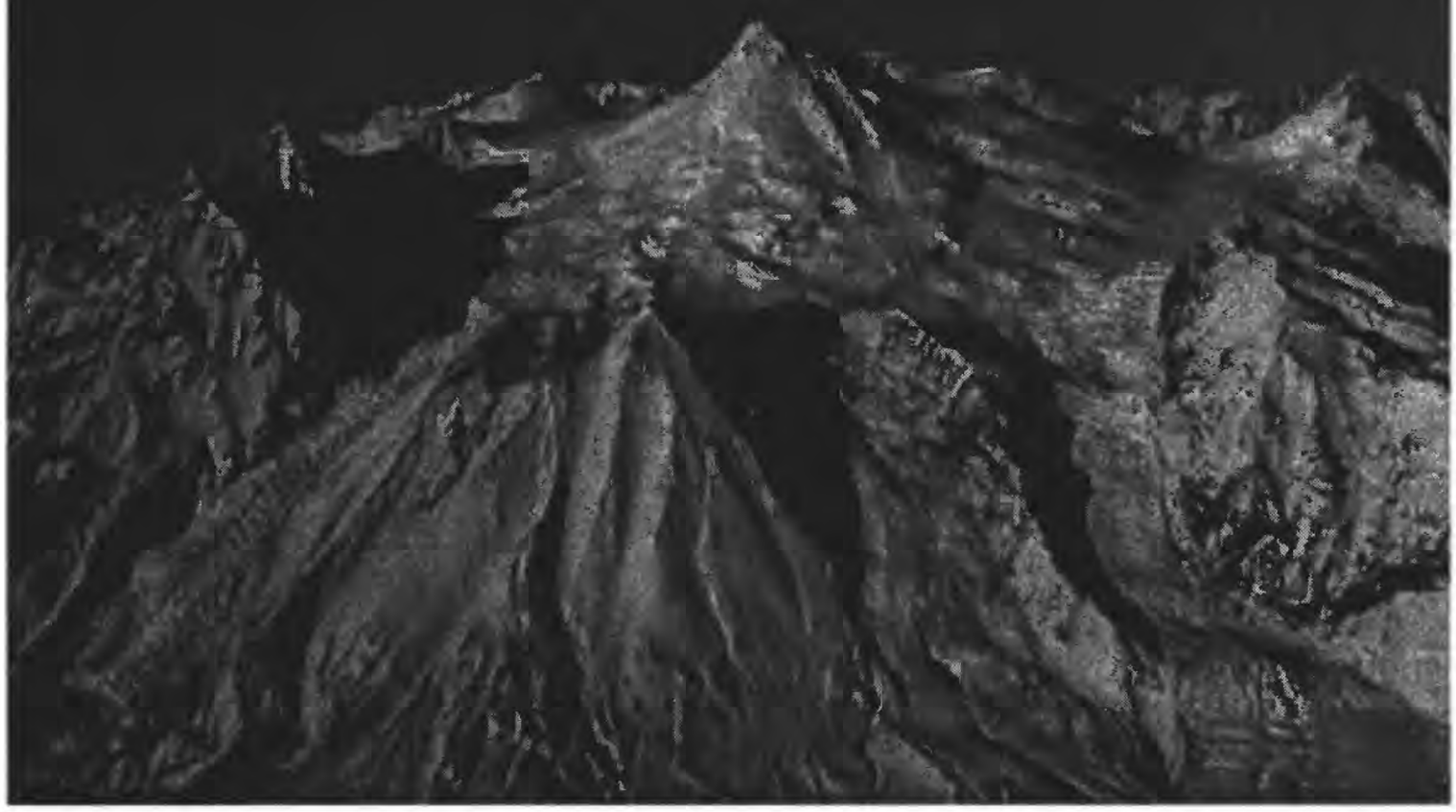
VOLCANIC ACTIVITY IN ALASKA: SUMMARY OF EVENTS AND RESPONSE OF THE ALASKA VOLCANO OBSERVATORY 1992



U.S. GEOLOGICAL SURVEY OPEN-FILE REPORT 95-83

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U. S. GEOLOGICAL SURVEY

1992 VOLCANIC ACTIVITY IN ALASKA: SUMMARY OF EVENTS AND RESPONSE OF THE ALASKA VOLCANO OBSERVATORY

By

Robert G. McGimsey, Christina A. Neal, and Michael P. Doukas

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Cover image is Mount Spurr (center) and Crater Peak (lower center)

During 1992, the Alaska Volcano Observatory (AVO) responded to 10 eruptions, episodes of eruptive activity, or false alarms at 8 volcanoes--Spurr, Redoubt, Iliamna, Mageik, Westdahl, Akutan, Bogoslof, and Seguam--located from upper Cook Inlet to 1770 km out the Aleutian island chain (fig. 1; table 1). AVO currently maintains seismic instruments on only three of these volcanoes: Spurr, Redoubt, and Iliamna. A research seismic network for the Katmai group volcanoes, which includes Mageik, is maintained by USGS seismologists in Menlo Park, CA.

Mount Spurr: Steady increase in seismicity for 10 months followed by three subplinian eruptions producing ashfall, pyroclastic flows, lahars, and ballistic showers.

Mount Spurr [61°18'N, 152°15'W], located 130 km west of Anchorage, is an extensively glaciated, 3400-m-high stratovolcano with an historically active, previously lake-filled, flank vent--Crater Peak (figs. 1, 2-3). AVO maintains 8 seismic instruments at Spurr. The area around the volcano is uninhabited and principal hazards involve airborne ash, ash fallout, and flooding. In addition to the potential impact on commerce and air traffic in the Anchorage area and on the Kenai Peninsula, Cook Inlet oil production and generation of electricity at the nearby Beluga Power station for southern Alaska are also susceptible to disruption from Mount Spurr's eruptions.

On June 27, after 39 years of quiescence, the Crater Peak vent on Spurr volcano began the first of 3 eruptions (June 27, August 18, and September 16-17) in 1992 (Alaska Volcano Observatory, 1993; Eichelberger and others, in press). The eruption was preceded by 10 months of gradually increasing seismicity (fig. 4) that culminated in 19 hours of precursory volcanic tremor. Upwellings in the crater lake and a color change from green to gray were observed three weeks prior to eruption onset. In response to increasing seismicity and changes in the crater lake, AVO issued an alert on June 8 and observatory scientists briefed local officials on June 17 about potential volcanic activity. In mid-afternoon on June 26, following the onset of continuous tremor, AVO issued a formal warning that Crater Peak might erupt. A field crew that day noted that the crater lake had disappeared (C. Nye, oral commun., 1992). An explosive eruption began at 7:04 am ADT the next morning and lasted 4 hours, sending an ash plume to an altitude of 14.5 km. Poor weather prevented direct observation of the eruption. Southerly winds carried the ash cloud northward over the Alaska Range with ashfall reported as far as 420 km north of Mount Spurr (fig. 5). The bulk volume of tephra erupted is estimated to be 44×10^6 m^3. Small-volume pyroclastic flows mixed with snow and ice to form hybrid flows that swept down the south side of the cone to the Chakachatna River, 6 km from the crater (Waitt, in press). The eruption destroyed the crater rim seismic station located 400 m from the vent.

Seismicity at Crater Peak declined dramatically following the eruption and remained low for the next 7 weeks. At mid-

afternoon on August 18, without any apparent precursory seismicity, a short interval of weak volcanic tremor began. Within 10 minutes, pilots were reporting an ash-rich plume over the volcano. Strong tremor began at 4:42 pm ADT and signaled onset of the main eruption, which lasted for 3.5 hours. AVO scientists dispatched by fixed-wing aircraft to investigate the situation visually confirmed the eruption in progress, direction the ash cloud was moving, and apparent absence of flooding down the south flank. The crew also took dramatic video footage of the eruption column (McGimsey and Dorava, 1994). AVO's lightning detection system recorded over 170 strikes near the volcano (Paskievitch and others, in press). The eruption column rose to an altitude of 14 km (fig. 6), and westerly winds carried the ash cloud southeastward along the eastern Alaska coastline (fig. 5). Light ashfall was reported as far as 1000 km downwind. Up to 3 mm of sand-size ash fell in Anchorage, closing the International Airport for 20 hours and disrupting commerce and transportation. An estimated 52 x 10^6 m^3 of tephra was vented. Small-volume pyroclastic flows descended the east and southeast flanks, some mixing with snow and ice to form minor debris flows (Miller and others, in press; Waitt, in press). The eruption culminated with a narrowly directed shower of juvenile and lithic ballistics extending up to 8 km from the vent (Waitt and others, in press).

Seismicity remained somewhat elevated for the next month until the evening of September 16. An abrupt increase in microseismicity culminated three hours later in an 11-minute eruption. After an hour of weak tremor, the main explosive phase began a few minutes after midnight on September 17 and lasted for 3.5 hours. The eruption column rose to an altitude of 14 km where westerly winds carried the ash cloud along a narrow track just north of Anchorage and eastward into Canada. The cloud was tracked across the U.S. and eastern Canada for the next 48 hours (Schneider and others, in press), and caused a disruption in air traffic in eastern North America. An estimated 56 x 10^6 m^3 of tephra was produced and fallout was detected as far as 700 km downwind. Pyroclastic flows advanced down the snow- and ice-covered east and southeast flanks evolving into debris flows that temporarily dammed the Chakachatna River, 6 km south of the vent (Miller and others, in press; Meyer and Trabant, in press). As during the August eruption, this eruption ended with a narrowly directed shower of ballistics (Waitt, in press).

Seismicity remained elevated after the eruption. Two episodes of abrupt, intense seismic swarms occurred in October and November, but did not culminate in eruption. During the next twelve months, seismicity declined to near-background levels.

All three eruptions produced porphyritic, hornblende-bearing andesite with minor unusual xenoliths of partially melted metamorphic rocks (Harbin and others, in press).

The eruptions of Mount Spurr generated much industry, public, and community interest. Throughout the eruptions, AVO distributed daily and weekly updates on the activity, issued timely alerts to the aviation industry, and sent alerts, warnings, and interpretations to other government agencies, the general public, the media, and the scientific community.

Additionally, AVO staff conducted many media interviews and made over 25 presentations to civic, school, public and private groups in addition to formal professional presentations at the Fall meeting of AGU. AVO also fulfilled numerous requests from both the public and private sectors for eruption photographs and slides.

Iliamna and Redoubt volcanoes: False alarms.

Iliamna [60°02'N, 153°04'W] and Redoubt [60°28'N, 152°45'W] volcanoes are large, glacier-covered stratovolcanoes located on the west side of Cook Inlet 225 km and 170 km, respectively, southwest of Anchorage (fig. 1, 2). No major Holocene activity is attributed to Iliamna (Riehle, 1985), however, a fumarole field located near the summit commonly produces steam plumes, some rising up to 1000 m above the summit. Redoubt volcano last erupted over a six month period in 1989-90 during which a series of lava domes were emplaced and subsequently destroyed in the breached summit crater. The final dome, emplaced between April and June 1990, is still cooling and occasionally produces a substantial steam plume as meltwater contacts hot dome rock. AVO maintains 4 seismic instruments at Iliamna and 8 at Redoubt.

On April 30, pilot reports of "a plume to 20,000 ft over Iliamna volcano" set off a chain reaction that culminated in a widespread rumor that an eruption had occurred or was in progress at Iliamna volcano. Subsequent reports also indicated Redoubt volcano was erupting. AVO promptly issued a widely distributed information release stating that no eruptive activity had occurred at any Cook Inlet volcano. Staff spent the afternoon answering dozens of calls and initiating calls in an effort to quell the false reports. Nonetheless, the rumormill persisted and by late afternoon local media were announcing that Iliamna had erupted and an ash cloud was headed towards Anchorage. AVO immediately contacted local government officials and the media to avert the crisis and then issued a final information release explicitly stating that no eruptive activity had occurred. AVO responds quite frequently to eruption reports by pilots and the general public who mistake fumarolic steam plumes at Iliamna for eruptive activity.

Mount Mageik: False alarm.

Mount Mageik [58°12'N, 155°15'W] is a 2165-m-high stratovolcano, one of a cluster of active volcanoes located in Katmai National Park, 450 km southwest of Anchorage on the Alaska Peninsula (fig.1). A local research seismic network is maintained by Peter Ward, USGS Menlo Park.

On March 3, a plume-like cloud seemingly originating from Mount Mageik appeared on two successive National Oceanographic and Atmospheric Administration (NOAA) satellite images prompting The Federal Aviation Administration to issue a warning to aircraft of a possible eruption. AVO responded by compiling

pilot reports, analyzing the satellite imagery, obtaining seismic information from the research seismic net in Katmai, issuing an information release, and then dispatching staff on an observation flight to assess the situation; AVO did not, however, confirm an eruption. Pilots reported smelling sulphur dioxide but detected no gas or ash plume. The seismic data indicated no unusual seismicity had occurred in the Katmai volcanic group. Airborne AVO observers found no evidence of eruptive activity at Mt. Mageik or in the areas downwind from the volcano. AVO then issued an update announcing that no eruption had occurred. The incident was deemed useful in exercising AVO's response to a potential eruption in a remote area.

Westdahl: Steam and ash emissions, lava fountains, a lava flow, and a debris flow occurred at Westdahl volcano during a fissure eruption that began in November 1991, and culminated in mid-January 1992.

Westdahl [54°31'N, 164°39'W] is a broad, 1560-m-high, glacier-covered, unmonitored shield volcano on Unimak Island, 85 km southwest of the tip of the Alaska Peninsula (figs. 1, 7). The nearest permanent settlement, False Pass, is situated on the east end of the island 90 km northeast of Westdahl Peak.

On November 29, 1991, commercial pilots reported a steam and ash cloud rising to more than 6 km above Westdahl volcano. The next day, pilots reported eruptive activity along an 8-km-long fissure that extended from Westdahl Peak north-eastward across the glaciated summit area (fig. 8). Many pits, craters, and gaping cracks were visible in the ice adjacent to the fissure. Ash plumes rose to 7 km (23,000 ft) altitude, prompting FAA to temporarily divert air traffic. In addition to ash and steam venting, spectacular lava fountains along the lower few kilometers of the fissure fed a lava flow that extended down the east flank. An AVO crew aboard a Coast Guard C-130 observed the lava flow on December 3 and estimated it extended 7 km from the vent and was as much as 1.5 km wide at the front and 5-10 m thick. The still-steaming deposits of a lahar that had advanced 18 km from the vent to enter the sea were also observed during the flight.

Stormy weather conditions prevented direct observation of the vent area for most of December 1991, but, when visible, pilots reported a constant steam plume, usually mixed with ash, punching through the weather clouds. Residents of nearby False Pass also reported thunder-like rumbling sounds, the occasional smell of sulfur, and light ashfalls on November 30, December 16, 25, and 26--evidence that the eruption was still continuing.

Steam clouds rose to almost 5 km altitude on January 2-3, 1992. Ash clouds observed January 8-9 reached 2.4 km altitude. Satellite images during the late afternoon of January 9 showed the plume extending about 150 km southeast. The eruption was declining, and by January 15 no sign of a vertical plume or any other eruptive activity was observed. U.S. Fish and Wildlife Service photographs taken on March 12, 1992, show that the lava

flow viewed on December 3, 1991, had not advanced, but had widened to cover an area about 2-3 times greater than in December (fig. 8A). The lava flow was fed from three lava streams originating from the fissure as well as from a newly formed cinder cone located at the east end of the fissure (fig. 8B).

Most of the ash produced during the eruption was confined to a narrow sector and remained at lower altitudes, dissipating harmlessly over the Bering Sea or North Pacific. Light ash falls occurred on Unimak Island including the village of False Pass, located 90 km east of the vent. AVO responded to the eruption primarily by daily compilation of pilot reports (commercial, private, and Coast Guard), satellite imagery, eye witness accounts, still photographs and video footage, and weather conditions. The information was analyzed and disseminated to federal, state, and local agencies as well as to the media. AVO tracked the ash plumes using NOAA satellite imagery and plume trajectory plots based on National Weather Service wind data.

Akutan: Small intermittent steam and ash emissions to various altitudes up to 4,600 m (15,000 ft) were observed periodically from March 8 through mid-December, 1992.

Akutan [54°08'N, 165°58'W] is one of the most active volcanoes of the Aleutian arc and frequently produces low-level eruptive activity. The volcano is a 1300-m-high stratocone with a nearly circular summit caldera containing several small glaciers, located 185 km southwest of the tip of the Alaska Peninsula (fig. 1); a 200-m-high cinder cone within the caldera is the source of historic activity (fig. 9). No seismometers are maintained on the island and the nearest village is Akutan, 16 km east of the cinder cone. The main hazard is possible interaction of ash with aircraft, which pass close to the volcano on approach to Dutch Harbor, a regional hub located 45 km southwest of the crater.

On March 8 at 1645, a pilot reported a small steam plume, possibly containing ash, rising about 2 km above the summit of Akutan (summit elevation 1303 m). Localized ashfall at the summit accompanied the eruption. Minor steam and ash plumes (<100 m high) were reported on March 11-12. On March 22 a pilot reported a 4.3-km-high ash plume at 1637 and fishing vessels off Akutan Island reported ashfall. A resident of Akutan Village, located 16 km east of the volcano, reported ash plumes rising 450-550 m above the summit on April 7. Two days later, at 10:00 am AST, a pilot reported an ash cloud at about 3-3.5 km altitude, drifting northwest. On April 26, a pilot reported ash rising to about 2.5 km altitude (1.2 km above summit). The next report of activity came on May 21 when an observer in Akutan Village saw fresh ash on the snow-covered flank and small ash emissions rising 250-300 m above the summit. Inclement weather prevented frequent observation of the summit during March-May and there were probably many more plumes than reported. Nearly continuous low-level emission of ash and steam is typical of historical eruptions at Akutan. The final episode of activity was reported

at 2:45 pm AST on December 18 when a pilot observed a small ash cloud rising several hundred meters above the summit.

AVO responded to reports of eruptive activity by monitoring pilot reports and satellite imagery, making daily inquiries to observers in Akutan and Dutch Harbor, studying video footage provided by commercial and private pilots, and issuing the information to federal and state agencies and the media.

Bogoslof: Ash and steam emissions accompanied extrusion of a new lava dome on the north end of Bogoslof Island.

Bogoslof volcano [53°56'N, 168°02'W] consists of a cluster of small, low-lying islands comprising the emergent summit of a submarine volcano located 50 km northwest of the main Aleutian arc and 100 km west of Dutch Harbor (fig. 1). The islands are remote and uninhabited. Bogoslof Island (1.5 x 0.5-km), largest of the cluster, consists of remnants of lava domes emplaced from 1796 to 1931 and is the site of the recent activity (fig. 10). The principal hazard is to aircraft from encounters with ash clouds. Trans-Pacific air routes cross the area and nearby Dutch Harbor is a regional air hub.

The recent eruption began in early July, 1992. At about 3:00 pm ADT on July 6, an eruption cloud rising to 3 km above Bogoslof Island was identified on NOAA satellite imagery. A few hours later pilots visually confirmed the steam and ash plume.

Satellite imagery showed intermittent small plumes through July 13. Continuous emission occurred during the next two days with the steam and ash plume rising up to 5.5 km and extending 100 km to SE. At 4:23 pm ADT on July 17 pilots reported a rapidly rising mushroom-shaped plume up to 4.5 km altitude. Inclement weather prevented direct observation of the island. The activity remained intermittent with an episode of vigorous steam and ash emission beginning about 5:00 pm ADT on July 20 that produced a plume as high as 8 km by 1725. A profusely steaming new lava dome at the north end of the island adjacent to the 1927 dome was first sighted on July 21 and confirmed by U.S. Coast Guard observations and photography on July 24. The last report of steaming and minor ash emission was July 24, and except for residual steaming of the dome, activity had subsided by late July, 1992.

AVO responded to the eruption by compiling pilot reports, monitoring satellite imagery for ash plumes, collecting photographs and video footage of the activity, and disseminating information to government agencies and the media.

U.S. Fish and Wildlife Service (USFWS) scientists who approached the island by ship several times later in the summer to assess the impact on sea mammals and birds photographed the new dome. During the summer of 1994, an AVO scientist spent a day examining the island and collecting samples of the new lava dome (Harbin, 1994).

The dome, measuring 150 m x 275 m across and approximately 150 m high, has a steep-sided central spire surrounded by prismatically jointed, blocky debris that originally formed more

gentle slopes (fig. 11). By the summer of 1994, the northern and northwestern sides of the dome had been reduced to sheer sea cliffs. The dome is composed principally of gray to black porphyritic hornblende basaltic andesite (Harbin, 1994).

Seguam (Pyre Peak): Steam and ash emissions.

Seguam Island [52°19'N, 172°31W] is located in the central Aleutian Islands 645 km from the tip of the Alaska Peninsula (fig.1). The island is remote and uninhabited. The nearest village is Atka, 120 km to the west. Pyre Peak, one of three Holocene cones that make up the island, occupies the center of a large caldera and was the site of eruptive activity in 1977 (fig. 12). The only hazard is that posed to aircraft flying near the island.

On December 27, 1992, U.S. Coast Guard pilots reported an ash cloud to 1200 m above Pyre Peak and extending 24 km north. Intermittent, localized bursts of ash rising 100-200 m and ash accumulation on the south flank were observed on December 30. The vent was confirmed to be a satellite cone located 1.5 km south of Pyre Peak at the north end of a fissure that produced lava fountains in 1977. The activity apparently subsided soon thereafter. No subsequent activity was reported until May 1993.

AVO responded by contacting the Coast Guard to verify the location and eruptive activity observed, analyzing satellite images and hypothetical plume trajectory plots based on local wind data to determine whether or not the ash cloud would be a hazard to aircraft, and then issued an information release to federal, state, and local authorities and the media. AVO determined that the ash clouds were localized and rapidly dissipating, thus posing little hazard. The staff continued daily monitoring of pilot reports, satellite images, and weather data until the activity subsided.

AVO is a cooperative program of the U.S. Geological Survey, University of Alaska Fairbanks Geophysical Institute, and the Alaska Division of Geological and Geophysical Surveys.

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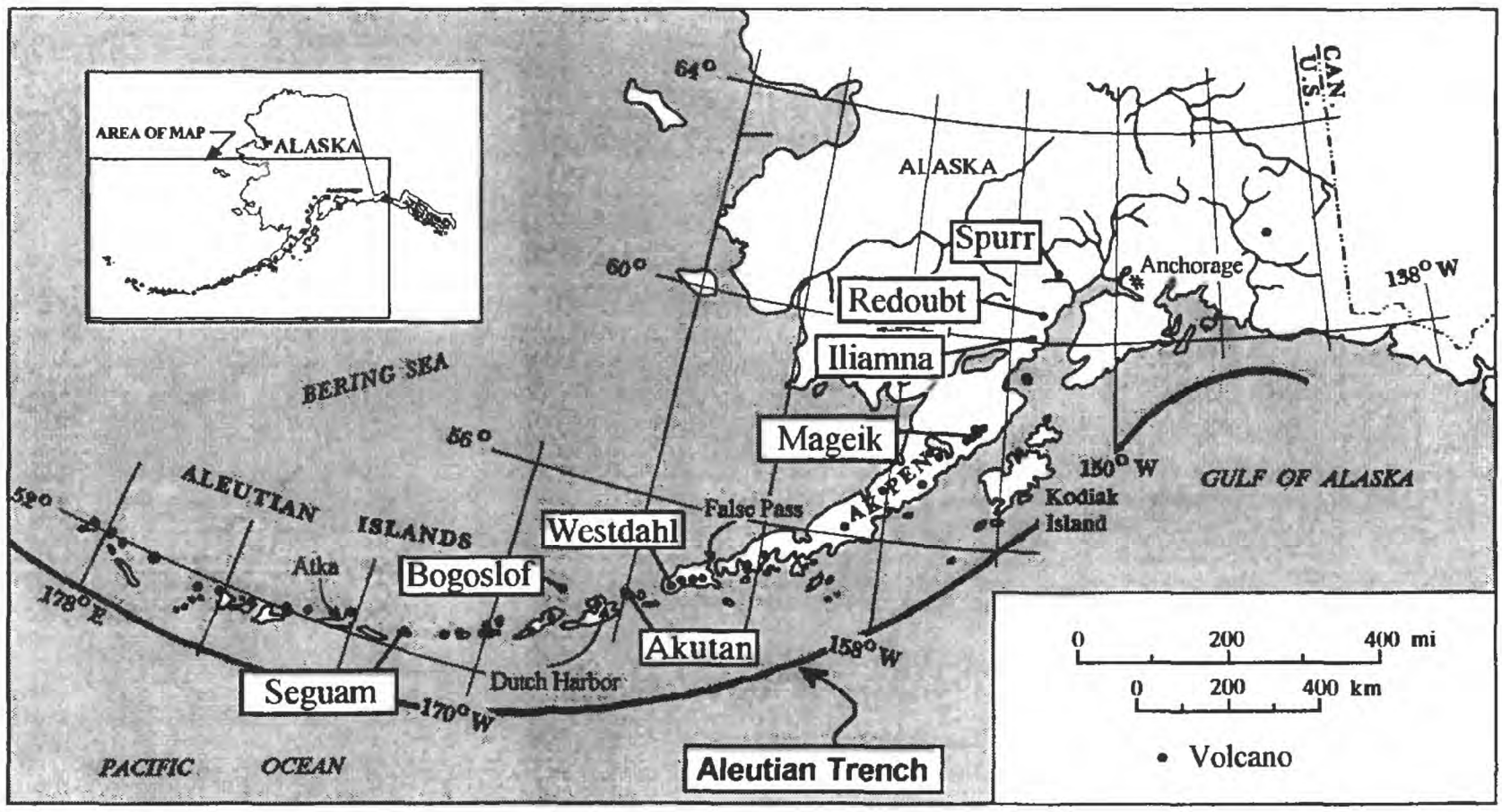

Figure 1. Index map for Alaskan volcanoes active in 1992.

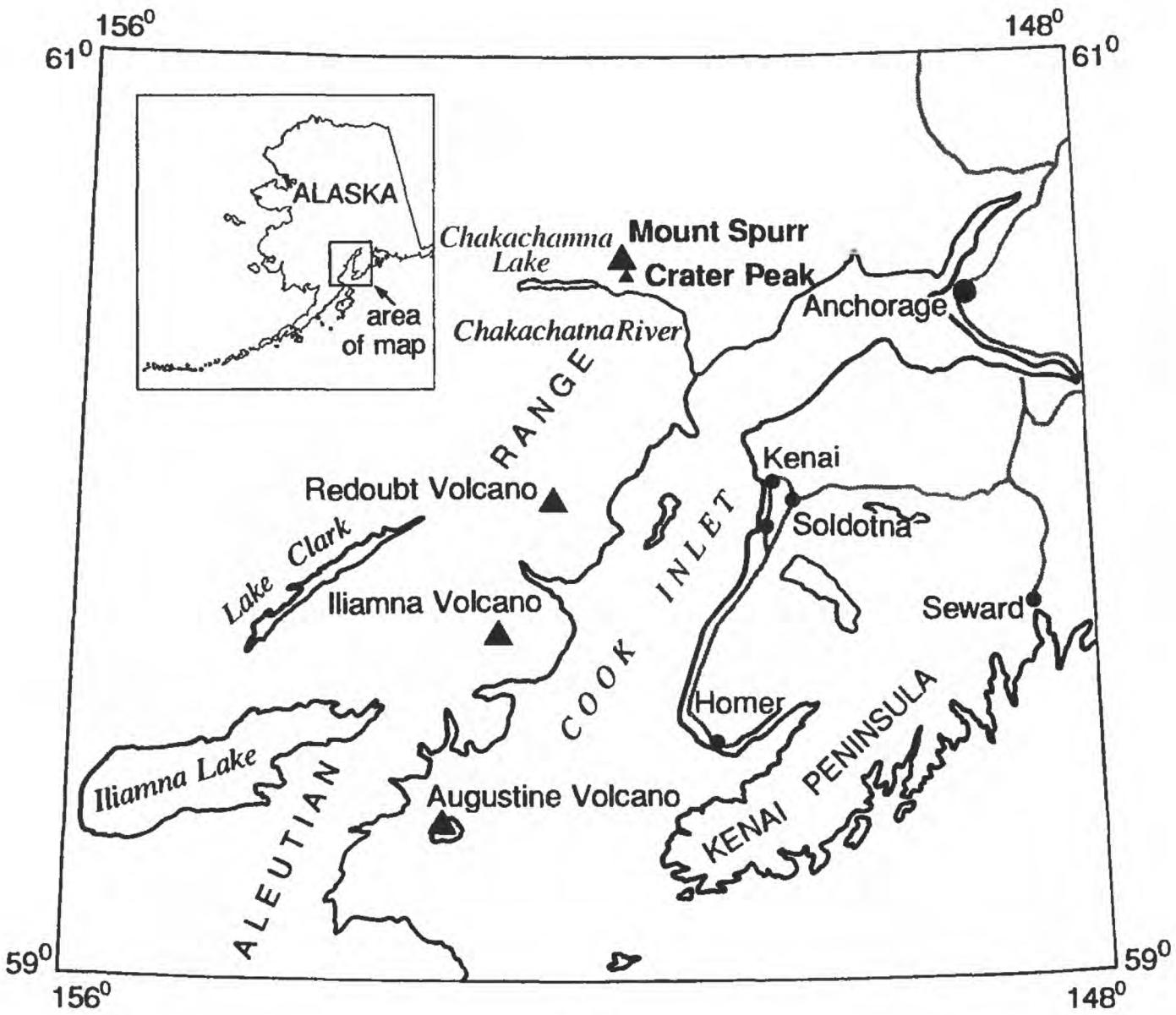

Figure 2. Map of Cook Inlet region showing active volcanoes.

Figure 3. View of Crater Peak (right foreground) and Mount Spurr (high peak on skyline, left center) from the southwest. Crater Peak straddles the southern rim of the caldera delineated by the peaks at the far left and right in this view. Photograph by Cynthia Gardner, Cascades Volcano Observatory, September 26, 1992.

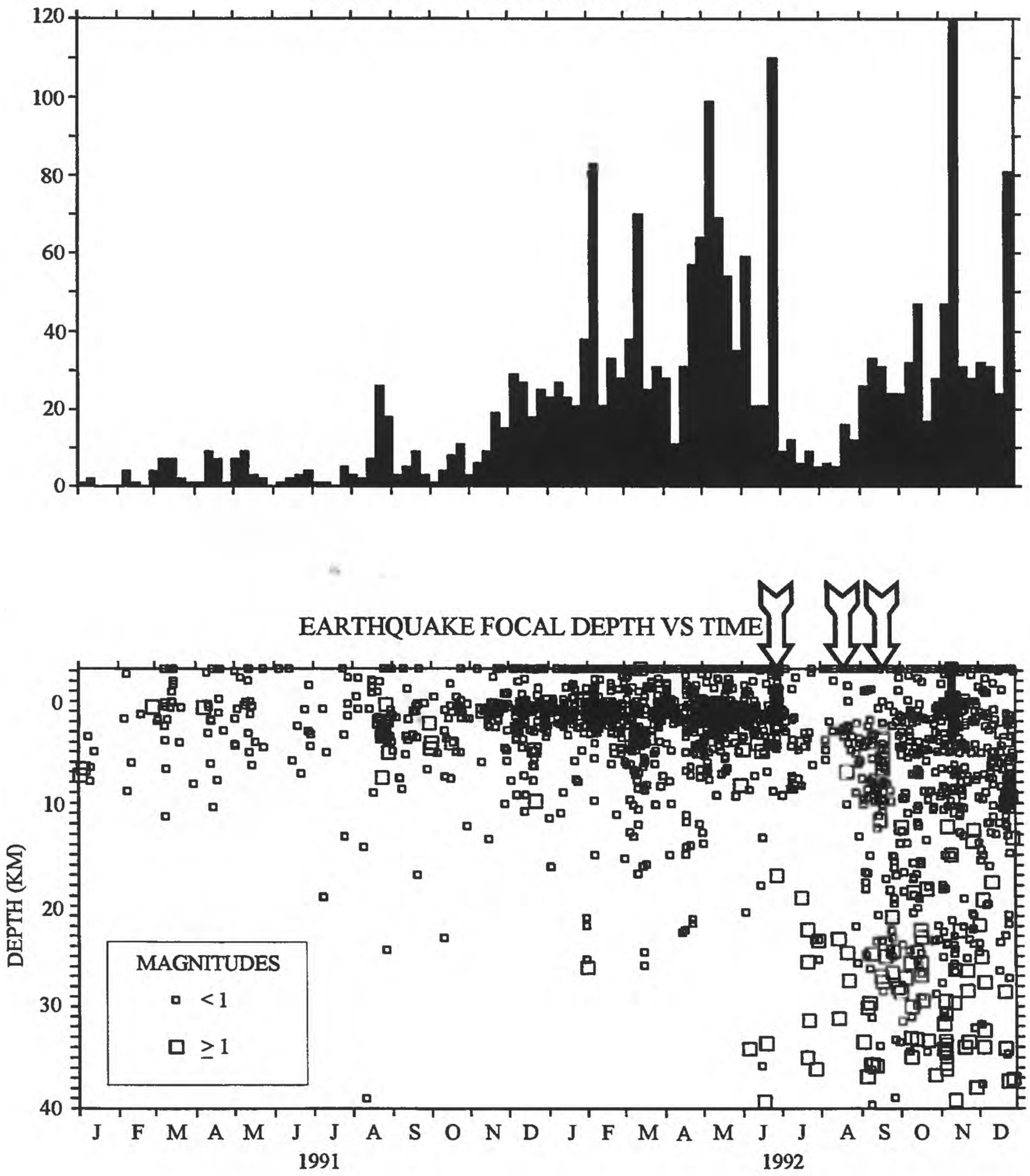

Figure 4. Diagrams showing frequency (upper panel) and depth (lower panel) of 1991-92 earthquakes within 10 km of Mount Spurr. Arrows on the lower panel designate the onset of the three principal eruptions in 1992. On the upper panel, the weekly earthquake counts show a marked increase beginning about 10 months before the first eruption and a lack of obvious increases in seismicity before subsequent eruptions. On the lower panel, the depth of the seismicity increases significantly after the onset of major eruptive activity. Diagrams from John Power of AVO (written commun., 1993).

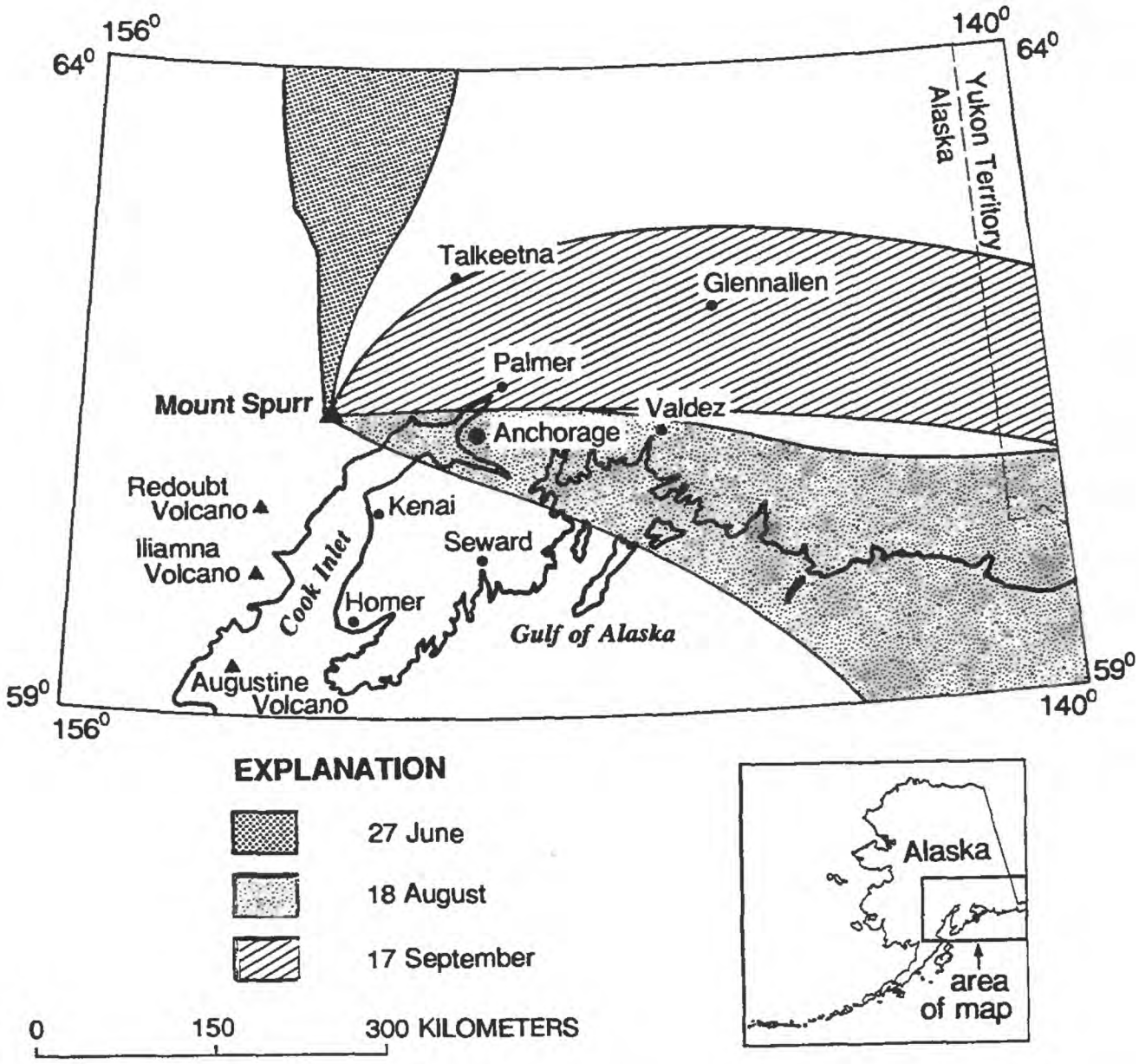

Figure 5. Map of south-central Alaska showing areas of ash fall from 1992 eruptions of Mount Spurr. From Neal and others (in press).

Figure 6. View from the west of August 18 eruption column rising to 14 km altitude to form an anvil top. Light-colored clouds at base are elutriated ash from pyroclastic flows on southeast flank. Photo by Robert McGimsey.

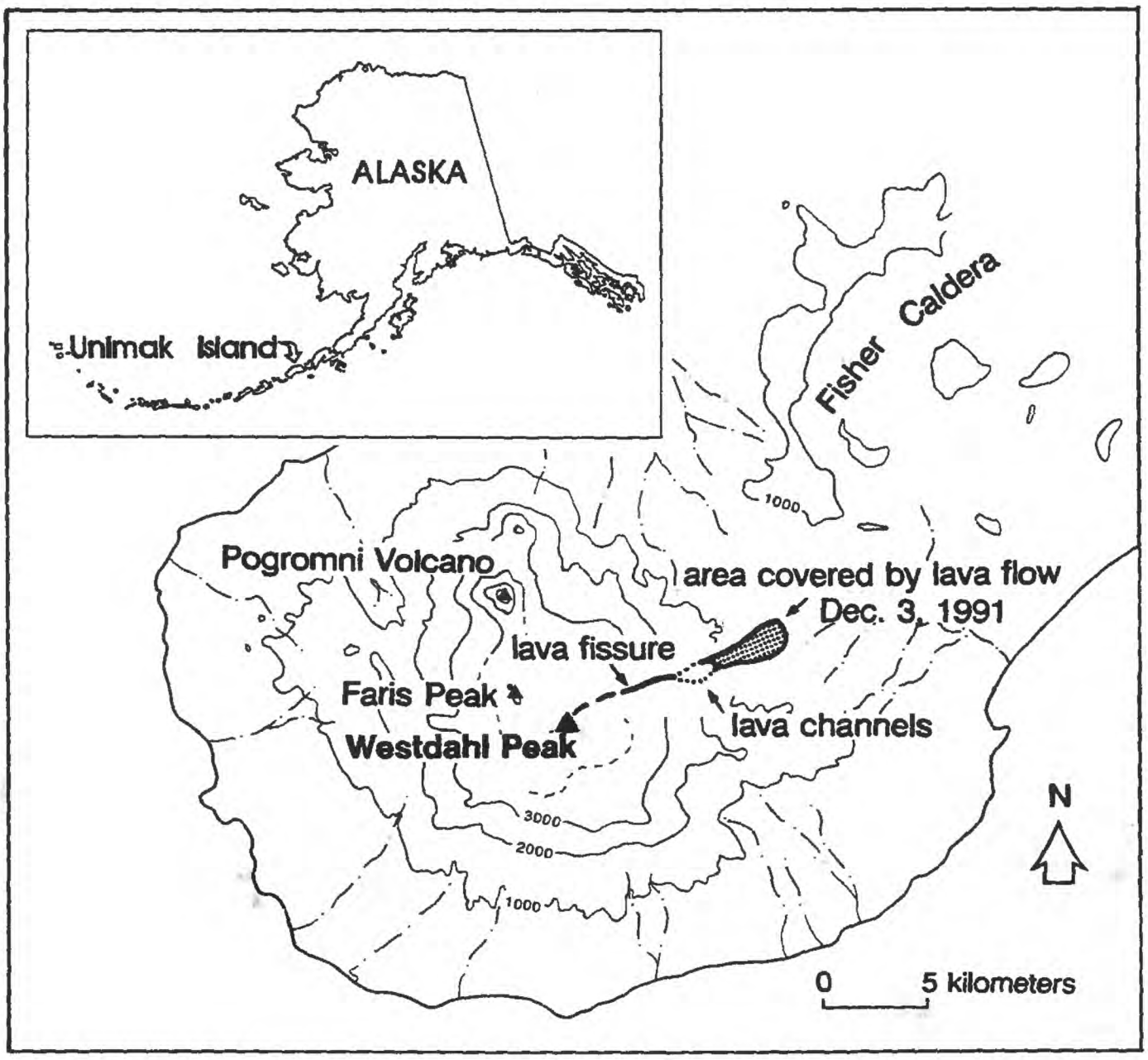

Figure 7. Map of Westdahl Peak volcano on the southwest end of Unimak Island. The eruptive activity in 1991-92 included lava fountains and lava flows that erupted through the ice-capped summit from fissures extending northeast from Westdahl Peak.

Figure 8. A) Westdahl Peak and lava flow extending down east flank. The flow was fed by three separate streams of lava originating at the fissure and a newly formed cindercone, visible in Figure 8B. Photograph by Chris Dau, U.S. Fish and Wildlife Service, March 12, 1992.

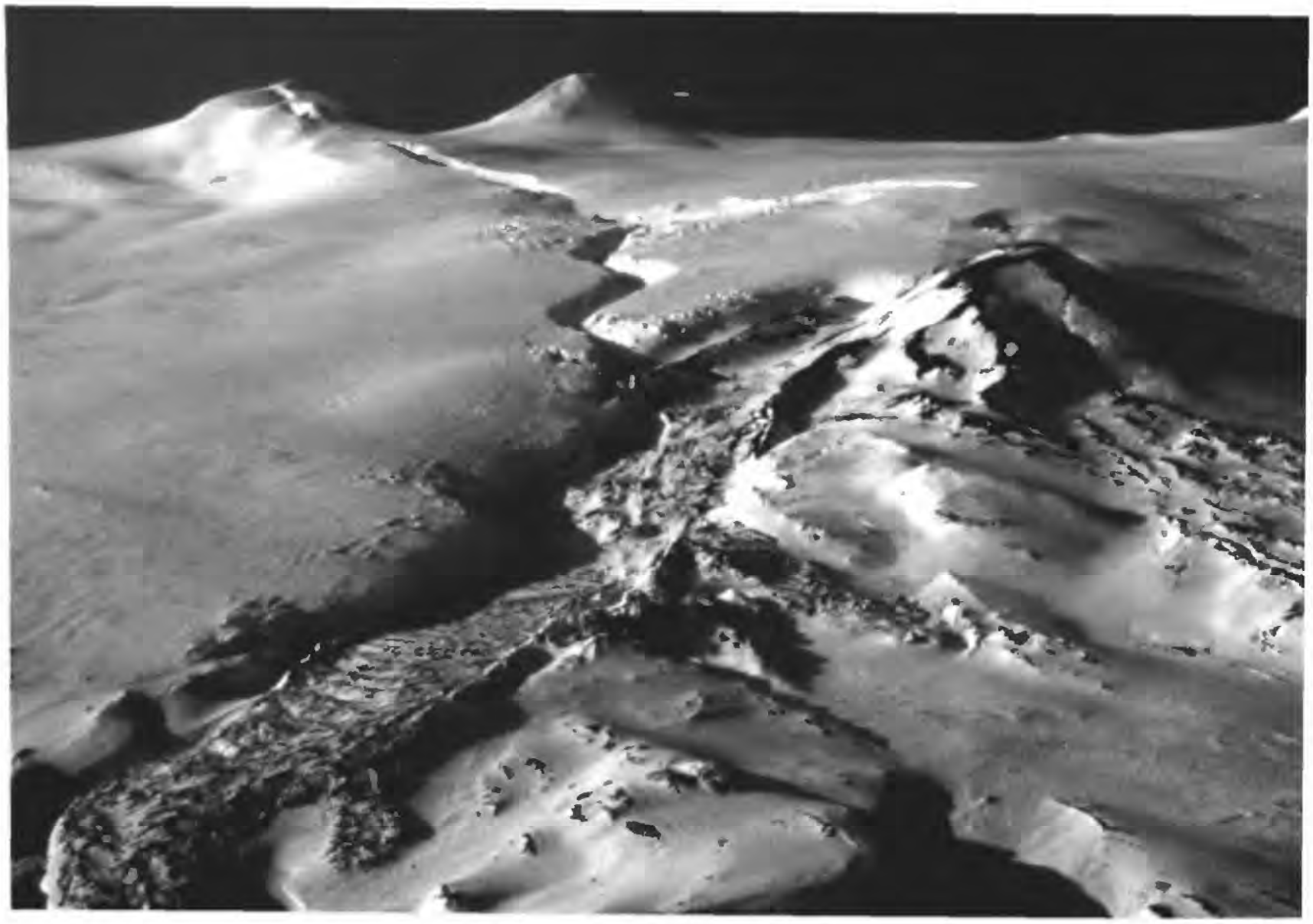

Figure 8. B) East flank of Westdahl Peak (upper left), the site of the 1991-92 eruption that cut through an extensive icefield (sinuous crack in upper center heading toward Westdahl and Faris Peaks on horizon). The photograph shows an active cinder cone (right center), the trace of the fissure that erupted through the icefield (trench from upper left to center), and the head of the lava flow (left foreground) that was erupted. Photograph by Fred Zeillemaker, U.S. Fish and Wildlife Service, February 2, 1992.

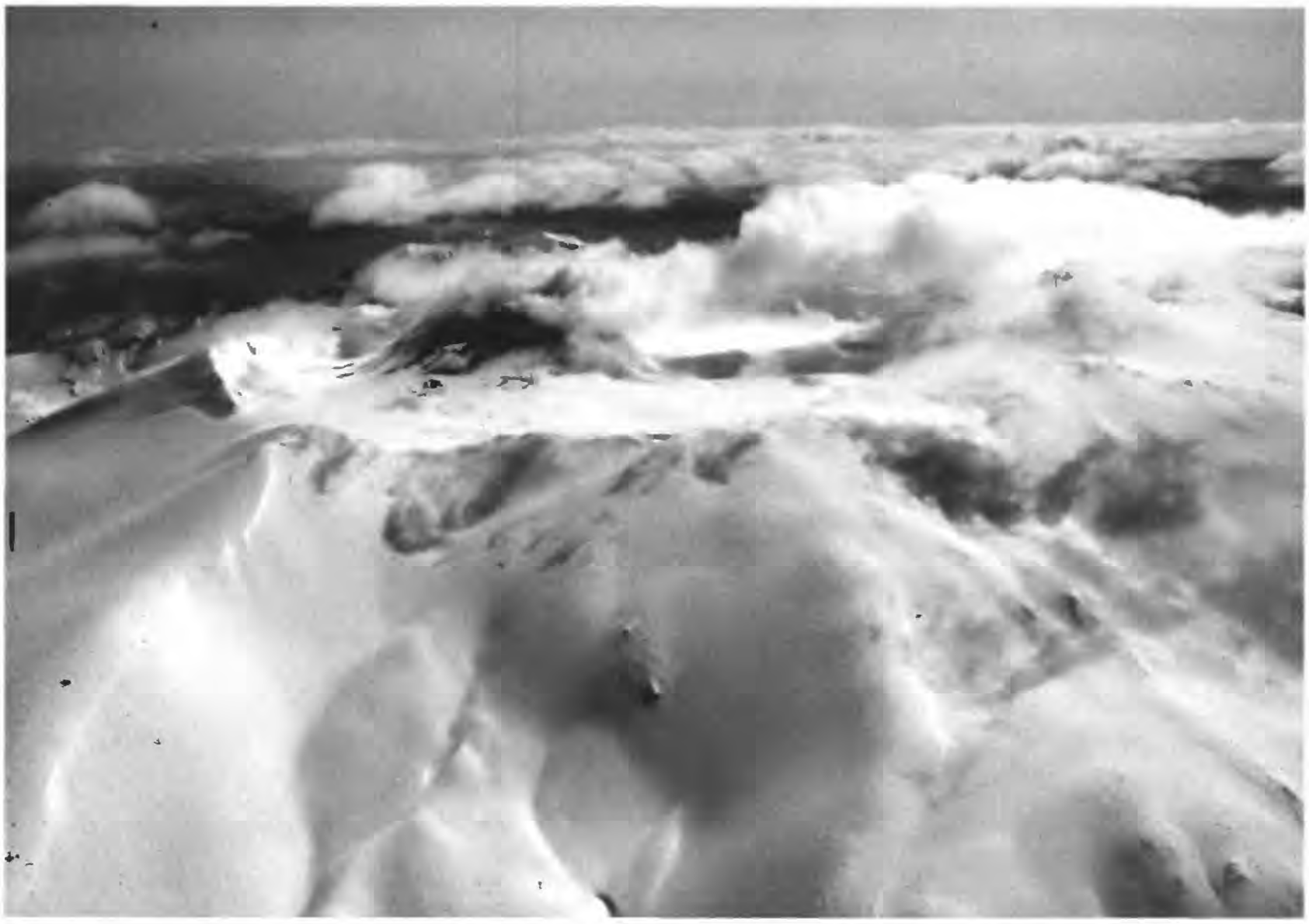

Figure 9. Oblique aerial view of Akutan volcano. The active cinder cone in the summit caldera is darkened by ash. Photograph by Chris Nye, May 10, 1994.

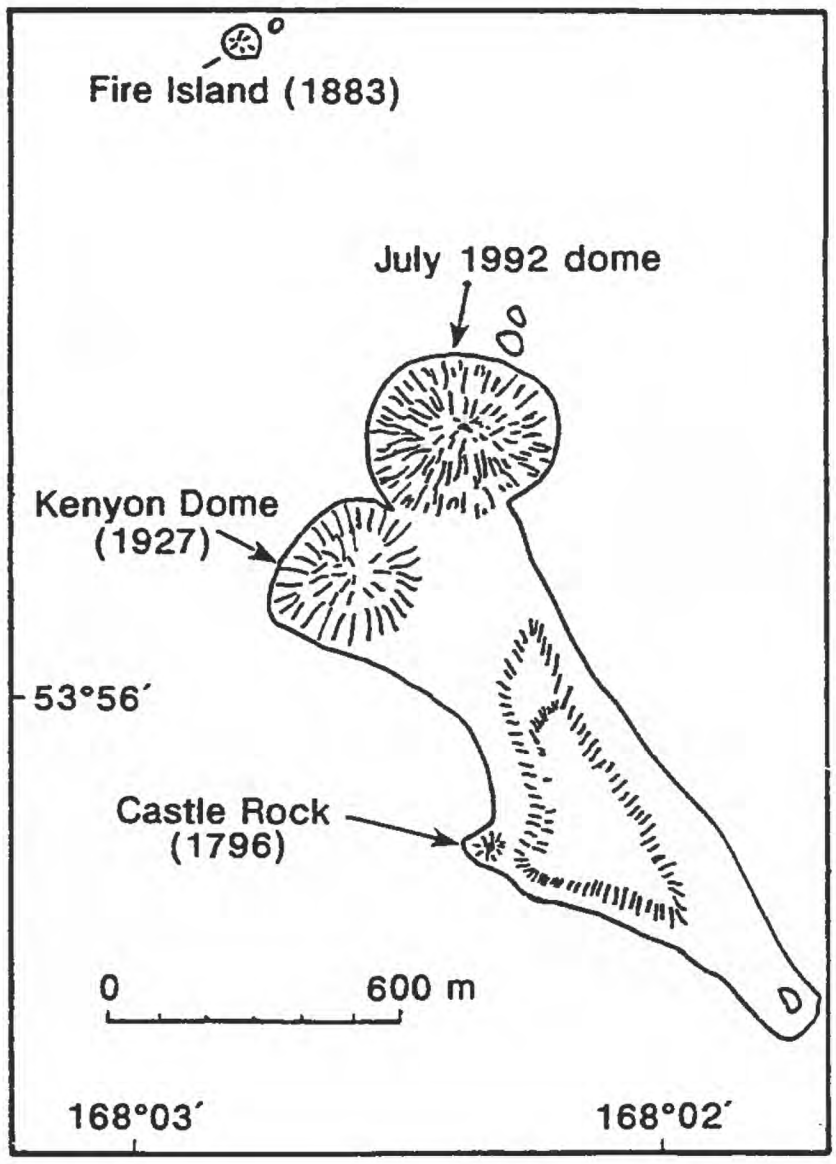

Figure 10. Sketch map of Bogoslof Island showing the 1992 lava dome. After map by John Reeder, Smithsonian Institution (1992).

Figure 11. Aerial view from the NE of Bogoslof Island. New lava dome at north end of island is about 150 m high. Photograph by Chris Nye, May 10, 1994

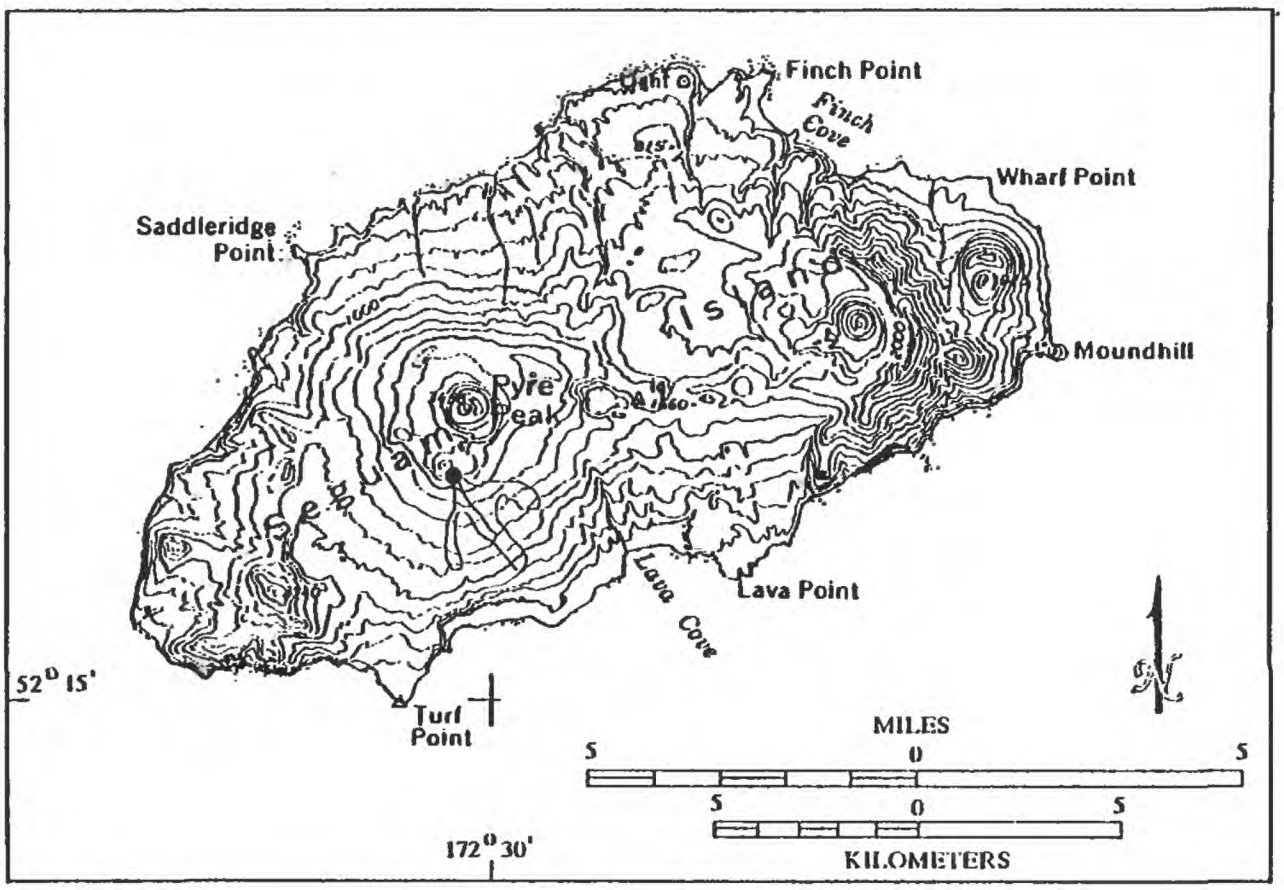

Figure 12. Map of Seguam Island showing active stratocone, Pyre Peak. The 1992 activity occurred from a small satellite cone located 1.5 km south of Pyre Peak. The cone is at the northern end of a fissure that produced lava flows (outlined) in 1977 (Smithsonian Institution, 1977).

Table 1. Summary of 1992 volcanic activity in Alaska. Locations of volcanoes are shown in Figure 1.

Volcano	Date of Activity	Type of Activity
Spurr		
Crater Peak vent	6-27-92	subplinian eruption following 10 mos. increasing seismicity; ashfall; minor debris flows
	8-18-92	subplinian eruption with little to no precursor; ashfall on Anchorage; pyroclastic flows and debris flows
	9-16,17-92	subplinian eruption; ashfall; pyroclastic flows and lahars
Iliamna	4-30-92	false alarm; fumarolic steam plume mistaken by pilots for eruptive activity; no unusual seismicity
Redoubt	4-30-92	false alarm; steam rising from 1990 lava dome mistaken by pilots for eruptive activity, no unusual seismicity
Mageik	3-3-92	false alarm; plume-like cloud observed on NOAA satellite imagery; AVO observation flight determines no activity; no unusual seismicity
Westdahl	11-29-91 to 1-15-92*	steam and ash emissions; lava fountains; lava flow; debris flow
Akutan	3-8-92 to 12-15-92*	intermittent steam and ash emission
Bogoslof	1-6-92 to 7-24-92*	ash and steam emissions; construction of new 150-m-high lava dome on north end of island
Seguam	12-27-92 to early 1-93*	steam and ash emission

*Date of ending activity is approximate