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

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Abstract: Surface temperature distribution in the crater of Mount Erebus, Ross Island, Antarctica, was surveyed during the 1986–1987 field season using an infrared radiation thermometer. A convecting lava lake with the diameter of about 20 to 30 m was observed in the Main Crater. The surface temperature of the lava was indicated to be about 800°C and the ground temperature by an active vent from which eruptions with ash ejection sometimes occurred was about 80°C. Except for some portions not covered by snow or ice, the ground temperature on the crater wall was below 0°C.

1. Introduction

Mount Erebus (3794m), Ross Island, Antarctica, is the most active volcano in Antarctica. It is characterized by the existence of a lava lake in its summit crater. An international cooperative project named IMESS (International Mount Erebus Seismic Study) was started in 1980 by Japan, the United States and New Zealand for the purpose of monitoring the seismic activity and investigating the mechanism of its eruptions. According to recent studies, on the average over 1987, 17 volcanic earthquakes per day occurred in and around the summit area (KAMINUMA *et al.*, 1988). 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 Fig. 1 (DIBBLE *et al.*, 1988).

In addition to the seismological observations, gravity surveys have been carried out in and around Ross Island every field season since 1982–1983 in order to investigate the subsurface structure of the volcano and the mechanism of eruptions of Mount Erebus (KAMINUMA *et al.*, 1984; MIURA *et al.*, 1987; MIURA and KAMINUMA, 1988). In the 1986–1987 field season, the measurements of surface temperatures on the lava lake and the crater wall were also carried out using an infrared radiation thermometer to study the mechanism of energy transfer concerning the persisting lava lake. In this paper, the surface temperature distribution in the Main Crater is reported preliminarily.

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

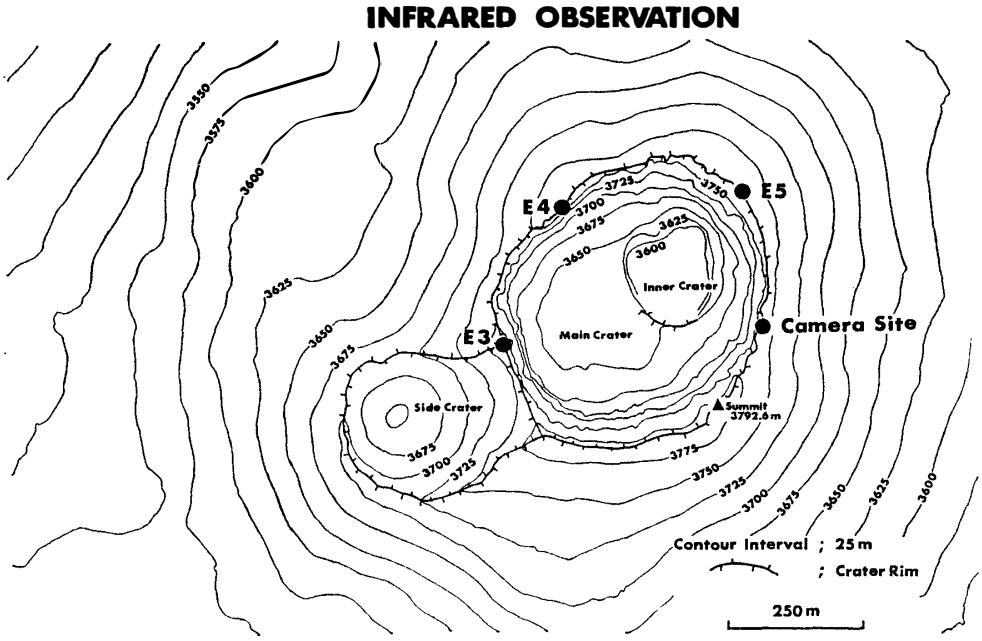

Fig. 1. Topographic map of the summit area of Mt. Erebus. Solid circles indicate observation points.

Table 1. Specifications of MINOLTA Radiation Thermometer IR-0510.

Range of temperature	−50-1000°C
LCD display	−50.0-104.9°C (0.1°C interval) 105-1000°C (1°C interval)
Measuring modes	continuous, peak, valley
Calculating mode	mean, maximum, minimum
Angle of measurement	1°
Angle of view	8°
Measurement distance	750 mm-infinite
Operation temperature	0-50°C
Detector	thermistor bolometer
optical band	8-14 micron
Reliability	±1% ±1 digit of indicated value
Repeatability	±0.1% ±1 digit of indicated value
Drift	±0.04%/°C ±1 digit of indicated value
Emissivity correction	0.01-1.00 presettable
Power consumption	40 mA
Response speed	0.5-1.5 s
Sampling time	0.5-1.0 s
Digital output	ASCII code, TTL level, serial out
External control	available through digital output terminal
Power supply	9 V dry battery (JIS S-006P)×1 external power supply is also available
Weight	820 g

Table 2. Specifications of MINOLTA Data Processor DP-110.

LCD display	16 characters ×2 lines dot matrix LCD display
Printer	24 characters per line (58 mm) thermal dot printer
Storage	1000 data (500 data with time) backup NiCd battery included
Automatic measurements	programmable sampling: 2–99 s interval: 5 s–99 min
Digital output	RS-232C (600–9600 bps)
Power supply	UM-3 dry battery (1.5 V) ×6, AC adapter
Weight	1300 g

surface temperature and the volcanic activity (*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. Observed temperature is displayed on the LCD in its finder after a correction for the emissivity of the target. The thermometer includes a micro-processor and can calculate and display mean, maximum or minimum value instantaneously after some samplings. The major specifications are listed in Table 1. Since the instrument does not work well below 0°C, chemical hand warmers were used to keep the thermometer warm throughout the observations.

The processor has a digital calendar and timer, memories to store observed values, a thermal printer and a serial output to communicate with other computers. By joining this instrument with the thermometer, fully automatic measurements are possible in ordinary circumstances. The instrument was used mainly to print out time and measured temperature simultaneously. The specifications of the processor are given in Table 2.

3. Results

Observation points where the thermometer was set, Camera Site, E3, E4, and E5, are indicated on a topographic map of the summit area of Mount Erebus in Fig. 1. Observations were carried out on 10 and 11 December 1986. The weather was fine and the atmospheric temperature was about −10°C. Figure 2 shows the surface temperature distribution in the Main Crater. The procedure of measurements was that 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 accurate because of the low quality and resolution of the pictures. The emissivity was assumed to be 0.7 throughout the measurements.

An active convecting lava lake with the diameter of about 20 to 30 m was observed in the Main Crater in this season. The surface temperature of the lava indicated about 800°C and the temperature by an active vent from which eruptions with ash ejection sometimes occurred was higher than 80°C as shown in Fig. 2i. Except some portions not covered by snow and ice, the surface temperature of the crater wall was below 0°C. These values would be closely related to the activity of the volcano so that the same measurements should be repeated in the near future.

Acknowledgments

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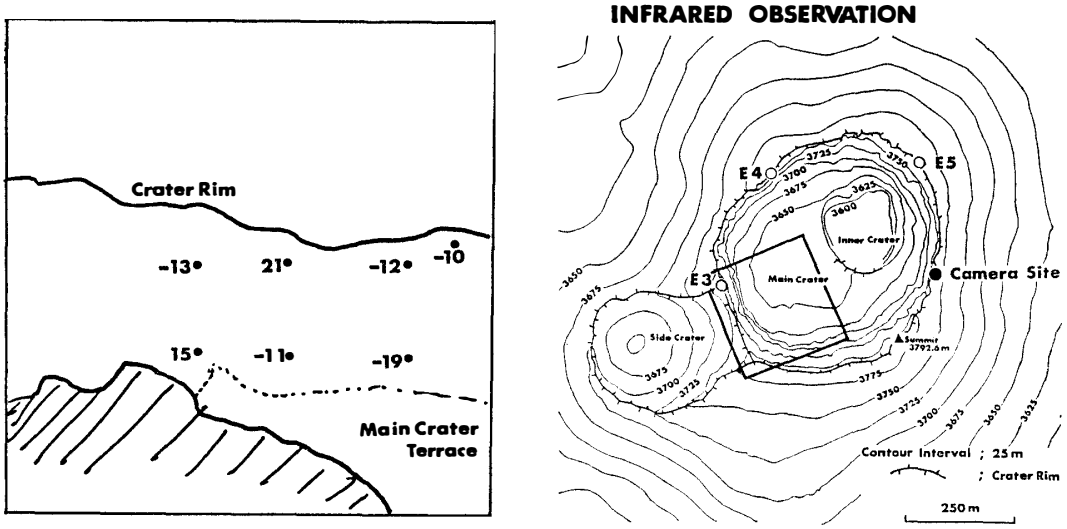

Fig. 2a.

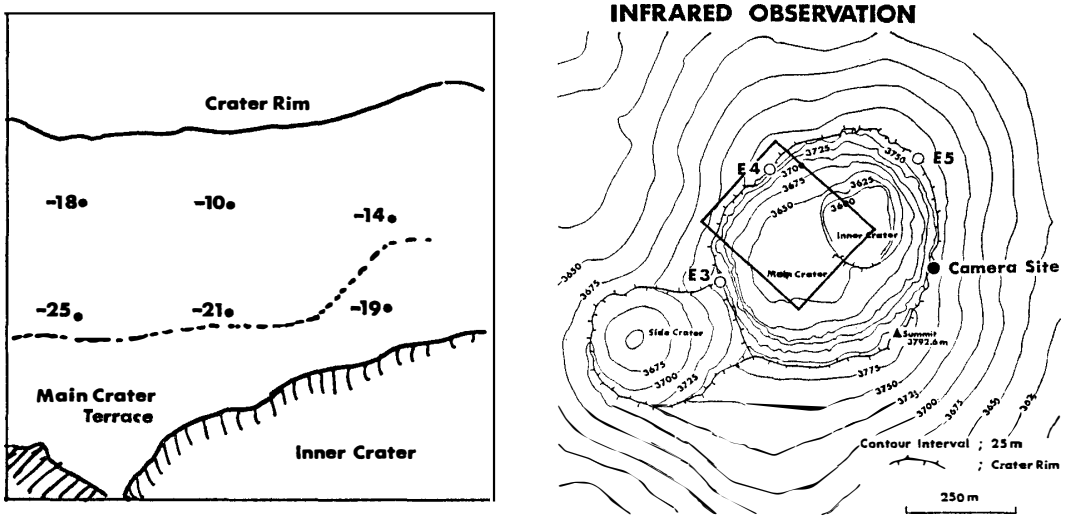

Fig. 2b.

Fig. 2. Surface temperature distribution in °C in the Main Crater (left-hand side). A solid circle indicates an observation point for the area shown in the map. Emissivity was assumed to be 0.7. The observation point is Camera Site through (a) to (e): (a) southwestern part, (b) northwestern part, (c) northern part, (d) Inner Crater, and (e) lava lake. In (f) northeastern part and (g) eastern part, the observation point is E3. (h) and (i) are for the Inner Crater from the observation points E4 and E5, respectively.

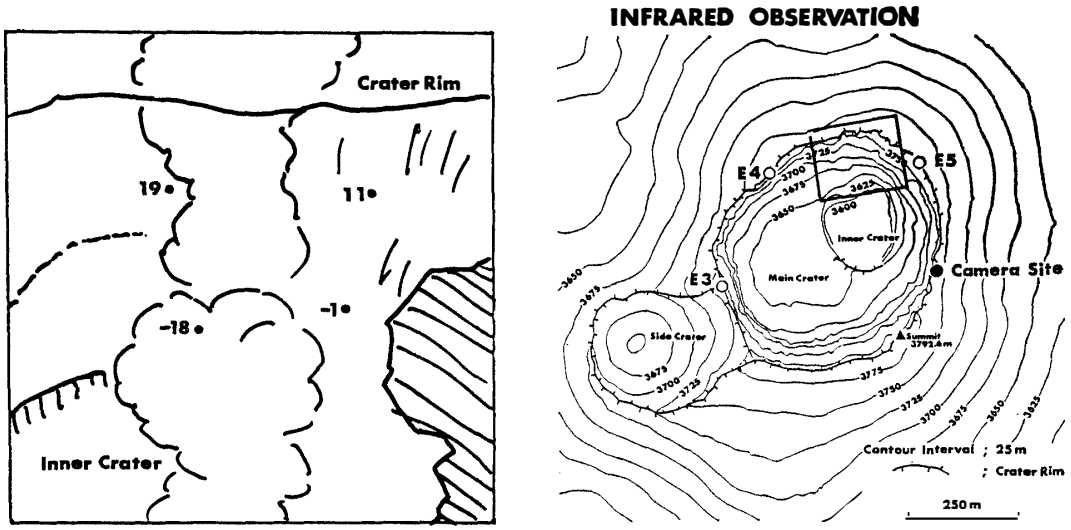

Fig. 2c.

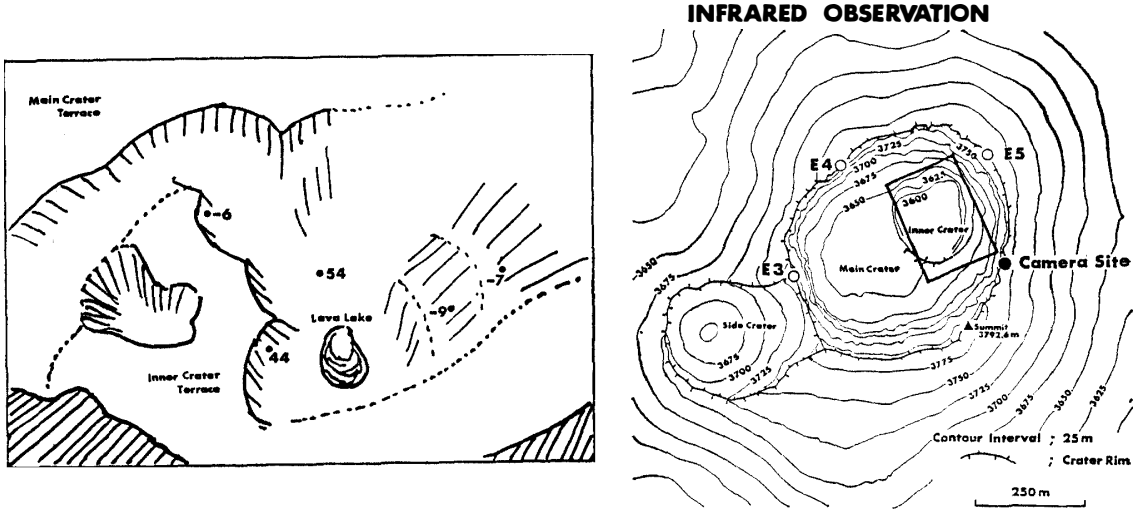

Fig. 2d.

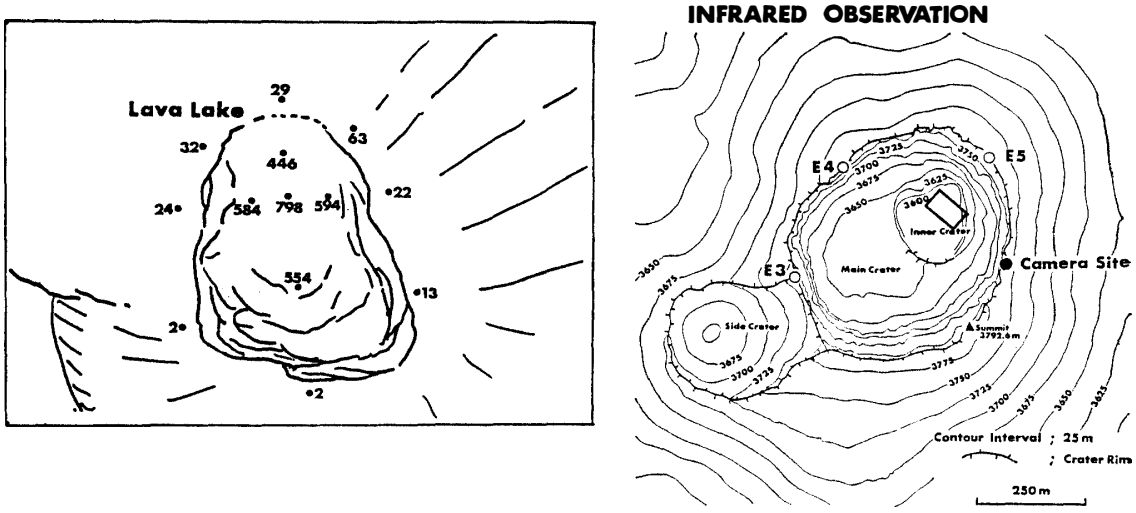

Fig. 2e.

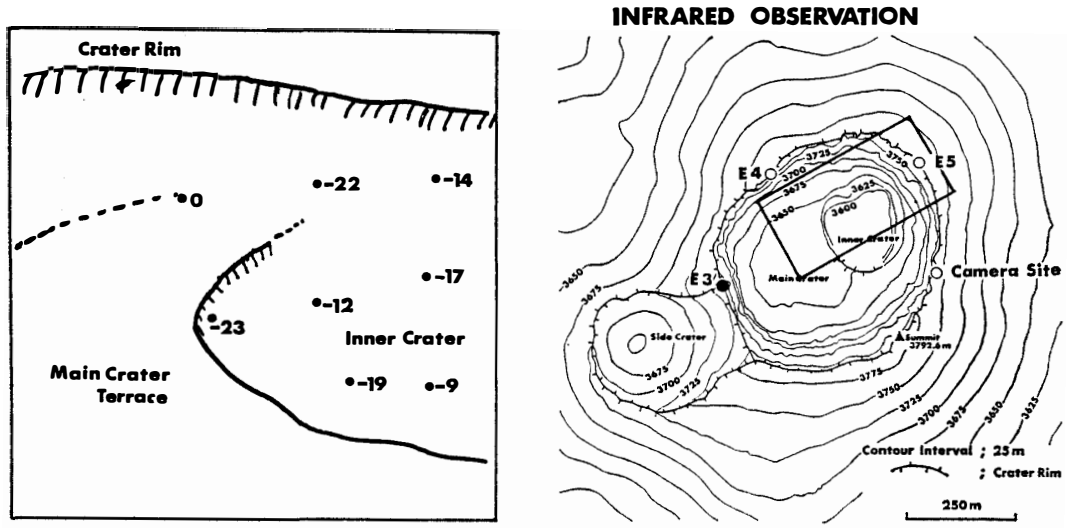

Fig. 2f.

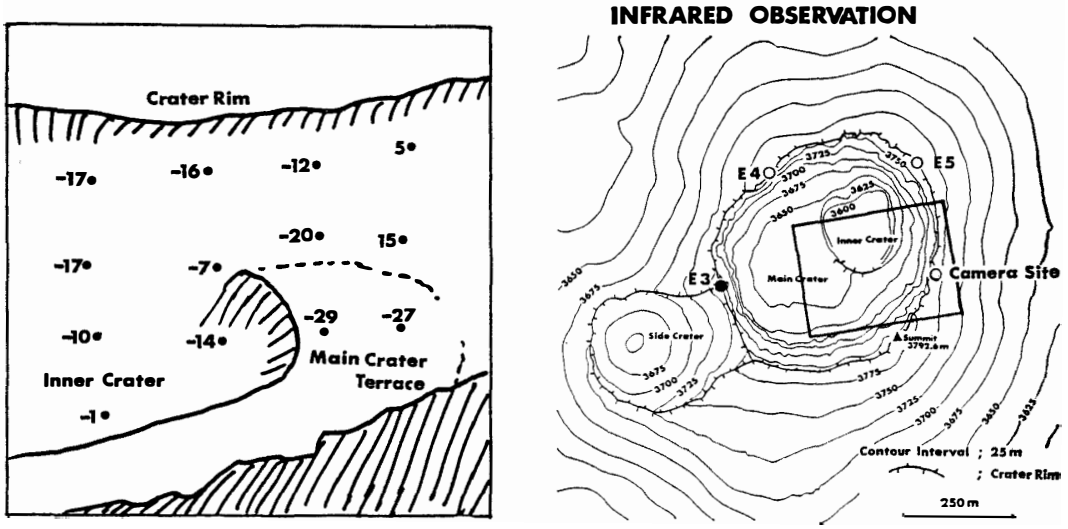

Fig. 2g.

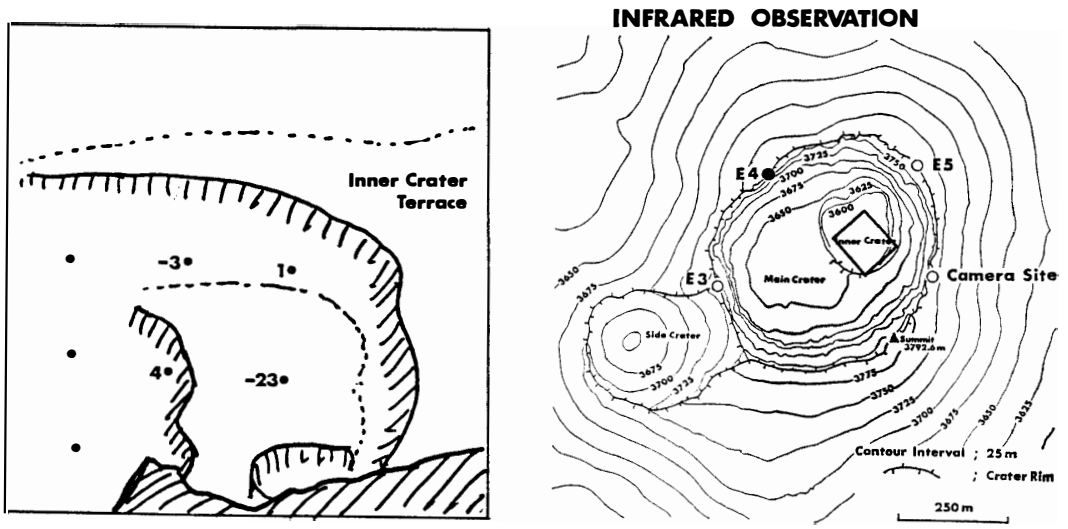

Fig. 2h.

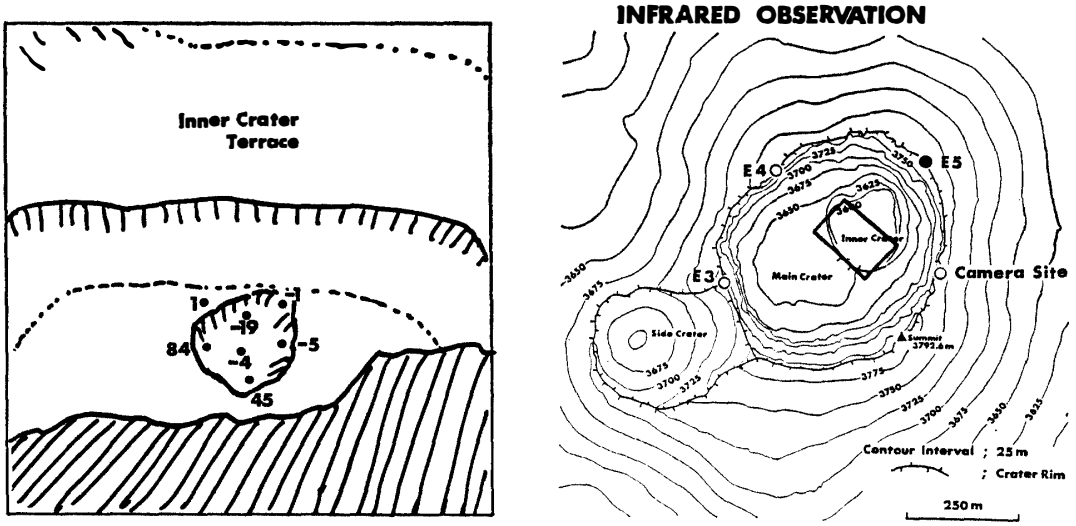

Fig. 2i.

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