

Topography

As seen from the sea, the northern end of Willaumez Peninsula is a low tree-covered cone, about 13 miles across and with a maximum elevation of 800 to 1000 feet above sea level. However, from the air it is seen that much of the area of the cone is occupied by Lake Dakataua. Projecting into the lake from the southern shore is Lalala Peninsula, 2½ miles wide at the base and 5 miles long, consisting of a complex of young lava cones and explosion craters.

The water in the lake is 155 feet above sea level; the cliffs around the lake mostly rise 200 to 500 feet above this (Fig. 14). Mount Langalanga on the southern rim of the caldera is the highest point, about 1000 feet above sea level. The most prominent feature on the peninsula within the lake is Mount Makalia, 870 feet high (incorrectly named Benda crater in Fisher, 1957). The mountain is covered with trees (Fig. 15) except on the eastern side, where ropy basalt flows extend from the summit almost to the lake shore.

Population

Only two villages are known in the area; Bulu Murli on the north-east coast, with a population of about 100, and Bulu Daba on the west coast, reported to be about the same size.

PREVIOUS VOLCANIC ACTIVITY

No eruptions from the Lake Dakatau caldera have been reported since Europeans came to the Territory, but the ropy, vesicular basalt flow down the eastern face of

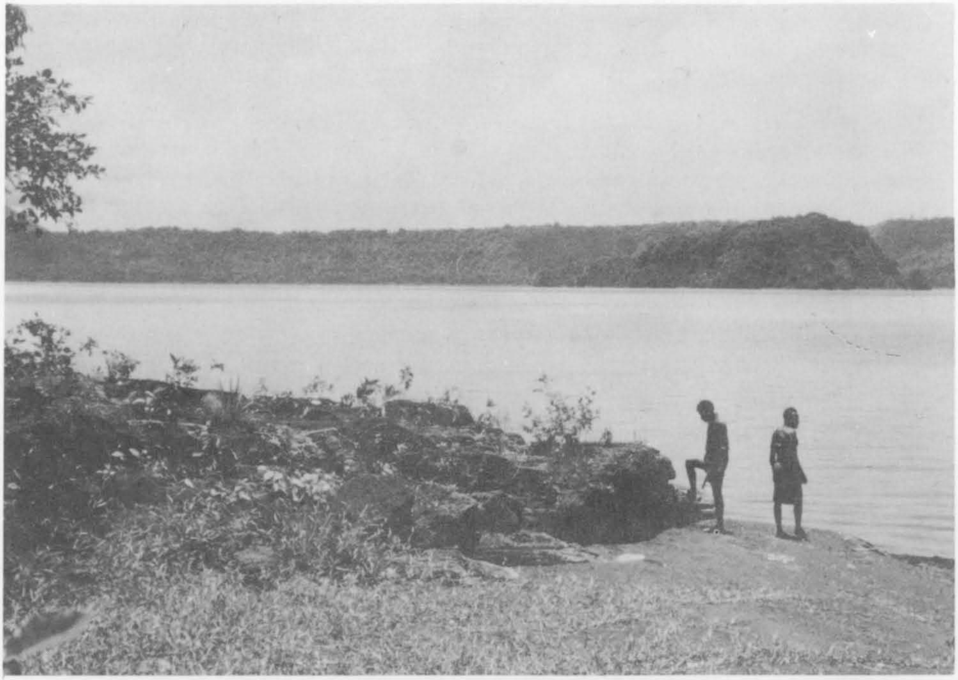

Figure 14: Mount Doko, part of the inner caldera, with the wall of the outer caldera in the background, from Lalala Peninsula.

Figure 15: The north-western side of Mount Makalia.

Mount Makalia probably was erupted between 1880 and 1890; the fathers of old men in the village of Bulu Murli sacrificed pigs to try to stop the eruption. One man, about 50, remembers that in his youth Mount Makalia was bare of vegetation and children rolled down the 'sandy' slopes.

A legend is extant that once a huge mountain used to stand where Lake Dakataua now is, and that it was an island divided from the mainland by a treacherous strait. Many people were drowned crossing the strait in their canoes, and the mountain became sorry for them. In order to help the people, the mountain one day subsided, forming Lake Dakataua, and rose again in the strait, filling it and joining Lake Dakataua to the mainland. This new mountain is Mount Bola, 3818 feet high, a symmetrical cone adjacent to the southern side of Lake Dakataua.

A vulcanological interpretation of this legend is that the large cone of Mount Bola was built up concurrently with the eruption that produced the Lake Dakataua caldera; a plausible hypothesis.

STRUCTURE OF LAKE DAKATAUA CALDERA

The caldera structure is complex (Fig. 13) and has passed through at least five phases in its development, as outlined below:

5. Mount Makalia apical crater.
4. Explosion crater complex.
3. Mount Makalia shield volcano.
2. Inner caldera.
1. Outer caldera.

Outer caldera

The outer caldera is oval, with an easterly diameter of 8 miles and a northerly diameter of 6 miles. The steep sides of the caldera descend unbroken to the lake and the water appears deep close inshore. Natives report that a naval party - possibly German - took a sounding in the lake, but the sounding is not shown on Admiralty charts of the area. The profile of the outer slopes of the caldera suggests that the volcano in which it formed was between 6000 and 9000 feet high.

The outer caldera wall appears to be composed mainly of lavas. A specimen collected from a flow at the lake edge on the northern side is vesicular quartz-augite andesite containing rare phenocrysts of plagioclase and augite in a pilotaxitic groundmass. The original volcano was presumably, therefore, a huge andesite stratovolcano.

Inner caldera

Remnants of a caldera inside the outer caldera exist across the base of the peninsula in the lake, along the north-eastern side of the peninsula (Mount Benda), and on the western side of Lake Dakataua (Mount Doko, Fig. 14). The inner caldera is oval, with the major axis $4\frac{1}{2}$ miles long, and the minor axis $3\frac{1}{2}$ miles long. Along the southern side the shape of the caldera is irregular and it is possible that another caldera overlapped the main one on the south-eastern side.

Vesicular augite basalt flows are exposed in the inner caldera wall near Mount Benda, interbedded with volcanic ash containing basalt bombs. Hence the volcano in which the inner caldera formed was probably a basaltic stratovolcano.

Mount Makalia shield volcano

A basaltic shield volcano fills the eastern half of the inner caldera, and forms the lower two-thirds of Mount Makalia. The volcano is 2½ miles in diameter, and about 500 feet high above the lake (Fig. 15).

Explosion crater complex

The southern and south-western sides of the shield volcano have been torn out by violent explosions to form an explosion crater complex. At least 11 craters are preserved in the complex, ranging from a few hundreds of feet to half a mile across. Possibly concurrently with this, basaltic ash cones were constructed between the inner and outer caldera walls on the northern side (Lalala Peninsula), and outside the outer caldera, on the eastern slopes of the original volcano.

Mount Makalia apical crater

The top 200 feet of Mount Makalia consists of an ash cone built above the shield volcano. A crater 300 feet across and 100 feet deep in the apex of the cone is breached on the eastern side, and the most recent lava has flowed through the breach and 1 mile down the eastern side of Mount Makalia. The lava issued from a fissure trending north-north-east across the floor of the crater and built a ridge of viscous lava along the line. Only a little lava flowed into the back of the crater. The lava is blocky and is an augite basalt containing microphenocrysts of augite and labradorite in a dark brown glass.

Three small cones were built above the flow, inside the main crater. The first, near the back of the crater, is a lava dome 100 feet high and 60 feet across on top. A small flow from the top of the dome flowed down the western flank and a little way around the north-western side of the main crater. The second cone is built of ash above the fissure from which the main lava flowed. It is about 100 feet high and contains a crater 40 feet across and 20 feet deep at the top. The third cone is between the other two and a little to the north-west, and has a shallow crater 20 feet across.

PRESENT MANIFESTATIONS OF VOLCANIC ACTIVITY

Present volcanic activity is limited to a mildly active solfatara in the apical crater of Mount Makalia, and to warm springs in the lake at either side of the foot of the mountain.

Thermal areas in the apical crater of Mount Makalia

Thermal areas are restricted to a shallow depression in the summit of the lava dome inside the main apical crater. In the depression slaggy basalt that resembles the cooled crust on a lava lake has mostly been altered to a red clay by fumarole activity. Hot gases rise through small fissures in the basalt and temperatures range from 50 $^{\circ}$C near the rim of the depression to 58 $^{\circ}$C at the centre.

Thermal areas at the foot of Mount Makalia

Along the lake shore on the south-western side of Mount Makalia the water is 35 $^{\circ}$C, which is slightly warmer than the average lake temperature of 30 $^{\circ}$C. There is no evidence of bubbling or an unusual taste or encrustations in the area.

Natives report that warm water rises through a sandy beach on the eastern shore of Twunumuri, a small crater lake south of Mount Makalia. The area was not visited.

Warm springs on the eastern shore of Mount Makalia range in temperature from 40°C to 42°C. The area is a shallow embayment in the snout of an old vesicular basalt flow. The springs issue just below the water line around the embayment, and the nearby rocks are encrusted with a white powder.

GEOLOGICAL HISTORY

The original volcanic structure appears to have been a large andesite stratovolcano, in the summit of which the main, outer, caldera formed, about 7 miles across. A basaltic stratovolcano grew within the caldera and collapsed to form an inner caldera 4 miles across. Basalt lavas inside the inner caldera built a shield volcano which now forms the lower two-thirds of Mount Makalia. Violent explosions tore out the south-eastern side of the shield volcano to form an explosion crater complex and at least eleven craters are preserved in this complex. Other ash cones formed Lalala Peninsula, and small craters were built east of the outer caldera. Finally, about 70 to 80 years ago, a basaltic lava flow was erupted from an apical ash cone on Mount Makalia. Future eruptions would be expected to be similar to this last eruption and should not prove dangerous to the present population.

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APRIL 1964 ERUPTION OF MANAM VOLCANO

SUMMARY

A small climactic eruption from a new vent high in the south-east valley of Manam volcano in April 1964 was preceded by five months of sporadic, weak ejection of ash mainly from the Main Vent. The continuous mild emission of white vapour characterized activity at the Southern Vent.

Suddenly, at 1600 hours on April 16th, heavy emission of grey ash began from the Southern Vent. Fountains of incandescent lava were seen that night, and boulders cascaded down the upper south-east valley. Audible explosions occurred at the rate of 17 per hour on the 17th; the rate increased to 640 per hour on the 19th, then declined and became irregular until the 24th. A large earthquake was felt on April 24th, and explosive activity increased from a new vent high in the south-east valley - the South-east Vent. Lava spatter was hurled to 1500 feet above the new vent every three to four seconds, accompanied by innumerable boulder slides down the south-east valley. A blocky lava flow of olivine basalt descended 3000 feet below the South-east Vent. The activity decreased to about 75 explosions per hour at the end of April and became irregular during May. On 30 May 1964, explosions ceased and the only evidence of the South-east Vent was a widespread fumarole field steaming strongly in the general area of the vent.

PREVIOUS ERUPTIVE HISTORY

Manam (lat. 4°S., long. 145°E.) is a basaltic island volcano situated 10 miles off the north-western coast of New Guinea. The volcano is a symmetrical cone 7 miles in diameter at the base, rising to a height of about 6000 feet above sea level. Taylor (1960) describes the cone as 'of the strato type; it consists predominantly of fragmental material which is buttressed by numerous flows and dykes of basaltic lava. The most prominent topographical features are four great radial valleys, or chasms, which descend from the summit area and dissect the cone in azimuths between the cardinal points of the compass.' Ejecta from the two summit craters drain off in these valleys: from the Main (northern) Vent into the north-east and north-west valleys, and from the Southern Vent into the south-east and south-west valleys.

Manam is perhaps the most active volcano in the Territory of Papua and New Guinea, and Fisher (1957) lists 12 eruptions between 1877 and 1947. Most eruptions were explosive, with minor lava effusion. A cycle of major activity began in 1956, reaching a climax in March 1958; this has been documented by Reynolds (1957) and Taylor (1958 a,b; 1960). Minor eruptions have occurred since then in March to May 1960; July to September 1961; April 1962; February 1963; and April 1964 (all described in monthly reports from the Vulcanological Observatory, Rabaul.)

THE NATURE OF THE CURRENT ERUPTION

Activity began in November 1963, after a period of four months during which nothing but a little white vapour was emitted from both the Main and Southern Vents. It culminated in a small climactic explosion in April 1964 from a new vent in the head of the south-eastern valley.

Preliminary activity: November 1963 to 15 April 1964

Both the Main and Southern Vents emitted a little white vapour continuously until 26 November 1963, when activity at the Main Vent changed to the sporadic ejection of

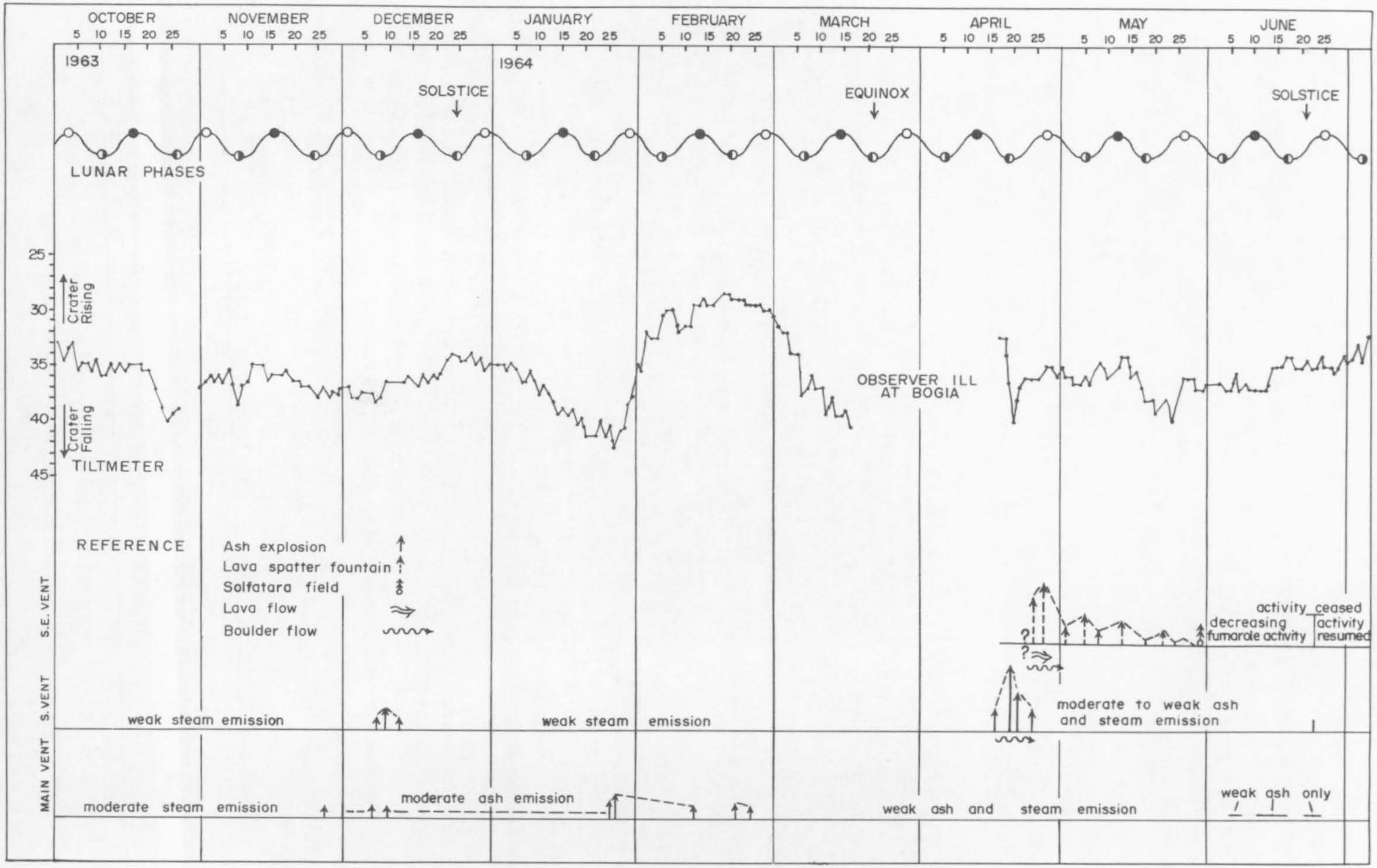

Figure 16: Eruptive activity at Manam, October 1963 to June 1964.

ash for one day (Fig. 16). A little ash fell at the observation post at Waris on the following two days. Grey ash was again ejected from the Main Vent from 30 November to 6 December, followed by white vapour only for two days, after which mild, continuous ash emission recommenced.

The weakening of activity from the Main Vent on 7 December coincided with the start of mild explosions of ash from the Southern Vent. The number of explosions per hour rose from three on the 7th to five on the 8th, and reached a maximum of 15 per hour on the 9th. The rate decreased to one explosion per hour on the 10th, when ash was emitted continuously for two days. The weak to moderate emission of white vapour recommenced on 13 December 1963 and continued until 15 April 1964.

At the Main Vent, a mild continuous emission of ash began on 9 December and did not change until 25 January 1964, when activity increased. This coincided with the maximum deflation of the volcano as indicated by tiltmeter measurements (Fig. 16). Ash fell at Waris on the 25th and 26th, and on the 26th the continuous ash ejection was accompanied by faintly audible explosions and a faint glow above the crater at night. Ash fell at Waris on 30 January and 2, 3, and 8 of February. The activity then weakened, and from the 13th to the 20th mainly white vapour was emitted, with a tinge of brown ash in the vapour cloud. After a tilt maximum on 20 February (Fig. 16) activity increased: inaudible weak ash explosions occurred at the rate of 29 per hour on the 21st, but decreased to 7 per hour on the 24th and ceased that day. Weak to moderate emission of vapour with a little ash commenced on 25 February and was unchanged at the end of June 1964.

Climactic and declining phases: 16 April to June 1964

Most of the preliminary activity was from the Main Vent, and from the end of February 1964 both vents had emitted vapour only.

Suddenly, at 1600 hours on 16 April grey ash began to pour from the Southern Vent. A short while afterwards a small boulder slide swept 4000 feet down the southern side of the south-east valley, igniting vegetation. Fountaining of incandescent lava was seen at night, and sporadic debris-slides descended down the upper south-east valley.

On the 17th, ash explosions, many audible, were occurring at the rate of 17 per hour. The explosions increased to a maximum of 640 per hour at 1700 hours on the 19th and were accompanied by continuous rumbling. A north-easterly wind swept the ash away, and on the 20th it fell in the Iassa to Tabele area on Manam and from Potsdam to Awar on the mainland, and formed a film a few millimetres thick. The rate of explosions declined to between 300 and 400 per hour on the 20th, then to 200 to 300 on the 21st. Most explosions were audible and sounded like distant thunder. Lava fountains and boulder-slides were seen each night.

At 1000 hours on the 22nd G.W. D'Addario inspected the volcano during a 10-minute diversion on the DC3 flight from Madang to Wewak. The activity was mostly explosive, with rhythmic emission of ash and scoriae every few seconds. At the climax of each ejection, lava fountains appeared bright red in full sunlight. An area of steaming ash was seen high in the south-east valley. The height of the Southern Vent was calculated to be 5700 feet above sea level.

On the 22nd, 23rd, and 24th the rate of explosions fluctuated markedly from hour to hour, ranging from 100 to 500: most were audible.

At 1556 hours on 24 April a large earthquake occurred in the New Guinea highlands near Mount Hagen, and was felt on Manam as intensity 5MM. No immediate response from the volcano was noted, but next day the activity had increased and the rate of explosions no longer fluctuated.

When the volcano was inspected from the air by C.D. Branch at 1200 hours on the 25th, it was seen that a new vent 100 feet across had opened in the area noted as steaming by D'Addario on the 22nd. The lava column reached almost to the top of this vent, named the South-east Vent, but was drained off through a lava tunnel one or two hundred feet below the rim. A lava flow emerged from the tunnel and extended a little more than half way down the southern side of the south-east valley, where, because of its high viscosity, it was almost at a standstill. Bubbles of gas bursting from the lava column every 4 to 10 seconds sent a spatter of orange-yellow molten rock to 500 feet above the crater. Activity at the Southern Vent was confined to the continuous emission of weak vapour and ash. That night, from Bogia, boulder slides were seen descending 2000 feet down the south-east avalanche valley every 5 to 10 minutes.

On the 26th, activity from both the Main and Southern Vents was confined to continuous weak emission of vapour and ash. The ash was falling lightly in the Iassa area and doing no damage. Lava spatter from the South-east Vent high in the south-east valley was ejected 1000 to 1500 feet above the crater. It fell mainly around the vent, then avalanched down the valley. Some fell into the south-west valley, where it accumulated at the base of the cliff. Explosions occurred every 4 to 5 seconds (rate about 700 per hour) and most were audible, sounding like the ignition of a flame.

The most spectacular activity during the eruption occurred that night, and was observed and photographed from a camp at the foot of the south-east valley (Fig. 17). Throughout the night loud explosions every 3 to 4 seconds threw orange-yellow lava spatter to heights of 1500 to 2000 feet above the crater. The spatter sprayed in an incessant rain on the surrounding cinder cone. At intervals of 2 to 3 minutes red-hot avalanches of the ejected material swept in radiating sheets as far as 2000 feet down the south-east valley. At 0530 hours on the 27th, after a strong 'soft' explosion, a possible small nuée ardente flowed swiftly to the base of the terminal cone in the valley, about 2500 feet below the summit. During the day the intensity of the explosions declined (Fig. 18), but not their rate; on following days the rate also declined gradually, to between 50 and 100 explosions per hour at the end of the month.

The new lava flow, noted earlier, had descended about 3000 feet below the summit on the 27th (about 500 feet above the flow of February 1963). The flow was blocky (Fig. 19), and moving on a front 100 feet across and 20 to 30 feet high, at the rate of a few inches per hour. A specimen collected from a red-hot block that rolled off the flow contains well developed olivine phenocrysts, and is an olivine basalt (See Appendix).

During May, activity from the South-east Vent was explosive and fluctuated markedly, but on the whole decreased throughout the month. On 1 May, audible explosions were occurring at the rate of 19 per hour. The rate then increased and reached a climax on the 5th, when 103 audible explosions each hour were counted and a glow was observed above the crater. Next day the rate of explosions dropped to 52 per hour and no glow was seen that night. By the 8th only 24 explosions occurred each hour, but the glow reappeared and continued until the 17th. A maximum of 67 explosions per hour was counted on the 13th, and light ash fell at Waris. The number of explosions decreased to six per hour on the 18th, but rose to 30 on the 26th. By May 30th explosions had ceased and the only evidence of the South-east Vent was a widespread fumarole field, steaming strongly, in the

Figure 17: Lava spatter fountain and boulder flows from the South-east Vent on the night of 26 April 1964.

Figure 18: Activity at the South-east Vent on the morning of 27 April, viewed from the south-east valley. Nuée ardente debris from the 1957-58 eruption in the foreground.

general area of the vent. This condition remained unchanged at the end of June 1964. At the same time the Main and Southern Vents continued to emit vapour with a little ash.

No volcanic earthquakes were felt or recorded on a smoked paper mechanical shock recorder at Waris during this eruption.

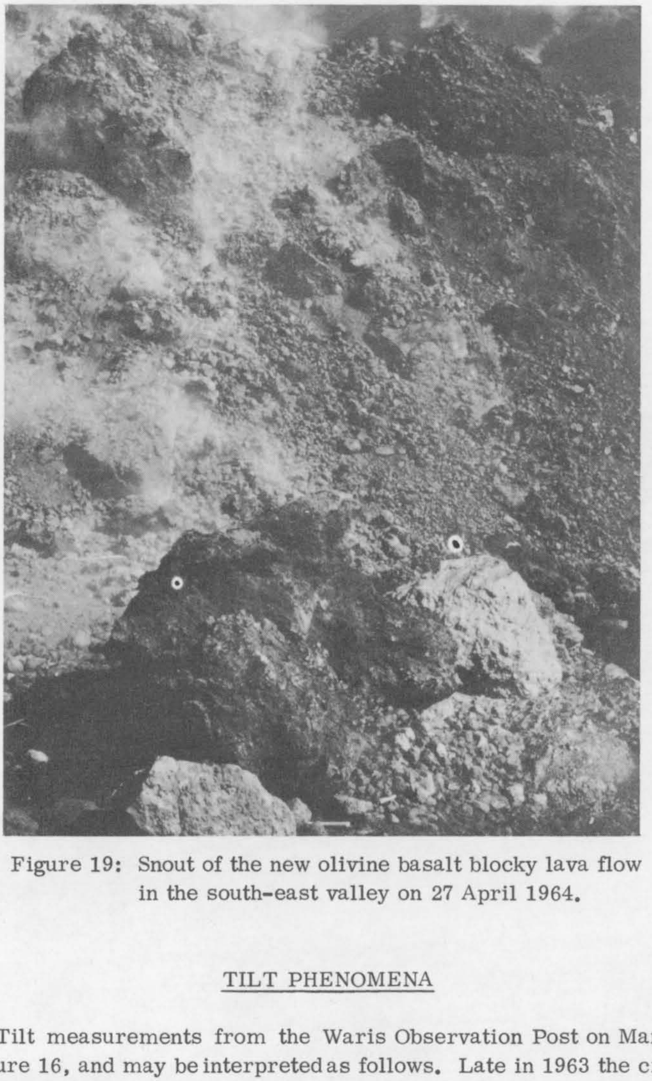

Figure 19: Snout of the new olivine basalt blocky lava flow in the south-east valley on 27 April 1964.

TILT PHENOMENA

Tilt measurements from the Waris Observation Post on Manam Island are plotted in Figure 16, and may be interpreted as follows. Late in 1963 the crater area was slowly subsiding, but responded early in December to the approaching solstice, and began to rise. The rise was accompanied by increased volcanic activity from both vents as magma rose in the volcano. During January 1964, as the luni-solar influence waned, the volcano became deflated, and at the time of maximum deflation (26 January), explosive activity increased at the Main Vent. Again, as the crater area rose during February, activity increased at the time of maximum inflation, but lasted only a few days.

Unfortunately no tilt measurements were made over the equinox, but immediately after the explosive outburst from the Southern Vent on 16 April, the crater area subsided rapidly. It rose slightly a few days later as magma entered channels high in the volcano and began to pour out as a lava flow from the new South-east Vent. During the next three weeks, while activity waned gradually, a balance was maintained between the inflow of magma from depth and the outflow at the surface; but by mid-May the inflow decreased and the volcano deflated. After activity stopped at the South-east Vent at the end of May, the crater area began to rise irregularly.

CONCLUSIONS

The April 1964 eruption was small by comparison with most previous eruptions, but was unusual in the interplay of activity between the Main and Southern Vents, culminating in the opening of a new but short-lived vent. The Main Vent was the most active in the preceding months, but the first major outburst on April 16 was from the Southern Vent, with no response from the Main Vent.

A few days later a new vent opened only 400 or 500 yards from the Southern Vent, but at the same elevation. Activity quickly shifted to the new South-east Vent, and declined rapidly at the Southern Vent. This suggests that the Southern Vent became blocked just below the orifice and the upwelling magma had to force a new passage to form the South-east Vent nearby. The blocked magma, under pressure, would erupt rapidly once the confining pressure was released. This would provide a mechanism to form the lava flow in the south-east valley very quickly: the flow was not in existence when the volcano was inspected on the 22nd, but by the 25th lava had flowed 3000 feet down the valley, and was in an advanced stage of cooling.

Activity virtually ceased at the South-east Vent only six weeks after it began. Now, depending on how severely the two vents are blocked, it is uncertain which vent will be the site of future activity. In this regard the activity on June 22 may indicate the future pattern. On this day a few weak ash explosions occurred at the Southern Vent, and fumarole activity at the South-east Vent ceased entirely, only to resume next day when the explosions stopped: it suggests that the Southern Vent is at present the more open of the two.

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APPENDIX

Olivine Basalt from the April 1964 Eruption of Manam Volcano

by
W.R. Morgan

Specimen R.17706 was collected by C.D. Branch from the snout of an advancing lava flow in the south-east avalanche valley of Manam Volcano.

Thin section shows the lava to be seriate porphyritic; the phenocrysts range in size from 2.5 mm down to the average groundmass grainsize of 0.015 mm. The phenocrysts form about 20 to 25 percent of the rock, and consist of plagioclase, augite, and olivine.

Plagioclase phenocrysts form tabular to subtabular crystals, whose margins are slightly zoned. Many occur as parallel and interpenetrant growths. Their composition is about An85, zoned to labradorite. Augite forms pale green euhedral prismatic crystals. Olivine occurs as colourless prismatic crystals with rounded margins; many olivine crystals are surrounded by a very thin rim of pale green granular clinopyroxene grains.

Groundmass crystals have random orientation, and are tabular, commonly pellucid, crystals of plagioclase, prismatic augite and probable hypersthene, and octahedral black iron oxide. All the crystals are enclosed in a dark brown somewhat altered glass that forms about 25 percent of the rock.

A few cognate xenoliths are present. Some consist of clusters of slightly intergrown grains of augite; others are similar, but also contain granular olivine. Another is formed of anhedral olivine grains subophitically enclosing small laths of plagioclase. The diameters of these inclusions are about 1 to 1.5 mm and the average size of the grains within them is about 0.3 mm.

A very rough estimate of the percentage of minerals present is: plagioclase 40; augite and (?)hypersthene 25; glass 25; olivine 5; black iron oxide 5.

The specimen is a porphyritic olivine basalt which, generally speaking, is typical of Manam volcano. The main difference between this sample and specimens from the 1957 eruption is the present of phenocrystic hypersthene in the latter.

A sample (1514) was analysed by S. Baker, and gave the following chemical composition:

	Percent
SiO_2	51.10
Al_2O_3	16.65
Fe_2O_3	4.98
FeO	4.00
CaO	10.60
MgO	6.80
Na_2O	4.25
K_2O	0.88
MnO	0.16
TiO_2	0.58
P_2O_5	0.19
H_2O (110 °C)	Nil
Loss on ignition	Nil
	100.19

VOLCANIC ACTIVITY AT MOUNT YELIA, NEW GUINEA

SUMMARY

Mount Yelia is a dormant volcano, 11,135 feet above sea level, in the Owen Stanley Range north of Menyamya. The volcanic structure is clear in the upper 3000 feet of the mountain and comprises a northern dome and crater complex, a southern crater ridge, and a dome, all of augite-lamprobolite dacite.

Decadent solfatara areas are located along the inner face of the southern ridge and at the base of the dome on the southern and eastern sides, at an altitude of about 9000 feet above sea level. All the areas are cold and consist of sulphur-encrusted talus blocks with hydrogen sulphide and a little sulphur dioxide issuing from fissures between the blocks.

The volcano is similar in character to Mount Lamington and nuées ardentes may be produced in future eruptions. Two possible avalanche valleys exist, one on the east and one on the west of the mountain, which drain steeply to sparsely populated valleys 5000 to 6000 feet below. These areas would need to be evacuated should an eruption appear imminent.

INTRODUCTION

Mount Yelia is a prominent dome-shaped peak 11,135 feet above sea level, at latitude 07°03'S., and longitude 145°51'E., in the Owen Stanley Range north of Menyamya, T.P.N.G.

Although Mount Yelia has been a familiar landmark for many years to pilots between Port Moresby and Goroka, it was not until 1962 that attention was drawn to its possible volcanic origin. In May 1962 Dr M. Alpers of the Department of Public Health crossed the mountain when walking between Okapa and Menyamya and noted the presence of sulphur gases and a crater lake. Local people reported that this centre has been active in the past. On receiving a letter from Dr Alpers, G.A.M. Taylor, Senior Resident Geologist, asked the A.D.O. at Menyamya for further information. As a result Patrol Officer D.C. Lindsay investigated the crater in October 1962, and collected samples of sulphur and altered lava. His observations were confirmed in January 1963 by Mr G. Rosenberg of the Division of National Mapping, who noted particularly the absence of heat, and collected samples of fresh lava from the cone complex when he established a survey beacon on the summit of Mount Yelia. Taylor inspected the volcano from the air on 27 February 1963, and concluded that the volcano is similar in structure to Mount Lamington.

I flew to Mount Yelia from Menyamya by helicopter on 12 November 1963. A camp was established for three days at an elevation of about 9750 feet above sea level (Fig. 21), from which traverses were made to the solfatara areas and dome, the summit area, and the south-western slopes of Mount Yelia. A little firewood and water of doubtful quality from nearby swamps are available near the camp site. The co-operation of the Division of National Mapping, who were using the helicopter at this time, and the assistance of Cpl Waengo of the Royal Papua and New Guinea Constabulary, are gratefully acknowledged.

TOPOGRAPHY

Mount Yelia lies at the end of a high ridge in rugged mountain country (Figs 20 and 21); it is a broad dome with a maximum elevation of 11,135 feet above sea level.

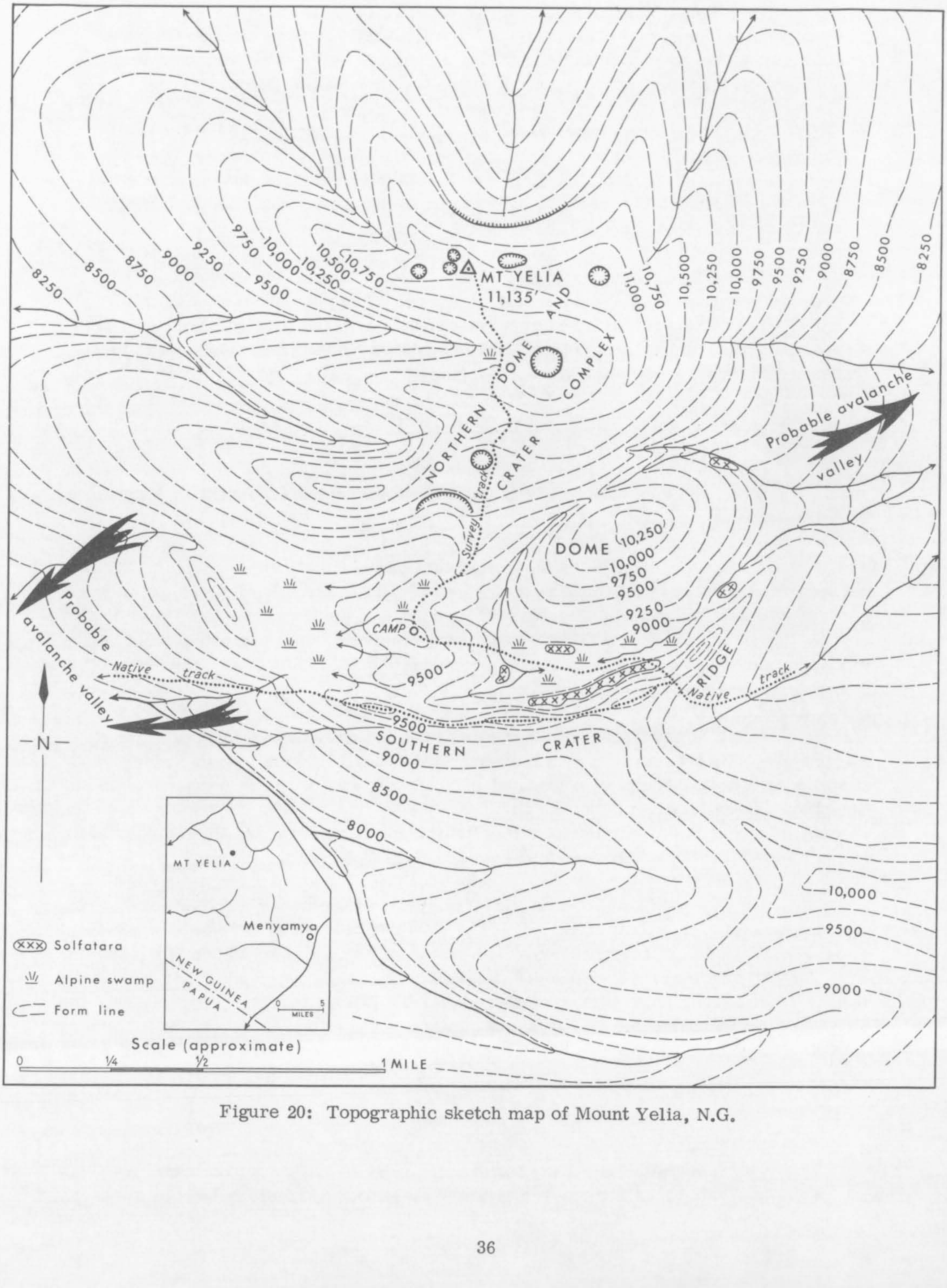

Figure 20: Topographic sketch map of Mount Yelia, N.G.

To the north and west the mountain slopes precipitously to wide valleys 5000 to 6000 feet deep containing the headwaters of the Vilolo River, and to the south-east Mount Yelia is connected to Mount Marble by a ridge with an elevation of about 9000 feet above sea level. On most maps of the area Mount Yelia is not indicated and Mount Marble is plotted in its position: it is also confused sometimes with Mount Akana.

The lower slopes of Mount Yelia are thickly vegetated, but above 8000 feet above sea level the mountain is covered by patches of stunted moss forest and alpine grass and swamps. The air temperature at the camp 9750 feet above sea level ranged from 25°C to 8°C.

STRUCTURE OF MOUNT YELIA VOLCANO

The volcanic structure of Mount Yelia is clear in the upper 3000 feet, and the main components are (Fig. 20): the southern crater ridge; the northern dome and crater complex; the dome; the crater; and solfatara areas.

Southern crater ridge

A narrow arcuate crater ridge, $1\frac{1}{2}$ miles long and up to 750 feet high, is preserved on the southern side of Mount Yelia, with a small outlier half a mile away on the south-western slope. The base of the ridge is about 9000 feet above sea level. Massive grey augite-lamprobolite dacite (Morgan, 1963) from the top of the ridge near the eastern end possibly represents the earliest rocks erupted from the volcano.

Northern dome and crater complex

The main bulk of Mount Yelia is a broad dome about 2 miles in diameter and 3000 feet high, with the Mount Yelia trigonometrical station at its summit. The dome is composed of augite-lamprobolite dacite ash, which in the summit area is oxidized, moderately cemented, and faintly bedded. Apart from erosion gullies on the flanks, the form of the dome is regular, but its large size suggests that it may be built of several overlapping small domes extruded over a period of time from centres in the same general area.

Superimposed on the dome are eight well preserved explosion craters ranging from 150 to 500 feet across and up to 200 feet deep. No cones are preserved around the craters: they may have been eroded, but it is possible that the craters are diatremes. No thermal activity is evident in any of the craters, and all are covered by alpine grass and moss forest.

Dome

A small dome, half to three-quarters of a mile across and 1250 feet high, has been extruded between the northern dome and crater complex, and the south-eastern end of the southern crater ridge. Moss forest on the slopes of the dome is stunted compared with the rest of the volcano, and suggests that the dome is the most recent volcanic structure. The dome is composed of dacite similar to the southern crater ridge, but it is strongly oxidized.

Crater

The irregular depression formed between the two domes and the crater ridge has been called a crater by previous observers. The crater is elongated east-west, with low swampy areas at either end, and a hill about 750 feet high in the centre. The low area

Figure 21: Summit area of Mount Yelia as seen from the east (cf. Fig. 20 for topographical features).

Figure 22: Solfatara area at base of southern crater ridge.

at the eastern end is an area of internal drainage in which a shallow lake forms after heavy rain.

Solfatara areas

The largest solfatara area lies along the base of the northern (inner) slope of the southern crater ridge (Fig. 22), and smaller ones around the base of the dome and at the foot of the hill in the centre of the crater, all at an elevation of about 9000 feet above sea level. Away from the volcano, cold springs depositing sulphur have been reported by Patrol Officer C.F. Booth in the Kwonguya River at an elevation of 7800 feet above sea level, and in the head of the Kwonaga River at an elevation of 7300 feet above sea level.

The solfatara areas are confined mainly to the talus slopes, and within each area the talus blocks are leached and commonly encrusted with sulphur. Cold hydrogen sulphide with a little sulphur dioxide issues from fissures between the blocks. Sulphur stalactites and stalagmites a few inches long have grown in some of the fissures. No heat was evident at any of the solfatara areas visited.

FUTURE VOLCANIC ACTIVITY

Both the form of Mount Yelia and the petrology of the rocks erupted are similar to Mount Lamington; hence similar types of Pelean eruption may be expected.

Two possible avalanche valleys exist, one on the east and one on the west of the mountain (Fig. 20). Both valleys drain steeply down to sparsely populated flat areas 5000 to 6000 feet below. These areas would need to be evacuated should an eruption appear imminent.

At present Mount Yelia volcano is dormant, but an unconfirmed local report suggests that an eruption occurred at this centre about 20 years ago. The nearest patrol posts, Menyamya to the south and Wonenara to the north, are unfortunately too far away to be able to observe the volcano, but changes in volcanic activity would be readily noted by pilots on the Port Moresby-Goroka flight, who fly almost over the mountain.

REFERENCES

MORGAN, W.R., 1963 - The petrology of lava samples from Mount Victory and Mount Yelia, Territory of Papua and New Guinea. Bur. Miner. Resour. Aust. Rec. 1963/60 (unpubl.).

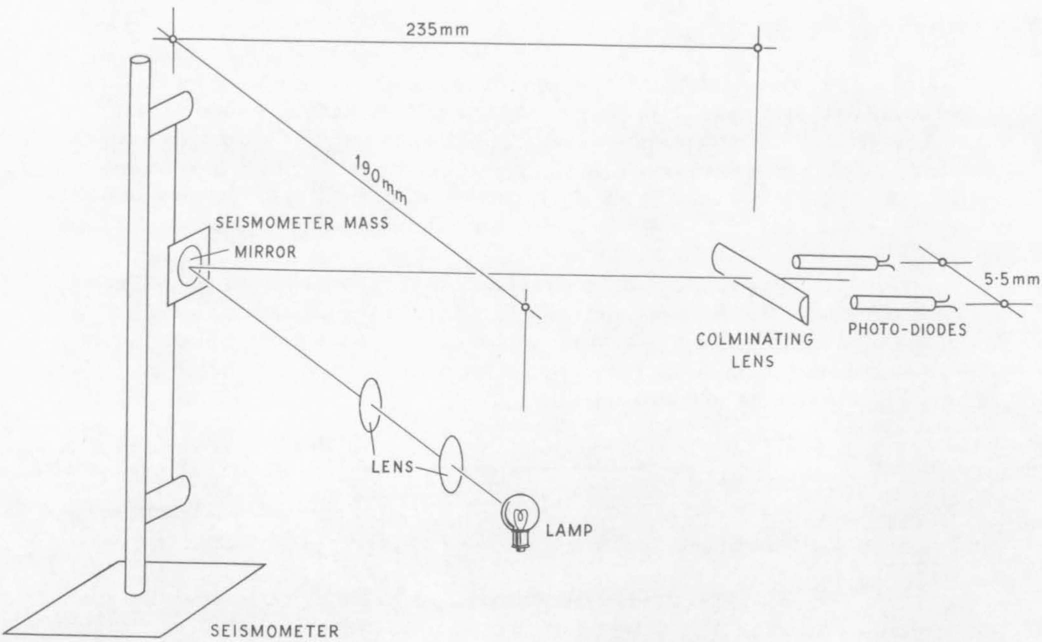

Figure 23.

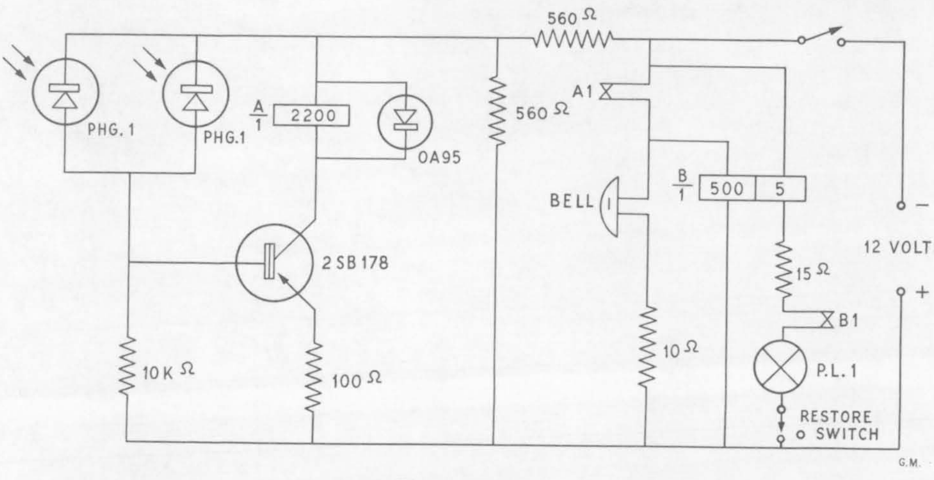

Figure 24.

AN EARTHQUAKE ALARM

by

N.O. Myers*

INTRODUCTION

A self-contained earthquake alarm providing audible indications of local seismic events of relatively high amplitude motion has been developed at the Vulcanological Observatory, Rabaul. It has proved a useful accessory to observatory equipment because (a) warning will alert an observer, who can then watch the arrival of the seismic waves on visual recorders; and (b) warning occurring when photographic records are being changed will alert attendant staff, who can then postpone operations until activity has ceased.

DESCRIPTION OF EQUIPMENT

The unit consists of:

(a) Light source

(b) Torsion seismometer

(c) Photo-electric transducer

(d) Switching unit

(e) Bell

(f) Monitors

The seismometer constants are:

Period (To) = 1.0 second

Static magnification of the light lever path (V) = 40

Damping ratio (e) = 10:1

A standard 6V 3W automobile lamp is used for the light source and two miniature germanium junction diodes serve as the transducer. The photo-diodes are moderately sensitive to the direction of light entering the cell. Therefore they may be used under normal artificial lighting without interference. A diagram of this arrangement is shown in Figure 23. Magnetic damping of the seismometer is not shown.

*Technical Officer, Administration of Papua - New Guinea, Vulcanological Observatory, Rabaul.

OPERATION

In the quiescent state, a light beam reflected from a mirror on the seismometer mass is brought into focus midway between the photodiodes. When the seismometer mass is displaced by seismic waves, the light beam scans the diode apertures alternatively for short periods, making them conduct, thus triggering the single stage switching circuit which operates the warning bell and monitor pilot lamp. The lamp glows until relay B is restored manually. The monitor is a simple means of indicating operation of the alarm. A circuit diagram is shown on Figure 24.

CONCLUSIONS

In practice, it has been found that the alarm is triggered by:

(a) All felt earthquakes;

(b) Many near earthquakes too small to be felt;

(c) High-energy teleseisms.

Because of the low magnification used diurnal seismometer drift does not operate the alarm prematurely.