Comparison of 1968 and 1966 Infrared Imagery of Surtsey

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AUGUST 1966 INFRARED SURVEYS

Infrared imagery obtained in August 1966 by an AFCRL C-130 aircraft equipped with a thermal infrared scanning system (Figure 1) showed areas of thermal emission from Surtsey and Jólnir (Friedman, Williams, Pálmason and Miller, 1967; Williams, Friedman, Thórarinsson, Sigurgeirsson, and Pálmason, 1968, etc.). In 1966, intensity of infrared emission was greatest from the August lava flow in the floor of Surtur I (Figure 2) and from lava cauldron activity in three craters (Figure 3) active during the August 23–29 survey

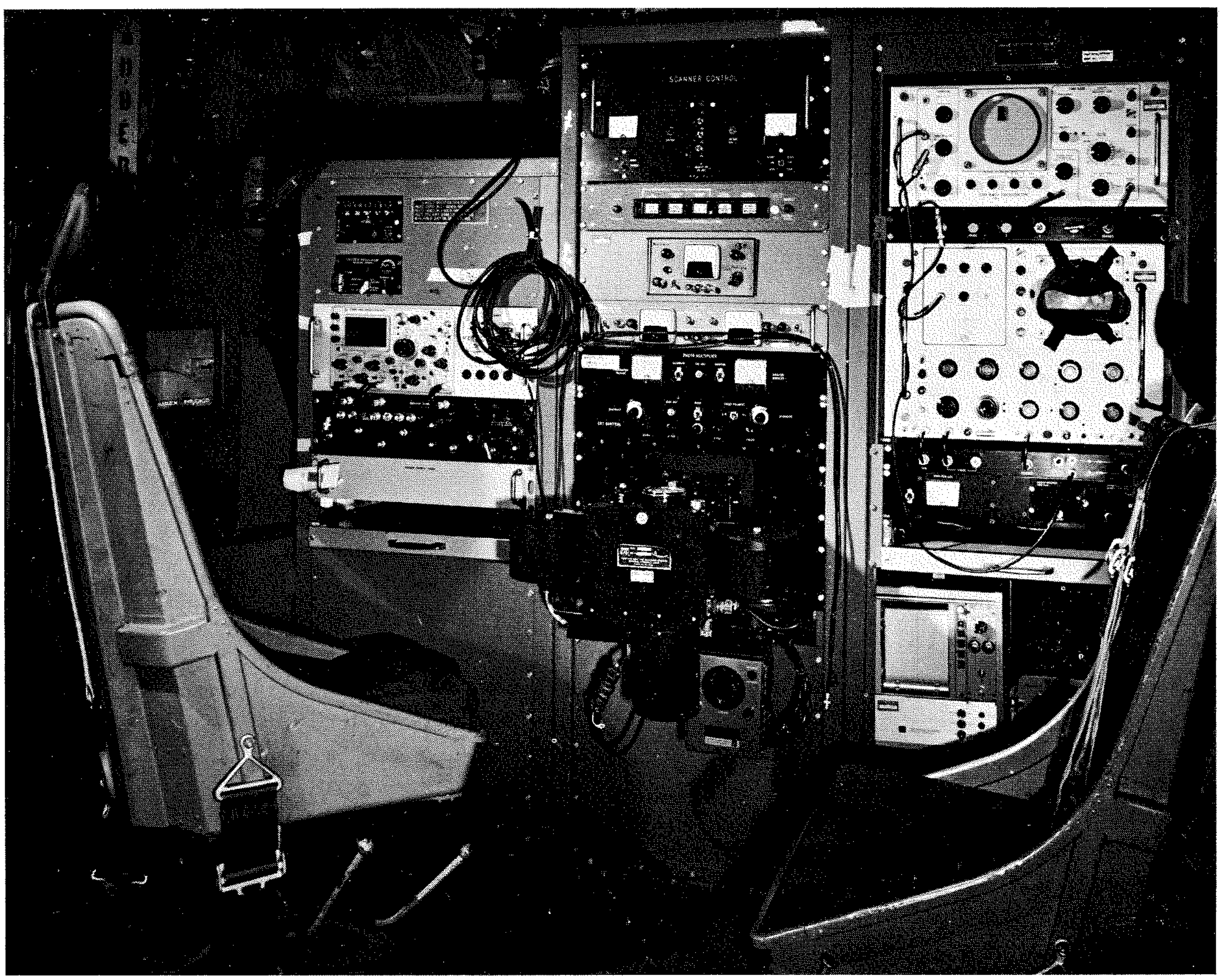

Fig. 1. M1A1 thermal infrared scanner and recording unit as mounted in aircraft. Photograph by AFCRL.

Fig. 2. Aerial infrared image of eastern half of Surtsey, August 29, 1966, UMT. Increased crustification of the active lava flow and a possible decrease in lava fountain activity reduced infrared emission sufficiently to make possible this record of the configuration of the Surtur I flow during the 10th day of its development. North is toward the top.

flights. Thermal anomalies of secondary intensity were recorded from the Surtur II vent and from a complex pattern of 1964–65 lava outflow channels, tubes and tunnels high on the Surtur II lava shield (Figure 4). Thermal anomalies, probably resulting from convective venting to the surface, outlined a possible subsurface lava course leading from the Surtur II vent area to a triangular area at the toe of the shield on the west side of the island which represents the last large surface expression of the flows of 1965. Within this flow, convective venting from secondary fumaroles, circular collapse features, and fractures was displayed as a variegated pattern of thermal anomalies in which point and curvilinear sources are prominent. East of the triangular area, somewhat fainter thermal anomalies seem to mark the position of convecting fractures and fumaroles at the surface of flows dating back to 1964.

The 1966 surveys also recorded the last phase of thermal activity of Jólnir. The main tephra crater (Figure 5A) contained a lake on August 19, 1966, the temperature of which was estimated by Thórarinsson at 40—50°C. A faint, generalized hydrothermal anomaly within the structural lagoon of Jólnir (Figure 5B) noted between August 19th and 23d, developed into a more distinct localized anomaly by August 29th (Figure 5C) after parts of the tephra island, including the main crater, were destroyed by wave action.

AUGUST 1968 INFRARED SURVEYS

A series of surveys of Surtsey was made in August 1968 to record changes in the thermal pattern since August, 1966. Prominent features of the imagery recorded in 1968 (Figure 6) can be divided into three categories:

1) *1966 thermal features which have disappeared.* This category includes: a) the hydrothermal anomalies of the last phase of Jólnir; b) the convection-feature anomalies of the eastern side of Surtsey, marking 1964 flows (now partly covered by 1966 flows from Surtur I); c) the convection anomaly marking a subsurface lava course connecting the Surtur II vent area with the triangular 1965 flow area; and d) the triangular configuration of the 1965 flow area itself. The disappearance of these anomalies indicates that they in general represented secondary thermal emission which diminished markedly during the two years elapsed since August 1966.

2) *Residual anomalies identified on both 1966 and 1968 imagery.* This category includes a) a bright curvilinear anomaly at the toe of the Surtur II shield (Figure 4A), previously inter-

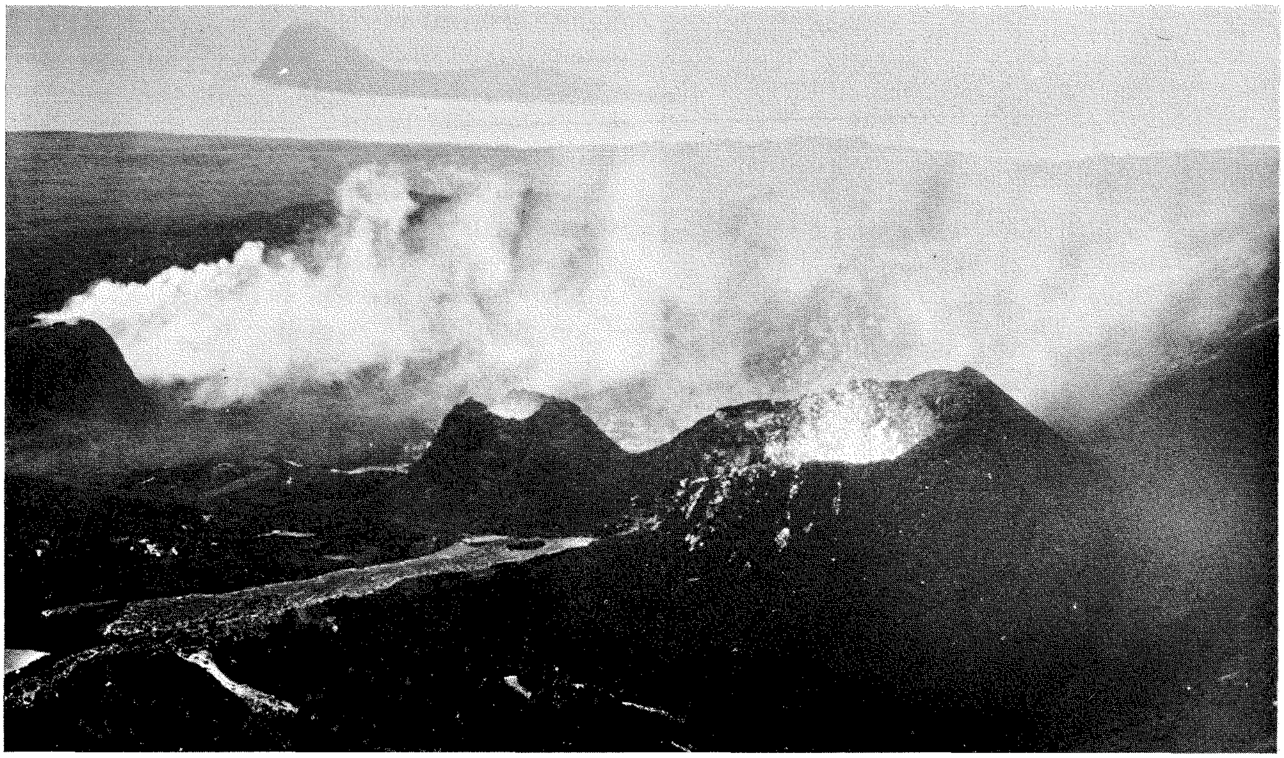

Fig. 3. Photograph (from Kodachrome) of the Surtur I crater row on August 27, 1966. Photo by Richard S. Williams, Jr.

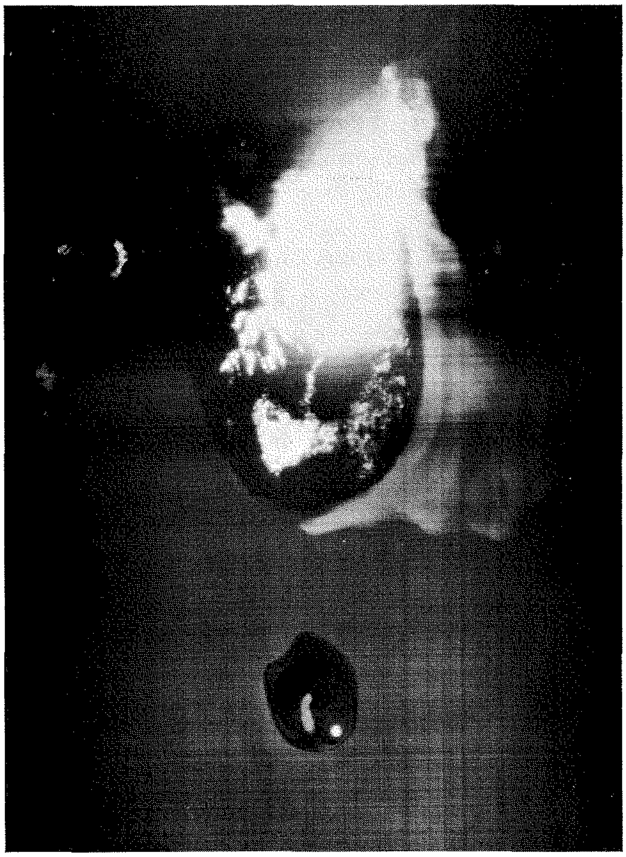

Fig. 4. Aerial infrared image of Surtsey and Jólnir, August 20 --21, 1966, showing, in white, intense thermal emission from Surtur I eruptive area, thermal currents in ocean along east coast of Surtsey where lava flow entered the ocean, and the still warm crater lake of Jólnir.

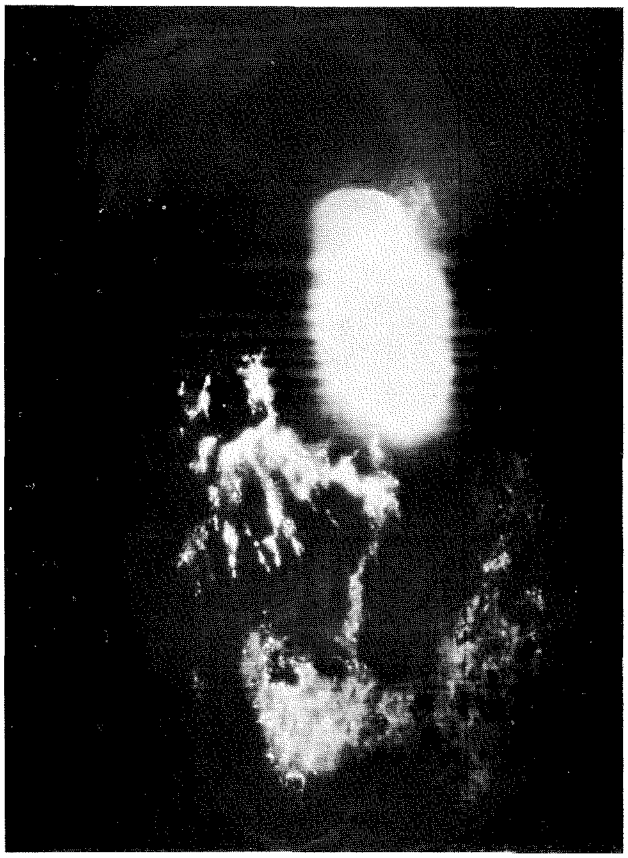

Fig. 4A. Aerial infrared image of Surtsey, August 19, 1966, 1845 UMT. Image made approximately 11 hours after first effusive activity from Surtur I eruption fissure, before lava flow entered the ocean. Secondary thermal anomalies associated with Surtur II vent, 1965 subsurface lava courses, convecting fractures and fumaroles appear in white on the left upper and lower quadrants of the island.

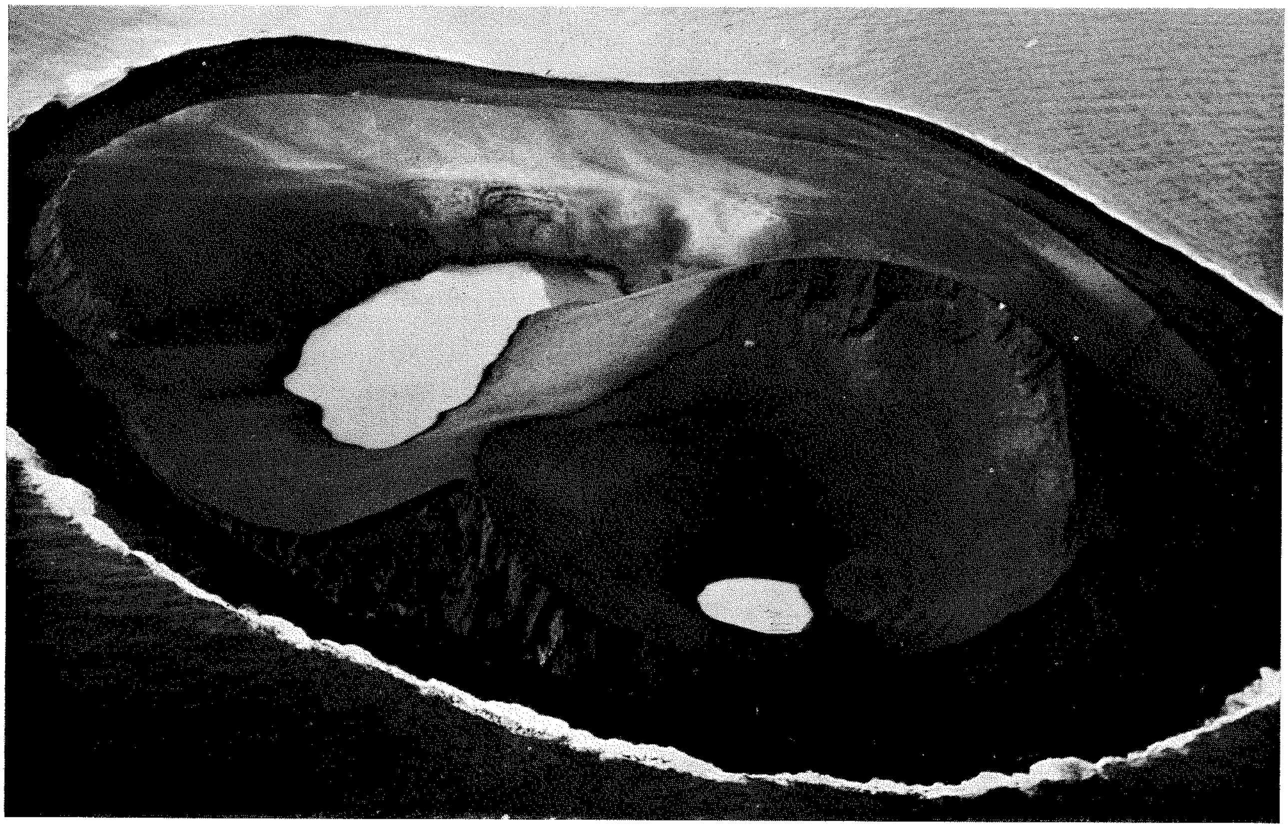

Fig. 5A. Photograph (from Kodachrome). Jólnir on August 19, 1966. Note concentric subsidence scars in tephra within main crater. Photo by Richard S. Williams, Jr.

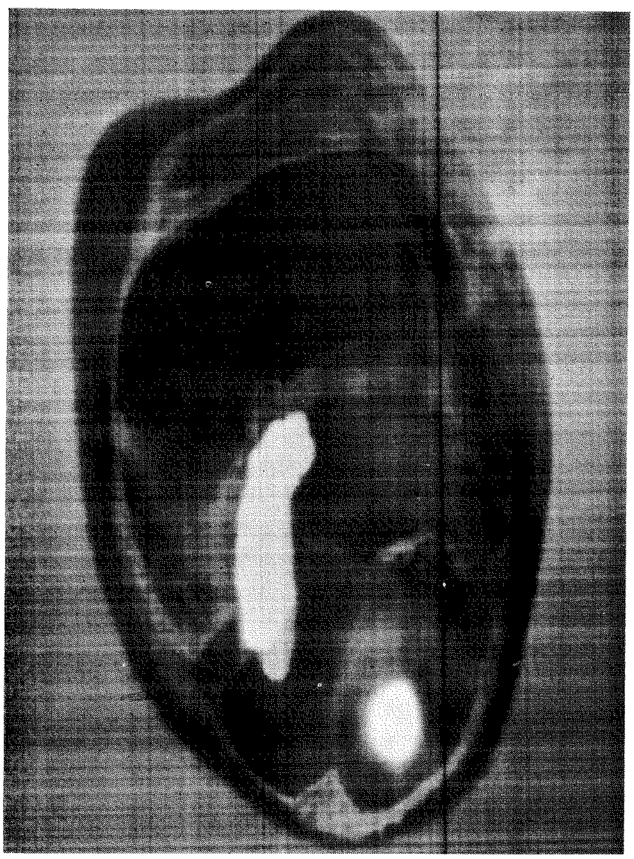

Fig. 5B. Aerial infrared image of Jólnir. August 21, 1966, 2341 UMT, approximately 11 days after last explosive eruption, showing warm crater lake and slightly thermal waters of the structural lagoon in white.

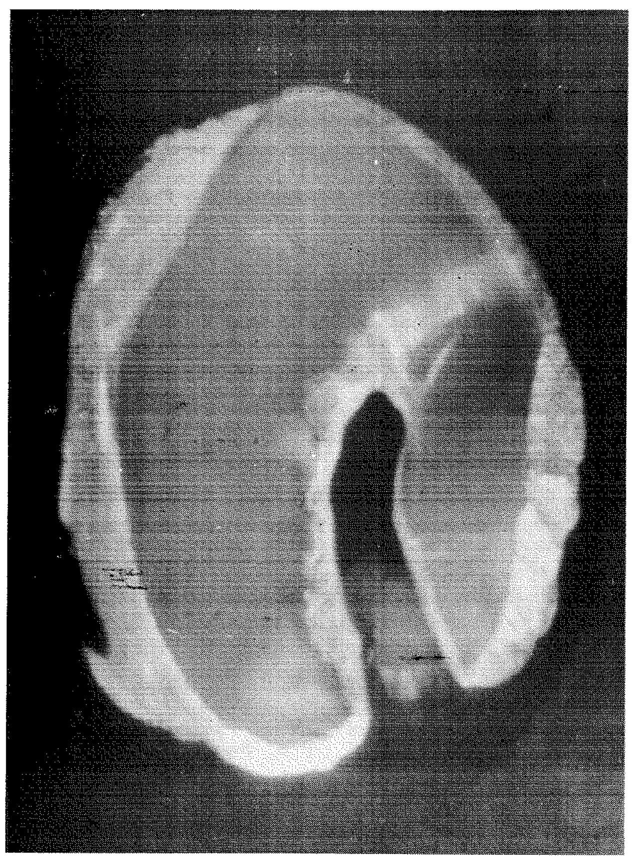

Fig. 5C. Aerial infrared image of Jólnir. August 29, 1966, 1721 UMT, after partial destruction of the island by wave erosion, showing remnant of structural lagoon with hydrothermal anomaly near mouth of lagoon.

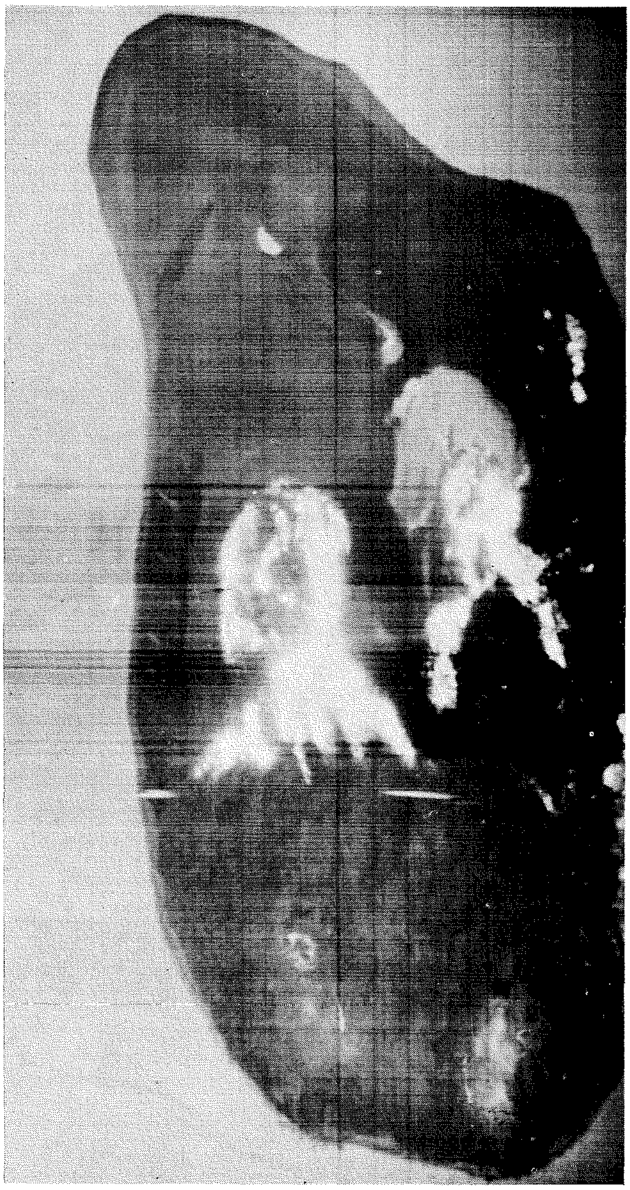

Fig 6. Aerial infrared image of Surtsey, August 22, 1968, 0217 UMT. Note, in comparison with Figure 4A, disappearance of several secondary thermal anomalies, including emission from triangular flow area (1965) at base of Surtur II shield in lower left quadrant and emission from subsurface lava course connecting the triangular area (of Figure 4A) with Surtur II vent. Surtur I anomalies associated with August, 1966 crater row (upper right quadrant), and December 1966 and January 1967 effusive eruptions along fracture lines are still present (in white tones). Note enhanced anomaly around walls of Surtur II vent.

preted as a fracture system parallel to the base of pressure ridges or apalhraun outflow channels within the triangular area of 1965 flows. That this curvilinear feature has persisted since 1966, while the thermal emission from the remainder of the triangular area has virtually disappeared, suggests that the thermal source of the anomaly is probably at a greater depth than the base of the cooling surface flows and may be primary rather than secondary. It is speculated that this outflow feature itself was a point of emergence of lava from some depth. The relationship of this persistent thermal feature to the now-disappeared anomaly representing a subsurface lava course between the Surtur II vent and the triangular flow area is not entirely clear. Whether the flow occupying the triangular area has a distinctly separate conduit from the main Surtur II is an interesting question; b) a circular anomaly which continues to mark the Surtur II vent area, suggesting increased primary convective heat flow along a circular fracture pattern parallel to the walls of the vent; c) diminished but still distinct anomalies which mark subsurface lava outflow courses high on the Surtur II shield. As with similar thermal features, these are interpreted as secondary in origin; d) considerable thermal emission from the 1966 flow emanating from Surtur I; radiant emission from these flows has diminished since 1966 and is secondary in origin.

3) *Thermal anomalies which have appeared since August 1966.* The most outstanding anomalies which have appeared since August 1966 are intense linear features marking the alignment of primary fumaroles along the eruption fissures of 1966 and 1967 on the Surtur I tephra rim, and on the Surtur I crater floor (Figure 6).

CONCLUSIONS

Thermal emission from primary volcanic structures associated with effusive activity in 1965, 1966 and 1967 continued through August 1968. Thermal emission from secondary sources, such as lava flow fractures, collapse features and secondary fumaroles diminished more rapidly than from primary convecting structures, including the circular fractures of Surtur II vent, a possible outflow area below the Surtur II shield, and linear convecting fractures of Surtur I. The fracture pattern of Surtur I associated with the effusive eruptions of December, 1966 and January, 1967 is thus still clearly marked on the images.

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