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TEMPERATURE MEASUREMENTS IN THE CRATER OF MOUNT EREBUS, ROSS ISLAND, ANTARCTICA (2)

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Abstract: Surface temperature distribution in the crater of Mount Erebus, Ross Island, Antarctica was surveyed during the 1989–1990 field season using an infrared radiation thermometer. A convecting lava lake with the diameter of about 20 to 30 m was observed in the inner crater of the main crater. The maximum surface temperature of the inner crater was 118°C.

1. Introduction

Mount Erebus (77.53°S, 167.15°E, 3794 m), Ross Island is the most active volcano in Antarctica. It is characterized by the existence of a lava lake in its summit crater since December 1972. An international cooperative program named IMEEMS (International Mount Erebus Eruption Mechanism Study) was continued since 1987 by New Zealand and Japan for the purpose of monitoring the seismic activity and investigating the mechanism of its eruptions (KAMINUMA and MURAKAMI, 1989). According to recent studies, on the average over 1989, 47 volcanic earthquakes per day occurred in and around the summit area (ASAKAWA *et al.*, 1991). It was clarified that some of these earthquakes were accompanied by eruptions in the main crater by comparing their seismograms with pictures recorded by a video camera installed at the spot indicated as Camera Site in the figures (DIBBLE *et al.*, 1988).

In the 1986–1987 field season, the measurements of surface temperatures on the lava lake and the crater wall were carried out using an infrared radiation thermometer to study the mechanism of energy transfer concerning the persisting lava lake (MIURA *et al.*, 1988). The maximum temperature of the lava lake surface was measured at 798°C. The surface of the lava lake was found to solidify in December 1988 and eruptions occurred from four vents on the solidified surface. In December 1989, the lava lake reappeared and eruptions occurred from it. The measurements of surface temperature were carried out by the same thermometer that was used in 1986–1987. In this paper, the surface temperature distribution in the main crater is reported.

2. Temperature Measurements

Infrared radiation thermometers have been used for remote sensing of the temperature distribution in and around the volcanic areas to clarify the relation between the

surface temperature and the volcanic activity and to measure the temperature of lava lake (*e.g.* SHIMOZURU, 1971; SHIMOZURU and KAGIYAMA, 1978).

The equipments used in this study comprised Minolta Radio Thermometer IR-0510 and Data Processor DP-110 which are the same ones used in 1987 (MIURA *et al.*, 1988). Observed temperature is displayed on the LCD in the finder of the thermometer after a correction for the emissivity of the target. The thermometer is controlled by a microprocessor and can calculate and display mean, maximum or minimum value instantaneously after some samplings. Since the instrument does not work well below 0°C, chemical hand warmers were used to keep the thermometer warm throughout the observations.

The procedure of measurements is the same as that in the previous paper. Observation points where the thermometer was set, Camera Site, E3 and E5, are indicated on a topographic map of the summit area of Mount Erebus in each figure. An instantaneous photograph of the target area was firstly taken and temperature measurements were carried out, then the observed points were marked on the picture. Unfortunately, locations of measured points were not determined accurately because the optical finder was broken. Then only the maximum temperature in the target area was obtained. The emissivity was assumed to be 0.7 throughout the measurements, because the same value was used in the previous work.

3. Results

Observations were carried out on December 11, 1989. The weather was fine and the atmospheric temperature was about −23°C. The activity of fumarole in the main crater has not obviously changed since the 1986–1987 field season, judging from photographs taken in 1986 and 1989. Photos 1 and 2 show the inside of the main crater, viewed from east (Photo 1) and west (Photo 2) on December 11, 1989. The south wall of the crater was in the sun, while the north wall and the bottom of the inner crater

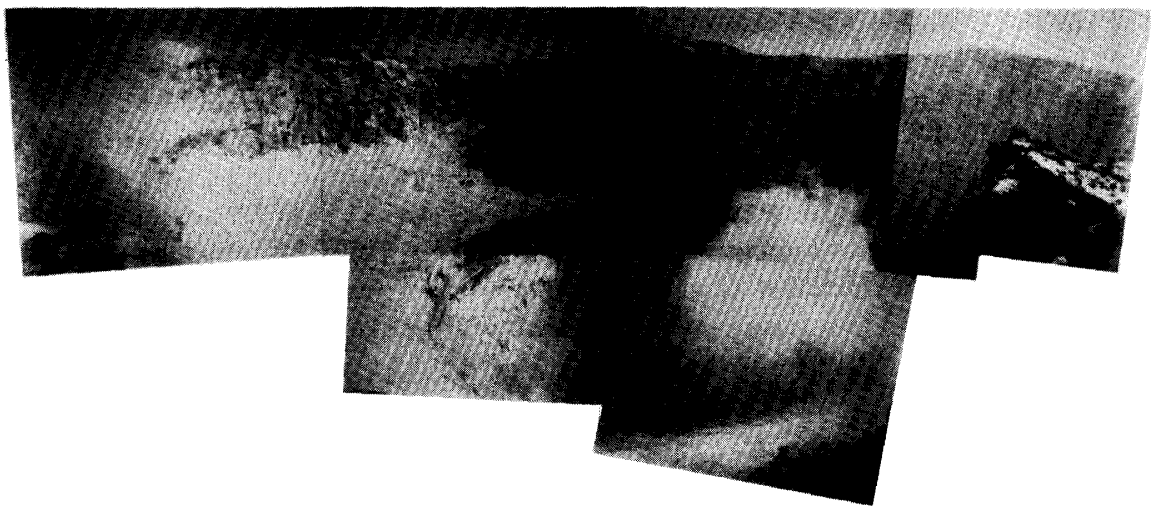

Photo 1. The inside of the main crater of Mt. Erebus, viewed from the observation point "Camera Site". The inner crater is formed in the northern part of the crater.

were in the shade. Some portions of the crater wall were not covered with snow, and the geothermal activity was recognized at them.

Figures 1–7 show the surface temperature distributions in the main crater. The measurement area is indicated with a square on the right-hand side of the figures. A solid circle indicates an observation point for the area shown in the map. Surface temperature distributions in °C are shown on the left-hand side of the figures. The values at the dotted points are the temperature measured by the previous work in December 1986 (MIURA *et al.*, 1988). The maximum temperature measured in the small square in 1989 was given by larger characters. Only the maximum temperature

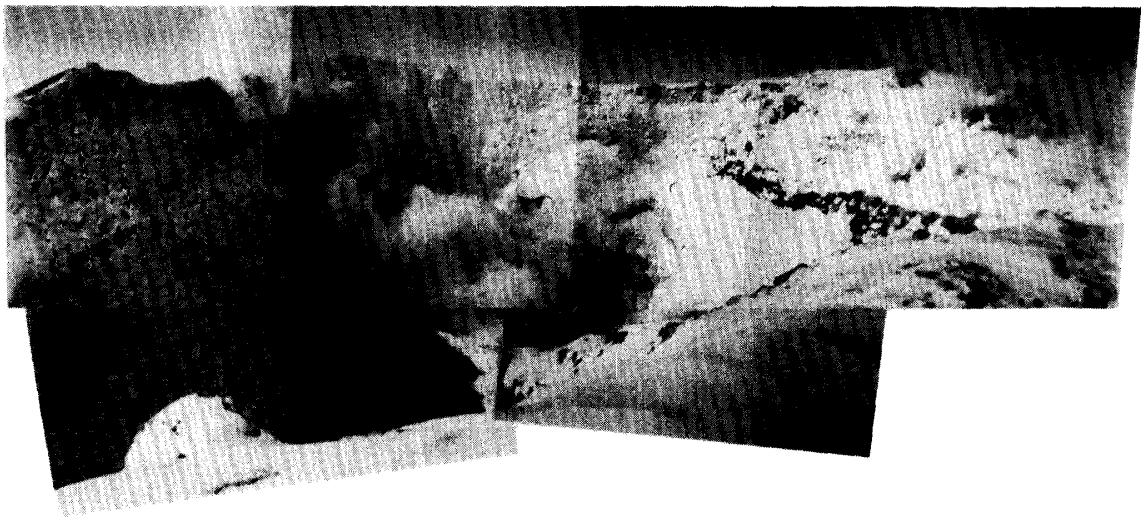

Photo 2. The inside of the main crater of Mt. Erebus, viewed from the observation point "E3". Fumarolic activities can be seen in the inner crater and the main crater rim.

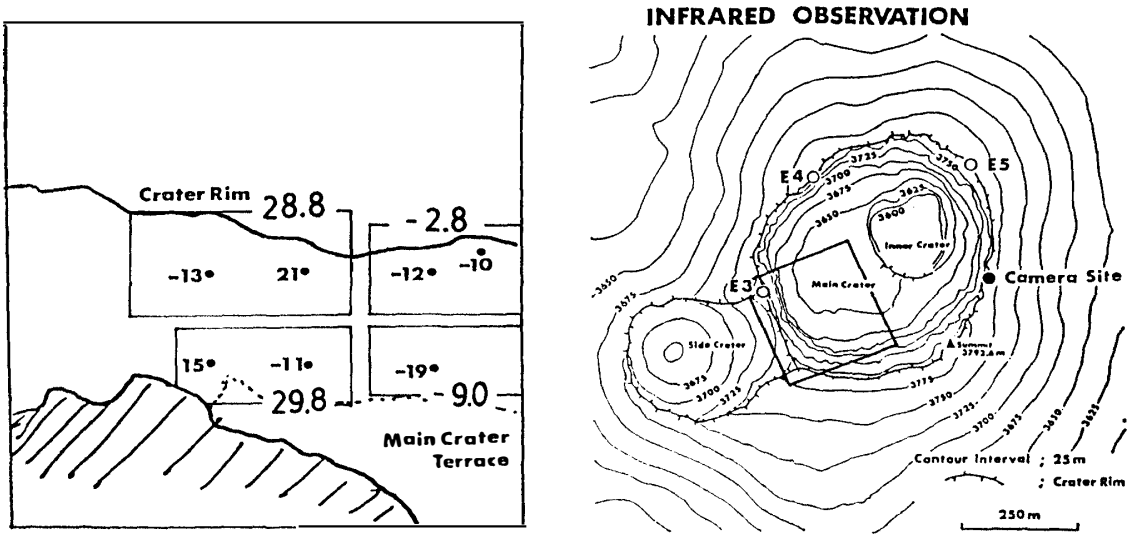

Fig. 1. Surface temperature distribution in °C in the southwestern part of the main crater measured from Camera Site. Solid circles indicate observation points in December 1986, and rectangles show the maximum temperatures within the area during December 1989.

measured in each target area as shown with a small square was given because locations of measurement points were not determined exactly due to the optical finder trouble. The values in parentheses are the maximum temperatures in areas where measurements were disturbed by the fumarolic activity.

The observation point is Camera Site in the measurements shown in Figs. 1–4. Figure 1 is the measurements in the southwestern part of the main crater. The temperature of the crater wall ranged from −9°C to 29.8°C, and it ranged from −19°C to 21°C in the previous measurements. The temperature of the northwestern crater wall was measured −8.3°C in the middle and −11.6°C near the rim as shown in Fig. 2. The temperature of the previous work in this area ranged from −10°C to −25°C. The temperature in the northern wall was 26.4°C, while the temperature in the previous measurements ranged from −18°C to 19°C as shown in Fig. 3.

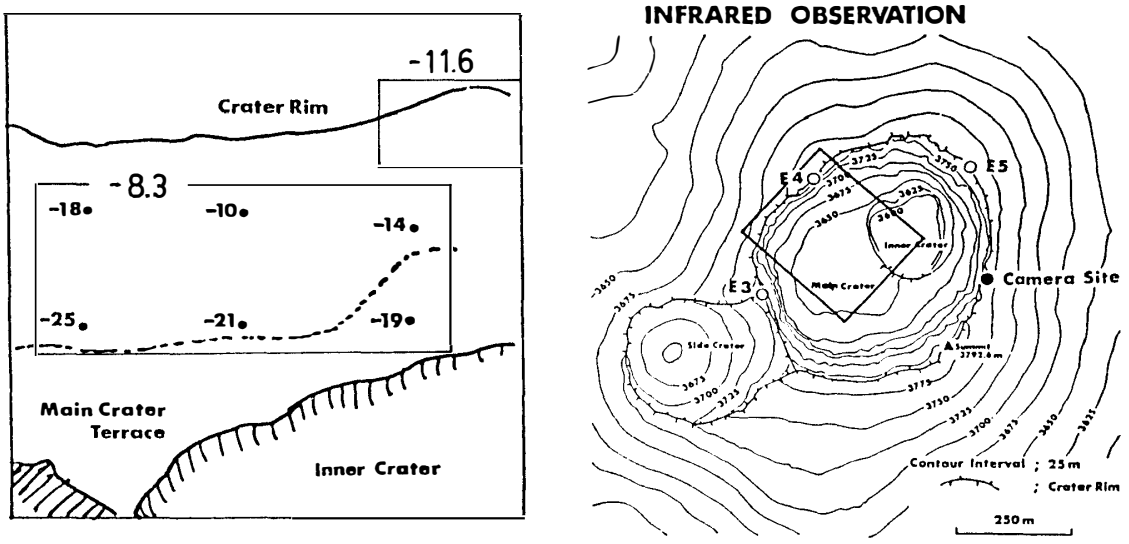

Fig. 2. Same as Fig. 1 except for in the northwestern part of the main crater.

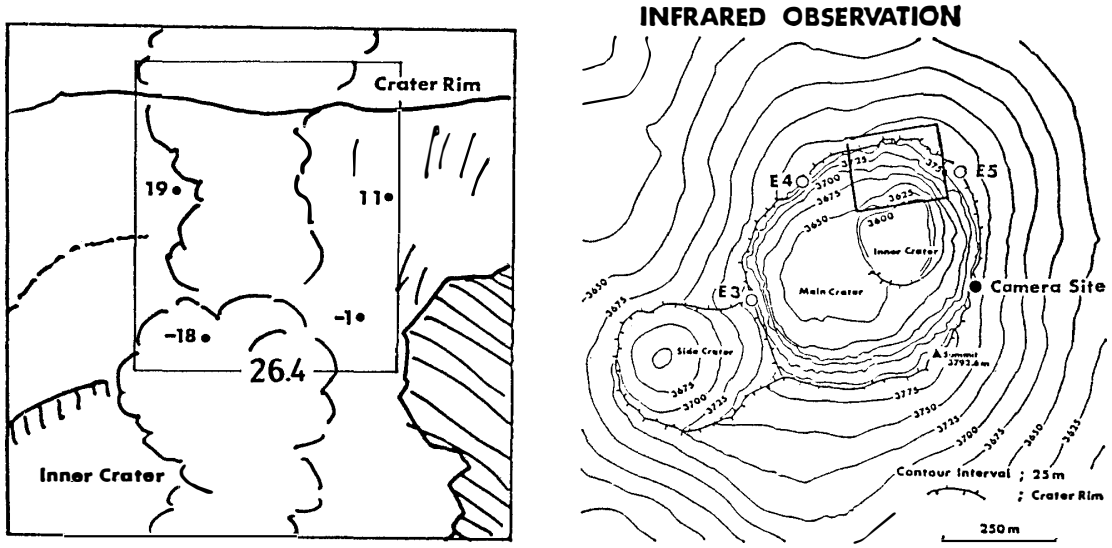

Fig. 3. Same as Fig. 1 except for in the northern part of the main crater.

The temperature in the inner crater was 118°C, and those in the active vent and the northern edge of the main crater terrace were 31.5°C and −1.7°C respectively as shown in Fig. 4. The active vent is located in the southern part of the inner crater terrace. The maximum temperature of the inner crater wall was 54°C in the previous work.

The observation point for Figs. 5 and 6 is E3. The temperature in the northern part of the inner crater was 21.1°C and those in the northern crater wall were −4.8°C and −8.4°C as shown in Fig. 5. The temperature in the southern part of the main crater terrace was −16.9°C and that in the southern part of the inner crater was 18.6°C as shown in Fig. 6. The temperatures in the eastern part of the crater wall were measured 14.4°C and −4.8°C.

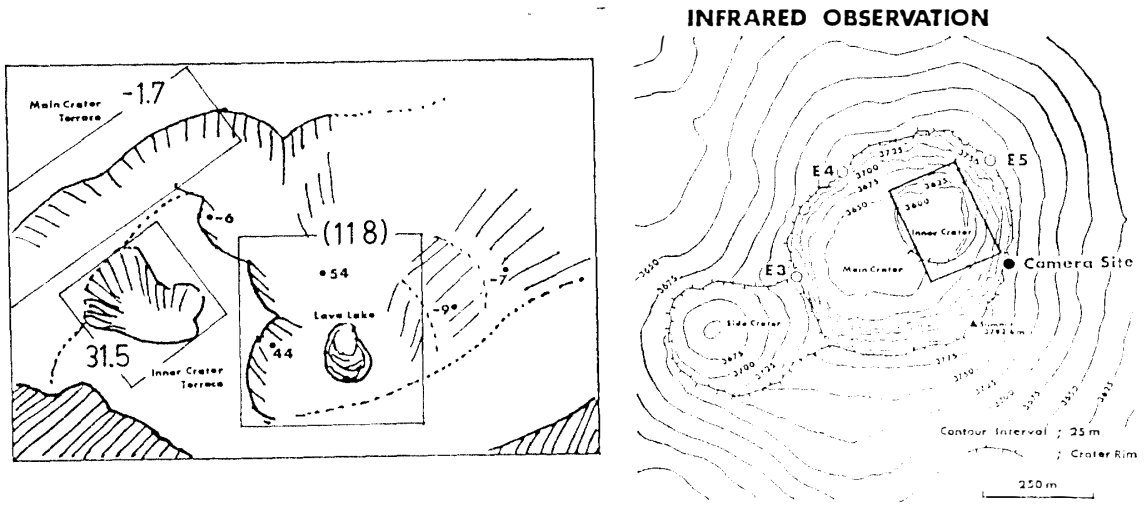

Fig. 4. Surface temperature distribution in °C in the inner crater measured from Camera Site. Spot values were measured in December 1986, and those for rectangles are maximum readings in December 1989.

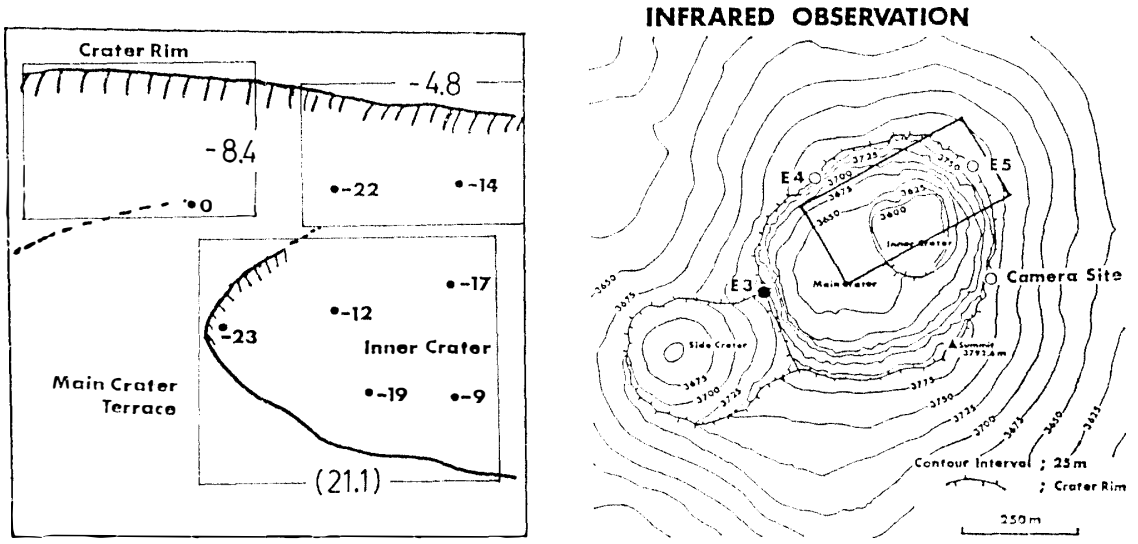

Fig. 5. Same as Fig. 1. except for in the northern part of the main crater measured from E3.

The temperature of the active vent in the inner crater terrace measured at E4 was 34.4°C as shown in Fig. 7. The maximum temperature recorded in the previous work was 84°C.

Fumarolic activities existed in the areas of which temperature was higher than 0°C. On the other hand, geothermal activity was not obvious in the areas of which temperature was lower than 0°C. The areas with temperature below −8°C were covered with snow or ice.

The temperature obtained in this measurement was compared with that in the previous work. The maximum temperature in each area did not grossly change from 1986 to 1989, except for the temperature of the active vent (Fig. 8).

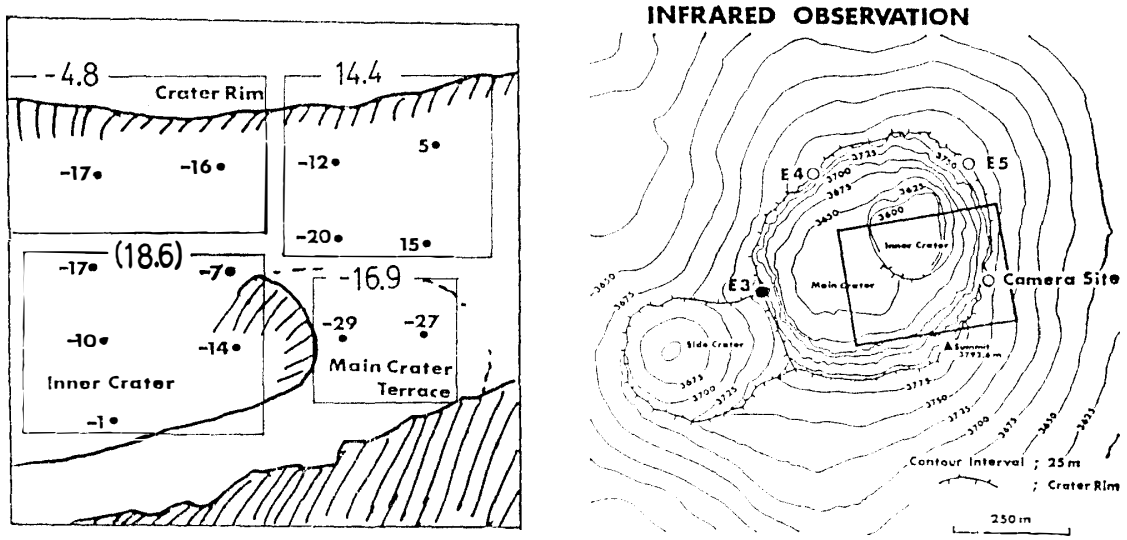

Fig. 6. Same as Fig. 1 except for in the eastern part of the main crater measured from E3.

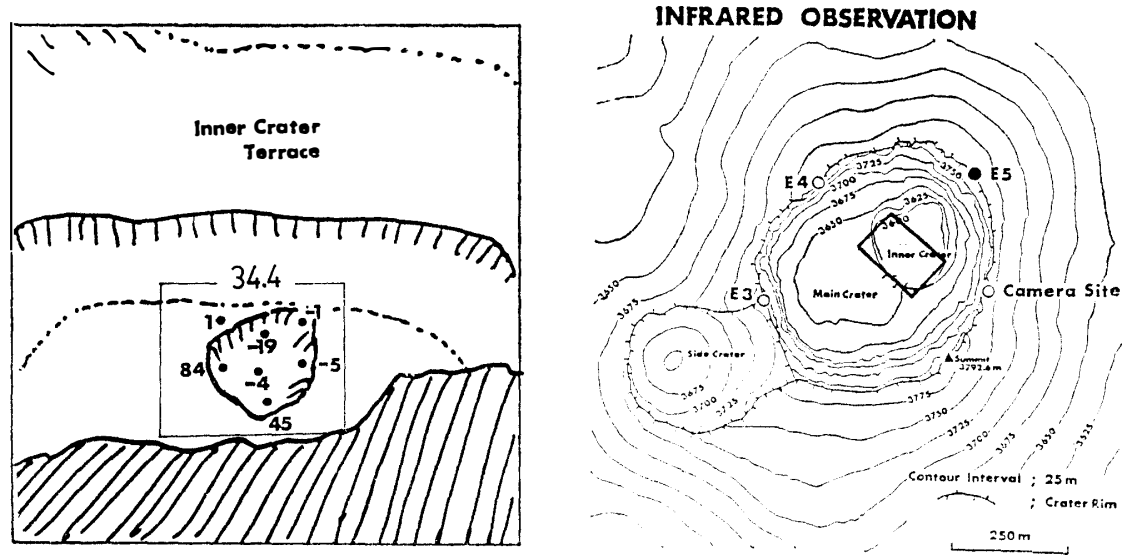

Fig. 7. Same as Fig. 1 except for in the inner crater measured from E5.

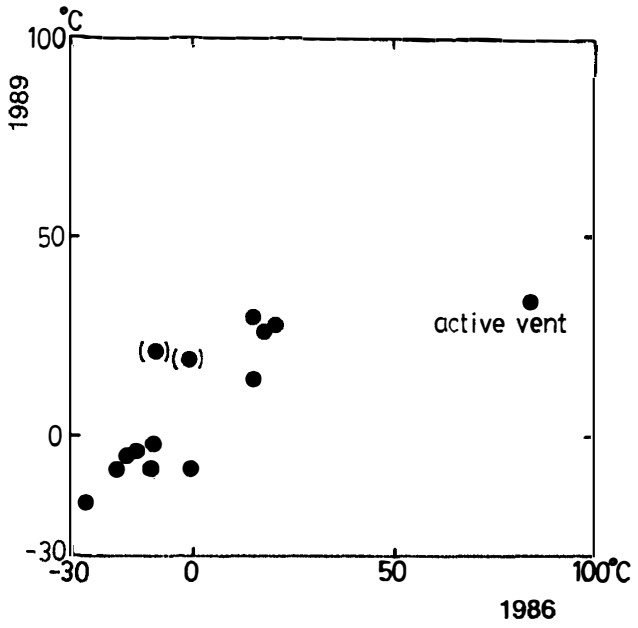

Fig. 8. Comparison of the maximum temperature in each measurement area between two field seaosn, 1986 and 1989.

Thus the thermal activity of the crater wall has probably kept roughly the same level. However, a decline was found in the thermal activity of the active vent.

It is regrettable that the temperature measurements of the lava lake were not successful in this study and we cannot make a detailed comparison between two measurements because the exact locations of the measurements points are not determined accurately due to the trouble of the optical finder. The surface temperature of the lava lake was not measured because of poor visibility of the lava lake from the rim for the fumarolic activity.

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