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

by

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SUMMARY

The Mount Balbi volcano complex, 9000 feet high, on Bougainville Island, consists of six well preserved ash craters (A to F) surrounding an amphitheatre containing a solfatara field one 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 trends north, and one trends east.

The most recent eruption was probably from crater B, between 1800 and 1850, and many natives were killed by nuee 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 (HCl), sulphur dioxide (SO_2) and some hydrogen sulphide (H_2S), is issuing under high pressure.

INTRODUCTION

Mount Balbi is located centrally in the northern third of Bougainville Island, in the Territory of Papua and New Guinea (Pl.1). It is the northern-most of four volcanoes in Bougainville: the others are Mount Bagana (Best, 1956) and Lake Billy Mitchell near the centre of the island, and Lake Loloru (Best, 1951; Reynolds 1955) towards the southern end of the island.

The summit of Mount Balbi consists of a number of dormant volcanic cones, the highest point of which is about 9000 feet above sea level. Tropical rain forest covers the lower slopes of the mountain up to an altitude of about 4000 feet. Between 4000 feet and 7000 feet above sea level bamboo is the dominant vegetation. Casurina trees grow above 4500 feet above sea level 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 above sea level, the forest is replaced entirely by a trough-cutting alpine rush (Fig. 6). The area above 2000 feet above sea level 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 the 6th and 15th 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 (Pl.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 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 four 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.

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 one 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 (Pl.1 & Fig.1). To the south-west the amphitheatre opens into a broad valley that falls steeply to the coast eight 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 natives claim many people died as a result of this activity.

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 area 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.

Description of craters A to F.

Craters A to E form a lineament two miles long trending north-north-west and slightly convex to the north-east. Crater F is slightly more than one 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 in Fisher (1957) mainly from air-photo interpretation, and his descriptions are repeated here with some elaboration; the dimensions of the craters are listed in Plate 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 A') 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 is devoid of vegetation (Pl.1; Figs 3 and 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 area, 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.

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 solfatara 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 progress 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 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.

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 comprising 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, one and three quarter miles south-east of crater A.

Spine

A possible spine is preserved one half 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, one mile in diameter, occupies an amphitheatre between the craters (Figs. 7 and 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 Pl.1).

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

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

The nuee ardente deposits at the top of the section cover the solfatara field. The surface of the field is cemented to form a crust $\frac{1}{8}$ to $\frac{1}{4}$ 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 one or two 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 Pl.1. They range from 75°C to 145°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 four 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 omitted 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°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 (Pl.1). The augite basalt surrounding the spring is iron stained; and the air is fetid.

Natives reported two other areas of hot springs further west, and their approximate locations are shown on Pl.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 nuee ardenites 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 nuee ardentes will be produced. It is stressed that any changes noticed in volcanic activity, and particularly any increase in seismic activity, should be reported immediately to the Senior Vulcanologist, Rabaul.

EVACUATION PLAN

The lack of accurate maps of the area around Mount Balbi make it difficult to clearly define a danger zone, and no precise evacuation plan can be formulated until maps are available. Any general evacuation plans should be based on the possibility of nuee ardente type eruptions. (Nuee ardentes are gravity controlled flows of red-hot ash charged with gas that sweep down from the point of eruption at a considerable speed (60 to 150 miles per hour). They tend therefore to follow the main valleys leading from the volcano, fanning out over the flatter ground on the lower slopes).

At Mount Balbi the most likely out-let for a nuee ardente is the valley trending ~~north~~ south-west from the low end of the ampitheatre containing the fumarole field. The valley to the north of Mount Balbi is also a potential danger area, although little debris would be expected to flow in this direction. To the east, along the valley of the Wakunai River, it is recommended that during an eruption all villagers be moved to the high ground on the south-eastern side of the Wakunai River.

TOPOGRAPHICAL MAP
Mt BALBI AREA - BOUGAINVILLE

REFERENCE

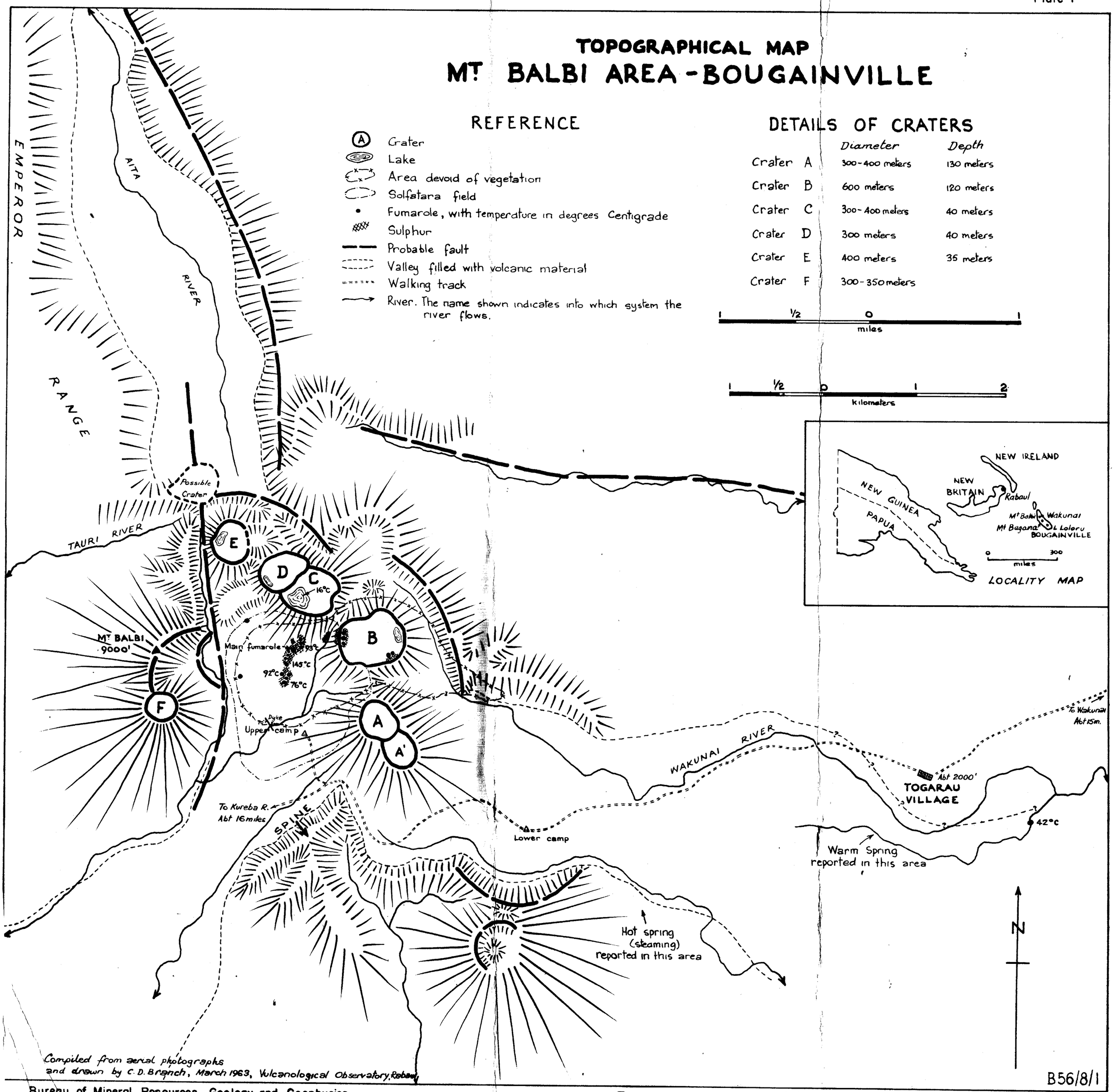
- Crater
- Lake
- Area devoid of vegetation
- Solfatara field
- Fumarole, with temperature in degrees Centigrade
- Sulphur
- Probable fault
- Valley filled with volcanic material
- Walking track
- River. The name shown indicates into which system the river flows.

DETAILS OF CRATERS

	Diameter	Depth
Crater A	300-400 meters	130 meters
Crater B	600 meters	120 meters
Crater C	300-400 meters	40 meters
Crater D	300 meters	40 meters
Crater E	400 meters	35 meters
Crater F	300-350 meters	

1 ½ 0 1 miles

1 ½ 0 1 2 kilometers



Compiled from aerial photographs and drawn by C. D. Branch, March 1963, Vulcanological Observatory, Rabaul

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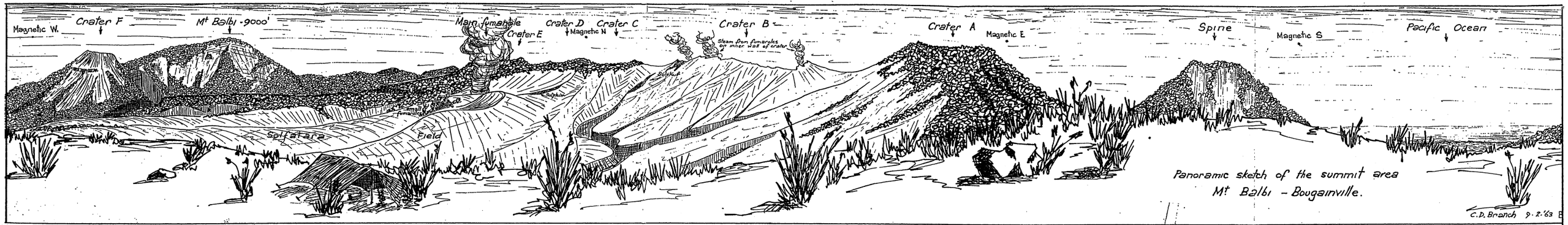
FIG. 1



Panoramic sketch of the summit area
Mt Balbi - Bougainville.

Bureau of Mineral Resources, Geology and Geophysics.

To accompany Record 1965/21

REFERENCES

BEST, J.G., 1951 - Preliminary report of vulcanological investigation of Lake Loloru, Bougainville, New Guinea. Bur.Min.Resour.Aust.Rec. 1951/38 (unpubl.).

BEST, J.G., 1956 - Investigation of eruptive activity at Mount Bagana, Bougainville, March 1952. Ibid.,1956/14 (unpubl.).

FISHER, N.H., 1957 - Catalogue of the active volcanoes of the world. Part V. Catalogue of the active volcanoes and solfatara fields of Melanesia. Int.volc. Assoc., 1957.

REYNOLDS, M.A., 1955 - An examination of thermal areas at Lake Loloru, Bougainville, New Guinea. Bur.Min.Resour. Aust.Rec., 1955/93.

TAYLOR, G.A., 1960 - An experiment in volcanic prediction. Ibid., 1960/74 (unpubl.).

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

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

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

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

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

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

Fig. 8. The solfatara field and main fumarole viewed from the upper camp.