2002 Volcanic Activity in Alaska and Kamchatka: Summary of Events and Response of the Alaska Volcano Observatory

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Open-File Report 2004-1058

U.S. Department of the Interior
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By Christina A. Neal[1], Robert G. McGimsey[1], and Olga Girina[2]

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Cover Photo: Aerial view of Veniaminof Volcano looking north-northeast across the ice-filled, 8 x 11 km (5 x 7 mi) wide summit caldera. The active intracaldera cone is in the upper left. Photograph by Chris Nye, Alaska Division of Geological and Geophysical Surveys and Alaska Volcano Observatory, July 2002.

INTRODUCTION

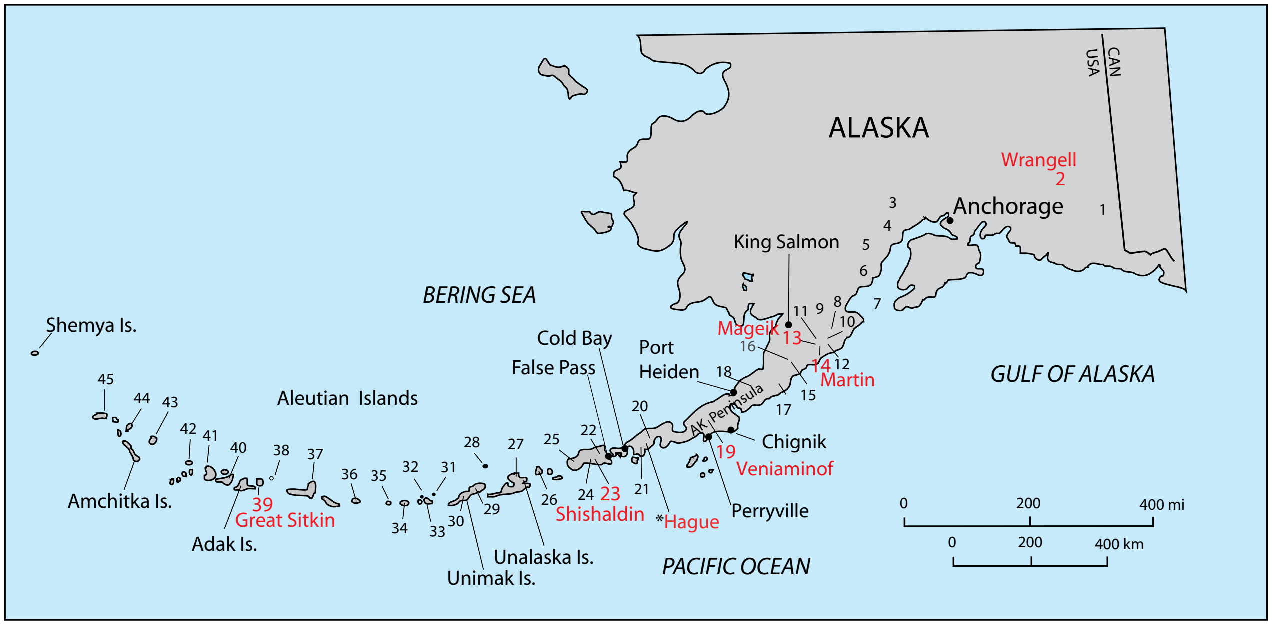
The Alaska Volcano Observatory (AVO) tracks activity at the more than 40 historically active volcanoes of the Aleutian Arc (fig. 1). As of December 31, 2002, 24 of these volcanoes are monitored with short-period seismometer networks (fig. 2). AVO's monitoring program also includes daily analysis of satellite imagery supported by occasional over flights and compilation of pilot reports, observations of local residents, and observations of mariners. In 2002, AVO responded to eruptive activity or suspect volcanic activity at 6 volcanic centers in Alaska — Wrangell, the Katmai Group, Veniaminof, Shishaldin, Emmons Lake (Hague), and Great Sitkin volcanoes (fig. 1; tables 1, 2)

In addition to responding to eruptive activity at Alaskan volcanoes, AVO also disseminated information on behalf of the Kamchatkan Volcanic Eruption Response Team (KVERT) about activity at 5 Russian volcanoes—Sheveluch, Klyuchevskoy, Bezymianny, Karymsky, and Chikurachki.

This report summarizes volcanic activity in Alaska and Kamchatka in 2002 and describes AVO's response. Only those reports or inquiries that resulted in a "significant" investment of staff time and energy (somewhat arbitrarily defined as several hours or more for reaction, tracking, and follow-up) are included. AVO typically receives dozens of reports of steaming, unusual cloud sightings, or false eruption reports throughout the year. Most of these are resolved quickly and are not tabulated here as part of the response record. On rare occasions, AVO issues an information release to dispel rumors of volcanic activity. The phrase "suspect volcanic activity" (SVA), used to characterize several responses, is unusual activity that is subsequently determined to be normal or enhanced fumarolic activity, weather-related phenomena, or other non-volcanic event.

AVO's level of response to remote volcanic activity varies depending on the source and content of the observation. After receiving a report, AVO usually contacts the National Weather Service (NWS) and Federal Aviation Administration (FAA) or local residents for corroboration and to solicit additional information. For verified, significant eruptive activity or volcanic unrest, an established call-down procedure is initiated to formally notify other government agencies, air carriers, facilities at risk, and the media. A special information release may be distributed if eruptive activity is confirmed, and the events are further summarized in the AVO weekly update distributed each Friday via electronic mail and facsimile to various government agencies, scientists, airlines and other businesses, the media, and members of the public. If an eruption or serious unrest is not confirmed, a notation is made in internal files.

This report presents descriptions of volcanic activity and AVO responses in geographical order from northeast to southwest along the Aleutian volcanic arc. All elevations reported are above sea level (ASL) unless noted, and time is reported as Alaska Standard Time (AST), Alaska Daylight Time (ADT), Kamchatkan Standard Time (KST), or Kamchatkan Daylight Time (KDT). We have chosen to preserve English units of measurements where they reflect the primary observations of distance or elevation such as those commonly received via pilot reports and aviation authorities in the United States. Information on 2002 responses is compiled from AVO weekly updates and information releases, internal bimonthly reports, the AVO 2002 "Chron book"—a chronological collection of daily or weekly staff notes for a particular year—and the Smithsonian Institution Global Volcanism Network Bulletins.



1. *Bona-Churchill*
2. Wrangell
3. *Hayes*
4. Spurr
5. Redoubt
6. Iliamna
7. Augustine
8. *Snowy*
9. *Griggs*
10. Katmai
11. Novarupta
12. Trident
13. Mageik
14. Martin
15. Peulik
16. Ukinrek
17. Chiginagak
18. Aniakchak
19. Veniaminof
20. Pavlof
21. Dutton
22. Isanotski
23. Shishaldin
24. Fisher
25. Westdahl
26. Akutan
27. Makushin
28. Bogosloff
29. Okmok
30. Vsevidof
31. Kagamil
32. Carlisle
33. Cleveland
34. Yunaska
35. Amukta
36. Seguam
37. Korovin
38. Kasatochi
39. Great Sitkin
40. Kanaga
41. Tanaga
42. Gareloi
43. Semisopochnoi
44. Little Sitkin
45. Kiska

**Hague*

Figure 1. Location of historically active volcanoes in Alaska and place names used in this summary. Volcanoes with no documented historical unrest but still considered hazardous based on late-Holocene eruptive activity are italicized. Volcanoes mentioned in this report are in bold red.

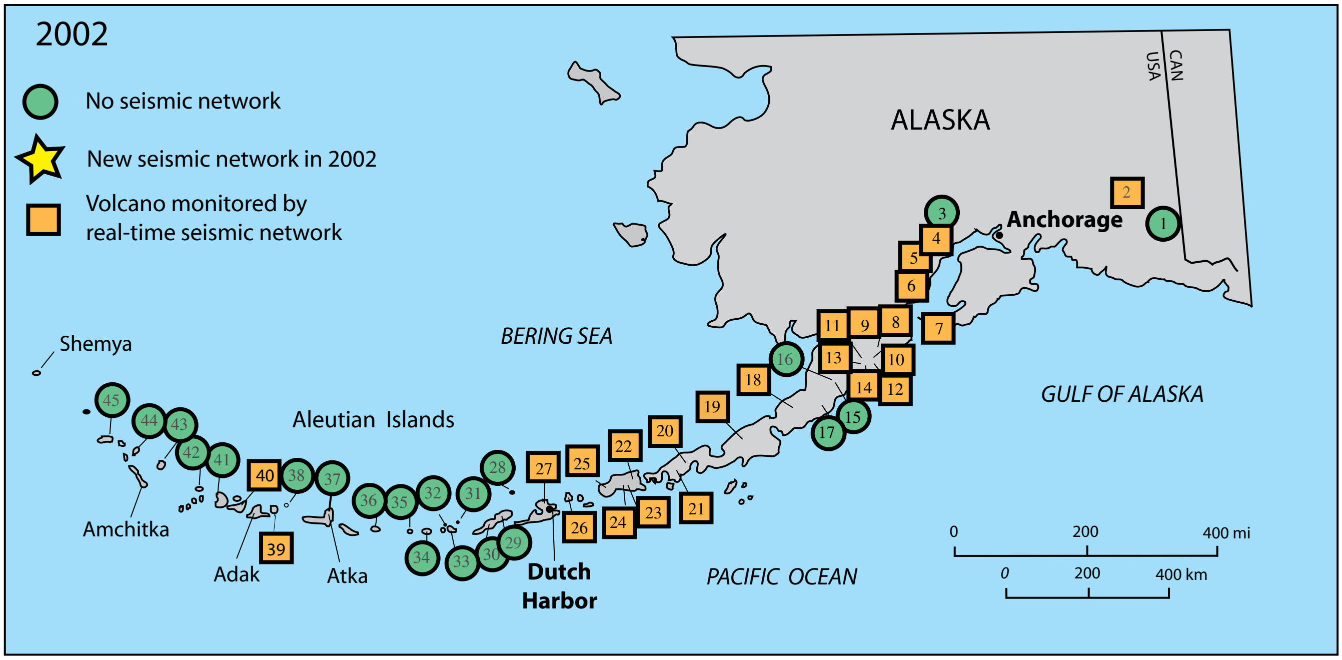


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Figure 2. Map showing those volcanoes monitored with a seismic network as of December 31, 2002. Volcanoes with no documented historical unrest but still considered hazardous based on late-Holocene eruptive activity are italicized. Volcanoes mentioned in this report are in bold red.

VOLCANIC ACTIVITY IN ALASKA

NORTHEAST TO SOUTHWEST ALONG ALEUTIAN ARC

WRANGELL VOLCANO
CAVW #1105-02
62°00'N 144°00'W
14,163 ft (4,317 m)

SUSPECT VOLCANIC ACTIVITY (SVA)
Discrete 'dark' clouds drifting downwind from Mount Wrangell summit fumaroles; no accompanying seismicity, but a deposit on the high flanks of the volcano is noted

On August 1, 2002, a spectacular, clear day in south-central Alaska, AVO received several calls reporting an eruption of Mount Wrangell (fig. 3a). Callers reported a dark cloud drifting downwind from the general summit area and a dark deposit high on the snow-covered flank of the volcano.

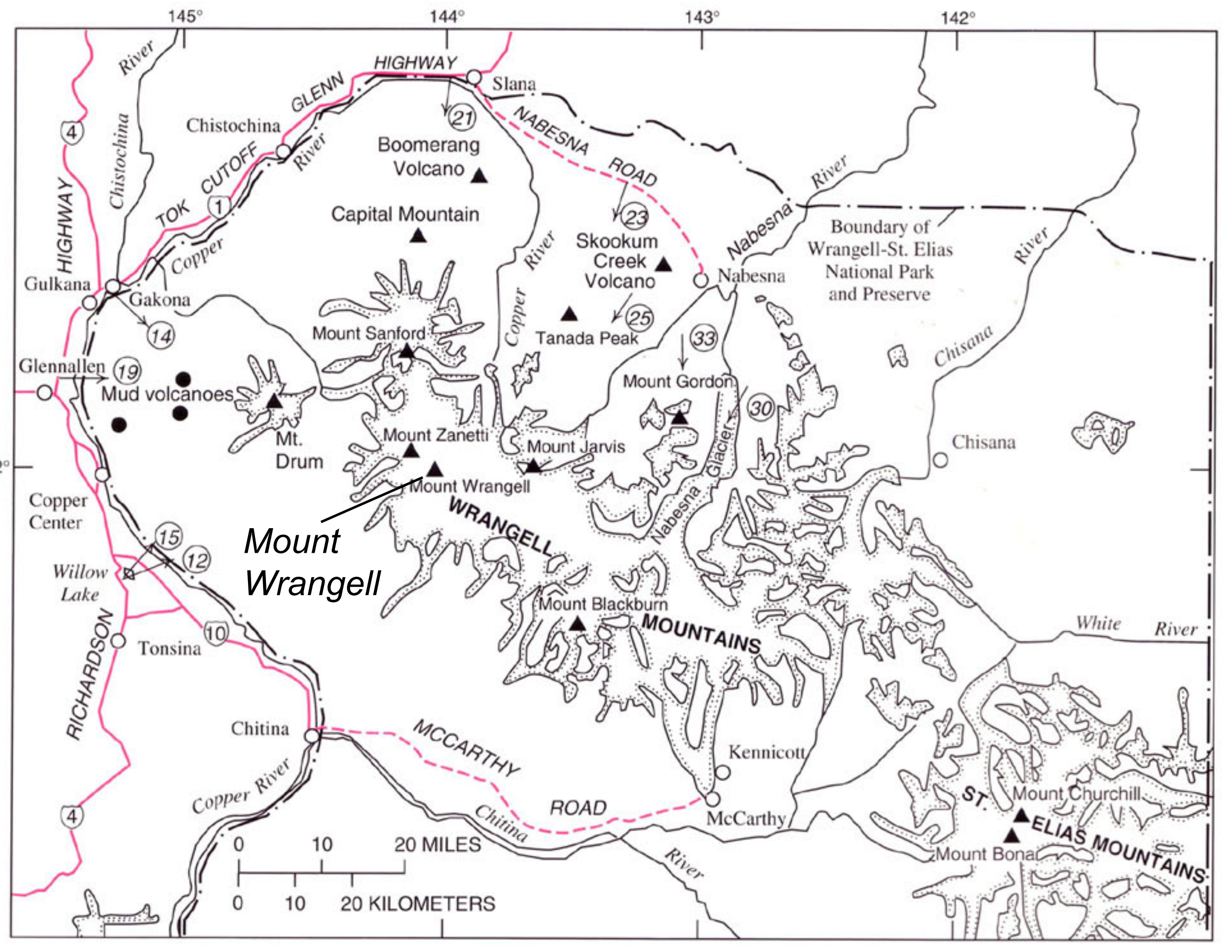

Figure 3a. Map of Wrangell-St. Elias Mountains showing location of Mount Wrangell. Modified from Richter and others, 1995.

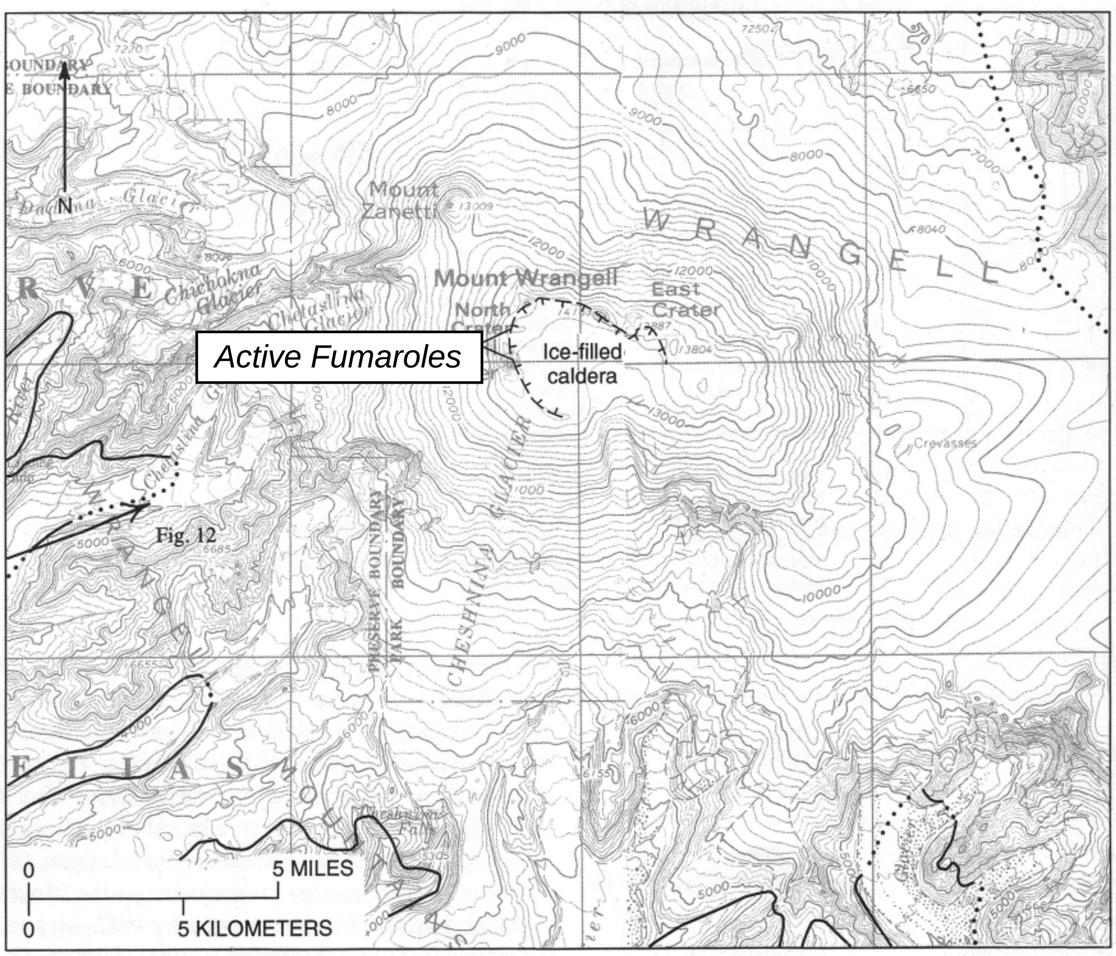

Figure 3b. Topographic map of Mount Wrangell. Area of active fumaroles indicated. Heavy lines approximate the present limit of Mount Wrangell lavas, dotted where concealed by ice. Base from U.S. Geological Survey Gulkana, Nabesna, Valdez, and McCarthy quadrangle maps. Figure from Richter and others, 1995.

AVO seismologists checked data from the Wrangell seismic network and, based on a lack of correlative seismicity, concluded that no eruption or explosion had occurred. AVO also consulted with Wrangell St. Elias National Park Geologist Danny Rosenkrantz, who suggested that high winds had lofted . ne-grained material exposed in the area near the summit fumaroles (. g. 3b). On August 4, an AVO geologist traveling in the area veri. ed that a diffuse, light gray stripe extended a short distance down the . ank of the volcano, emanating from the western rim of the caldera.

Subsequently, AVO received a video from Copper Center (. g. 3a) resident Brad Henspeter who witnessed the event on August 1. The tape is just a few minutes long and shows the waning portion of the event at approximately 1:15 pm ADT. In a written accompaniment to the videotape, Henspeter added his own commentary and recollections of the most signi. cant portion of activity. Notable excerpts from his words follow: ‘..ash was dark black….and billowing…multiple billows (puf. ng) coming one after the next, nearly touching each other. The wind where we were standing was still, however at the top of the mountain the wind was directly from the east…the billows were not rising above the top of the mountain." By the time he and his son returned to a good vantage point to film, about 10-12 minutes later, the billowing had stopped and the "puffs" had "turned a more grayish color."

In the video, there are indeed discrete, light gray "puffs" that moved downwind and retained their individual integrity. There are no other weather clouds in the vicinity. A light gray, relatively motionless and irregular-shaped cloud sits in the vicinity of the caldera rim. There is a good breeze at ground level (indicated by motion in the trees) but at altitude, clouds are not shearing rapidly. High on the snow-covered flank, a gray-colored swath extends from a high point that we identify as the west caldera rim near Mount Wrangell Crater (fig. 3b). The end of the video footage shows two distinct dark areas on the rim that is normally snow-covered. Henspeter's son reported a similar but more vigorous event on August 2, 2002 at about the same time of the day, but AVO received no further inquiries or reports.

AVO concluded that no volcanic process of significance was involved and no formal information releases were issued. However, these observations remain enigmatic: lack of any seismicity would seem to preclude a phreatic or magmatic eruption and yet the pulsatory, "puffing" nature of the dirty clouds is difficult to reconcile with a wind phenomenon.

Mount Wrangell is a large, glacier-covered shield volcano in the Wrangell-St. Elias National Park and Preserve of eastern Alaska (fig. 3a; Nye, 1991; Richter and others, 1995). The summit caldera is ice-filled. Three small, geothermally active craters occur on the west rim, historically the source of intermittent steam venting. Resultant steam plumes can be quite vigorous and sometimes reach hundreds of meters (thousands of feet) above ground level, occasionally entraining fine fragmental debris and producing very localized deposits of dark material on the ice. This, in addition to wind redistribution of debris from the summit area, is often mistaken for eruptive activity. AVO maintains a short period seismic network of 4 stations, one of which is located within just a few km of Mt. Wrangell Crater (Dixon and others, 2002). In addition to these data, AVO relies on local observers, pilots, and satellite imagery to track activity at the volcano. Except for a vigorous steam and ash emission and possibly a small lava flow in 1902, no historical eruptions are known to have occurred (Richter and others, 1995).

KATMAI GROUP

Martin
CAVW # 1102-14
58°10'N 155°21'W
6,102 ft (1,860 m)

Mageik
CAVW # 1102-15
58°12'N 155°15'W
7,103 ft (2,165 m)

SUSPECT VOLCANIC ACTIVITY (SVA)
Pilot and ground observer report of steam plume from Martin or Mageik

On December 11, 2002, the National Weather Service office in King Salmon reported a 'large steam plume' emanating from mountains east of King Salmon (fig. 1) and extending up into the cloud deck. No discoloration was noted in the cloud. AVO staff examined the real-time seismic data from the Katmai area network and saw no evidence of anomalous behavior. No cloud or thermal anomaly was detected in Advanced Very High Resolution Radiometer (AVHRR) images. This information was relayed back to NWS in King Salmon.

About 45 minutes later, the NWS at the Anchorage Air Route Traffic Control Center issued an urgent pirep (UUA) based on a pilot report of a 'strange plume' from Martin or Mageik that extended into cloud deck at about 7,000-10,000 ft. AVO concluded that this was the same observation reported earlier from King Salmon and took no further action.

Mageik and Martin are adjacent, mostly ice-covered stratovolcanoes within Katmai National Park and Preserve on the Alaska Peninsula (fig. 1). Other than fumarolic activity from summit craters, there are no credible reports of historical eruptive activity at either volcano (Fierstein and Hildreth, 2000). Steam from the 500-meter-wide (1,640 ft) summit crater of Martin is vigorous and nearly continuous, with plumes occasionally rising 600 m (2,000 ft) or more above the vent and extending downwind for up to 20 km (12 mi). Steam plumes rising from the summit crater of Mageik are also common. This activity at both volcanoes results in frequent telephone calls to AVO.

VENIAMINOF VOLCANO
CAVW #1102-07
56°10'N 159°23'W
8,225 ft (2,507 m)

LOW-LEVEL, PHREATIC (?) ERUPTIONS
Intermittent, low-level, dilute ash plumes from the historically active, intracaldera cone September – December (?) 2002; fallout limited to within ice-filled summit caldera

On the basis of several days of increasingly frequent, emergent seismic events on multiple stations of the new Veniaminof network (Dixon and others, 2002), AVO announced Level of Concern Color Code YELLOW on September 11, 2002. Following established protocols, the Anchorage Volcanic Ash Advisory Center (VAAC) issued a one-time volcanic ash advisory (fig. 4).

FVAK20 PANC 112317
VAAAK0
VOLCANIC ASH ADVISORY - ONE TIME WATCH
ISSUED 2002SEP11/2315 UTC VAAC: ANCHORAGE
VOLCANO: VENIAMINOF, 1102-07
LOCATION: N5610/W15923
AREA: ALASKA
SUMMIT ELEVATION: 7073 FT/2156 M.
ADISORY NUMBER: 2002-01
INFORMATION SOURCE: AVO
AVIATION COLOR CODE: YELLOW. PREVIOUS COLOR CODE: GREEN
REMARKS: LOW FREQUENCY TREMORS HAVE BEEN OCCURING EVERY 3-5 MIN
SINCE SEPT 10. TREMORS MAY HAVE BEGUN AS EARLY AS
SEPT 8. NO VISUAL REPORTS OF ANOMOLOUS ACTIVITY HAVE
BEEN RECEIVED AT VENIMIANOF. WEATHER CONDITIONS REMAIN
POOR AT THE VOLCANO AND HAVE LIMITED USEABLE SATELLITE
OBSERVATIONS. HISTORICAL ERUPTIONS OF THIS VOLCANO
HAVE PRUDUCED ASH PLUMES AS HIGH AS 6000 M (20000 FT)
WITH ASHFALL BLANKETING AREAS WITHIN 40 KM (25 NM) OF
THE VOLCANO. THE PREVIOUS ERUPTIONS OCCURING FROM
1993 TO 1995 PRODUCED INTERMITTENT LOW-LEVEL EMISSIONS
OF ASH AND STEAM AS WELL AS A SMALL LAVA FLOW.
NEXT ADVISORY: THIS WILL BE THE LAST ADVISORY UNLESS THE COLOR
CODE CHANGES.

Figure 4. Volcanic Ash Advisory from the Anchorage VAAC upon moving to color code YELLOW. This is a one-time Volcanic Ash Advisory Statement issued through formal aviation channels.

Over subsequent weeks, seismicity was characterized by periods of above-background activity alternating with quiet intervals. Telephone calls to Perryville and other nearby communities (fig. 5) turned up no unequivocal observations of unrest until September 24 when AVO received phone reports and digital photographs from the Perryville Native Council. These images showed small, faint gray clouds rising just above the intracaldera cone that has been the source of all known historical eruptions at Veniaminof (fig. 5; Miller and others, 1998). One observer described "puffs" of mixed dark and white clouds approximately every 5 minutes. Another observer described the "puffs" as solid white and emanating from the top of the cone.

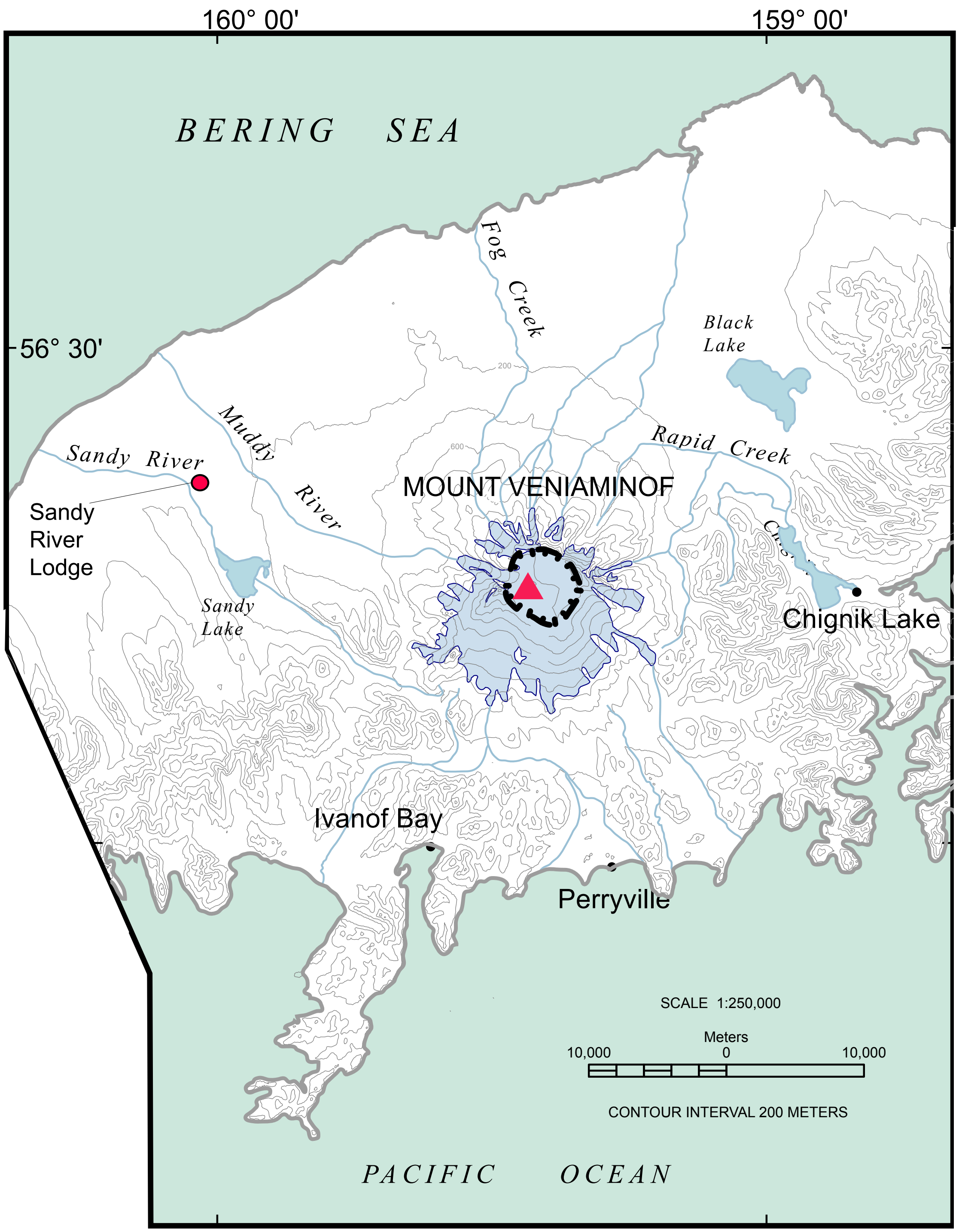

Figure 5. Map of Mount Veniaminof, the surrounding area, and nearby communities. Red triangle indicates location of historically active intracaldera cinder and spatter cone. Bold hachured line outlines the summit caldera. Blue area on Veniaminof indicates approximate permanent ice-cover.

Perryville residents next reported “plumes of smoke” between 8 and 10 pm on October 1. Others reported “rumbling” during the evening, however no clearly correlative signals were noted on seismograms. One and one half minutes of video taken on October 2 or 3, about 2 pm, from the vantage of the Sandy River (~45 km [28 mi] west of the active cone; fig. 5) showed several small, dilute, gray-brown clouds rising about 300-600 ft above the intracaldera cone and drifting a short distance to the north. In the 1.5 minutes of tape, two distinct “puffs”, about 1 minute apart, rise from the cone and drift downwind. The cone was not unusually snow free, however, a dark covering of ash was visible on the caldera ice field at the base of the cone and extending generally north. On October 6, Sandy River Lodge (fig. 5) reported black ash and “smoke” rising 400-500 ft above the cone, explosions, and ground shaking.

Cloud-free satellite images of the Veniaminof caldera revealed nothing unusual until October 2 when AVO acquired a Moderate Resolution Imaging Spectroradiometer (MODIS) image that captured a localized, gray deposit on the caldera ice field (fig. 6). The image shows a faint, fan-shaped deposit extending generally east from the cone to the caldera boundary and perhaps just beyond. When viewed in light of reports from Perryville and the video from Sandy River, the dark fan likely represents ash fall from low-level phreatic activity on October 1. No thermal anomalies were detected in satellite imagery throughout this period and no incandescence was reported. A compilation of reports from residents and other observers through the end of the year is presented in table 3. Seismicity and reports of discolored clouds over the intracaldera cone gradually declined through the fall.

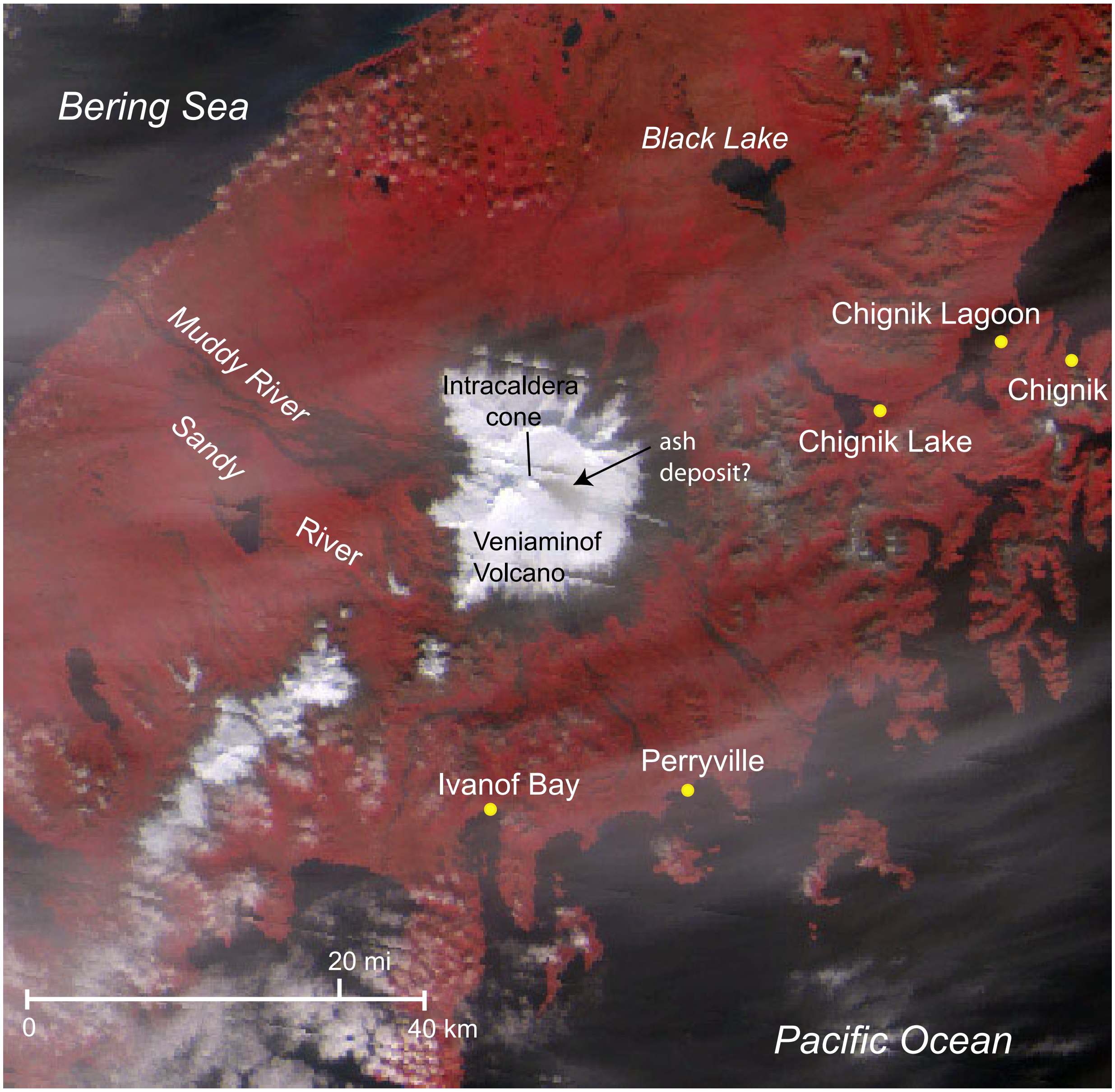

Figure 6. MODIS image of Veniaminof Volcano showing diffuse, light gray wedge of material (arrow) extending east and southeast of the intracaldera cone. Image taken October 2, 2002, ID 2125_214. North is towards the top. Parallel lines cutting WNW-ESE across the volcano are an artifact of the original data. Image courtesy Dave Schneider, USGS

A re-invigorated hydrothermal system beneath the intracaldera cone may account for these intermittent ejections of diffuse, ash-bearing clouds. It seems unlikely that this was prompted by a new magmatic intrusion at depth based on the lack of volcano-tectonic earthquakes. Increased hydrothermal activity may have been related to what was, according to some long time residents of the area, one of the rainiest autumns in memory. Although precipitation falling at the elevation of the intracaldera cone would have been in the form of snow (C. Searcy, NOAA, oral commun., 2003), precipitation in Cold Bay (fig. 1) was approximately 80% above normal for the month of October, according to long term climate records maintained by NWS (National Oceanic and

Atmospheric Administration: http://www.arh.noaa.gov/climate.php). King Salmon, the other nearby long-term weather station (fig. 1), recorded approximately 45% and 60% more precipitation than normal in the months of September and October, respectively.

In the summer of 2003, AVO geologists visited the summit caldera of Veniaminof and examined the intracaldera cone for evidence of the 2002 activity (K. Wallace, written commun., 2003). Within 50 m (160 ft) of the east side of the cone, the ice surface was dusted with fine wind blown debris derived from the cone. A crevasse at the base of the cone revealed a prominent, 1-cm-thick (0.4 in), black, scoriaceous deposit 1 m (3 ft) beneath the surface (fig. 7a,b). Scoria fragments ranged from fine ash to medium lapilli (with a maximum diameter of 5 mm [0.2 in]). The base of the crevasse was not visible, however no other debris layers were recognized over a thickness of at least 10 m (33 ft) suggesting that this type of depositional event was not common (e.g. wind reworking of cone debris). In hand sample, the tephra consists of abundant black iridescent, glassy scoria; hydrothermally altered scoria (with native sulfur and secondary minerals); and rare individual crystals. Microscopic investigation showed all glass fragments to be devitrified. Wallace and co-workers concluded that this deposit represented recycled cone material ejected during low-level phreatic explosions in October 2002.

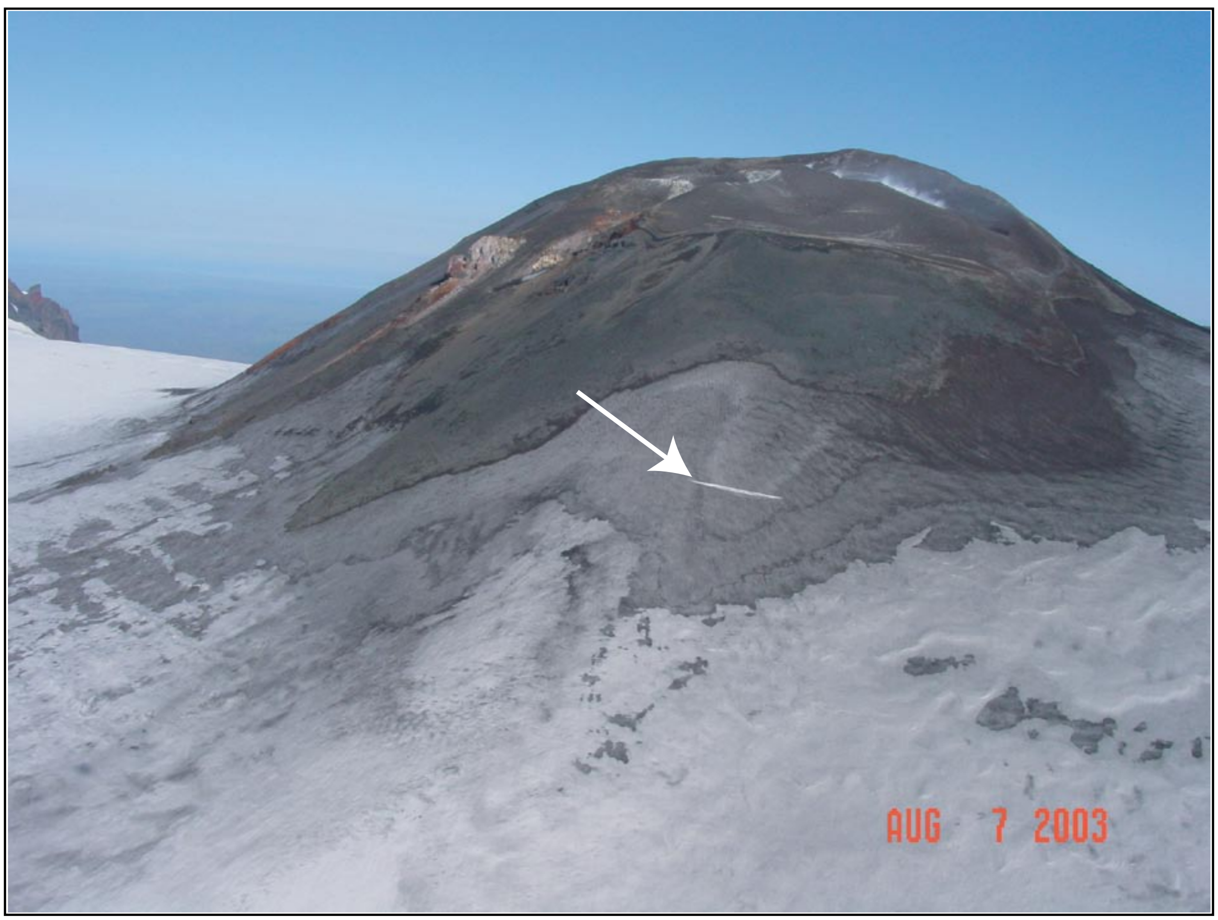

Figure 7a. East side of intracaldera cone at Veniaminof Volcano showing wind-blown debris cover; arrow points to ice crevasse at the base of cone and the site of tephra sampling in 2003 (fig. 7b).

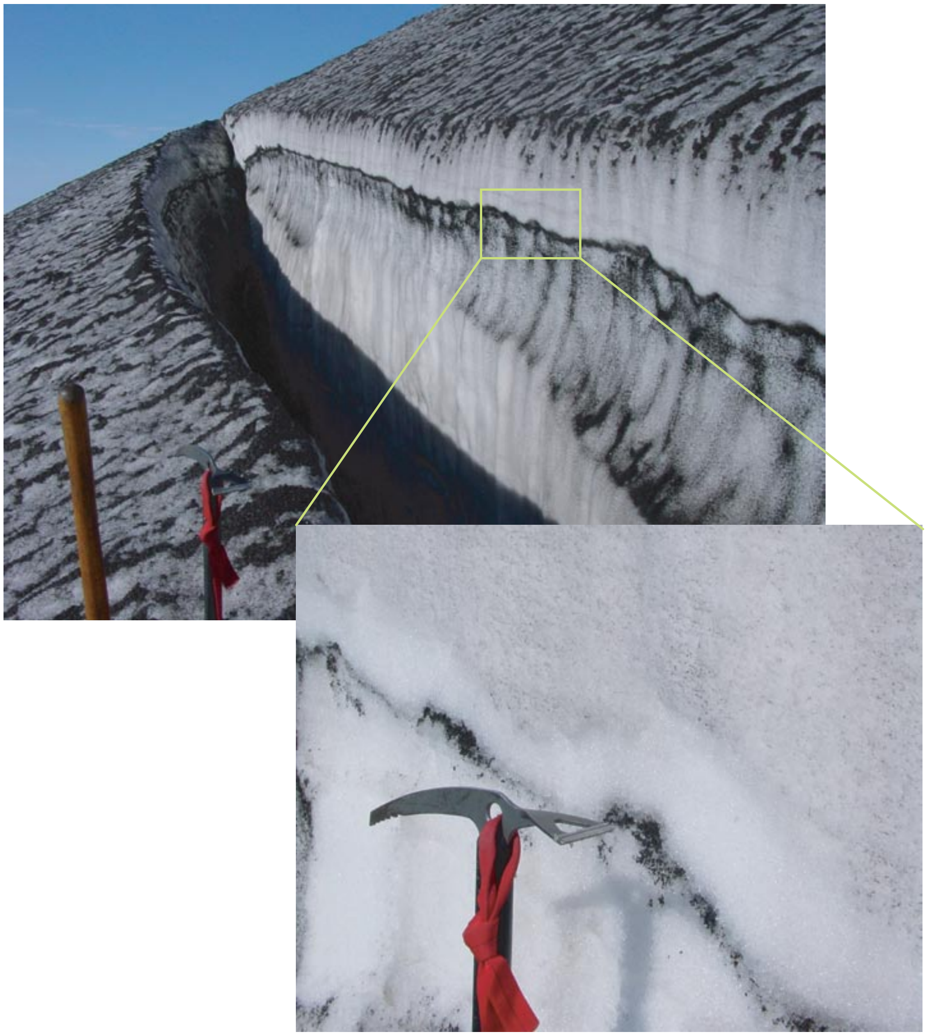

Figure 7b. Close-up view of crevasse and tephra deposit 1 m beneath surface. Photos by K. Wallace, USGS, August 7, 2003.

In response to the 2002 unrest at Veniaminof, AVO staff conducted outreach to communities in the vicinity of the volcano and compiled contact phone lists of observers and others who would be helpful in tracking activity on our behalf. We were in frequent telephone contact with people in Perryville, regional airlines, and our colleagues at U.S. Fish and Wildlife Service (USFWS) and the Alaska State Troopers who were often flying in the area. At least one private lodge near the volcano contacted AVO for information on potential hazards. AVO posted a "Frequently-Asked-Questions" about Veniaminof on our web site, a first in the history of AVO.

Interestingly, the change in Level of Concern Color Code to YELLOW for Veniaminof occurred on September 11, 2002, during a time when the Department of Homeland Security had recently established a Threat Level of ORANGE. It is therefore possible that reaction to our initial information release on September 11 may have been more pronounced than usual, and confusion over the two color designations may explain why some residents of the Peninsula thought AVO had declared an 'imminent' eruption.

From September 11 to November 18, 2002, AVO issued three special information release notices on the increased seismicity and its eventual decline at Veniaminof. The volcano was mentioned in weekly updates from September 13 through November 22. AVO reverted to color code GREEN on November 18. During the time of heightened activity, the AVO seismology and remote sensing groups increased the frequency of analysis of Veniaminof seismicity and relevant satellite imagery.

Veniaminof is an andesitic stratovolcano with an ice-filled, 10-km diameter (6 mi) summit caldera located on the Alaska Peninsula, 775 km (480 mi) southwest of Anchorage and 35 km (22 mi) north of Perryville (fig. 5). Veniaminof is one of the largest and most active volcanoes in the Aleutian Arc and has erupted at least 12 times in the past 200 years (Miller and others 1998). The most recent eruption occurred in 1993-95 from the prominent cinder and spatter cone in the northwest sector of the caldera (cover photo and fig. 5; Neal and others, 1995; Neal and others, 1996; McGimsey and Neal, 1996). The eruption was characterized by intermittent, low-level emissions of steam and ash, and production of a small lava flow that melted a pit in the caldera ice field. Previous historical eruptions have produced ash plumes that reached 6,000 m (20,000 ft) above sea level and ash fallout that affected areas within about 40 km (25 mi) of the volcano.

MT. HAGUE VENT OF EMMONS LAKE CALDERA

(CAVW #1102-02)
55°22'04 N   161°59'30 W
4,400 ft   (1,341 m)

SUSPECT VOLCANIC ACTIVITY
Possible increase in fumarolic activity from within summit crater beginning in late 2001.

On February 15, 2002, AVO received a pilot report of steaming from the vicinity of Pavlof Volcano on the Alaska Peninsula. AVO determined that the pilot had most likely spotted a steam plume from the summit crater of Hague, a youthful volcanic cone about 7 km (4 mi) southwest of Pavlof Volcano on the Alaska Peninsula (fig. 1). The pilot reported that snow had melted in a crater at the site of this steaming, but the “activity was not significant.” AVO had received a similar report in mid-December, 2001 (steam was reported emanating from a “hill” southwest of Pavlof, rising to about 6,000 ft [1,830 m] and dissipating, accompanied by a strong sulfur smell; McGimsey and others, 2005). The Pavlof seismic network showed nothing unusual in conjunction with any of the reports, and no anomalies were observed in satellite images.

“Steaming” reports for the vicinity of Hague on the Alaska Peninsula continued into the spring. In early April, AVO received email from a teacher in King Cove (35 km [20 mi] south-southwest of Hague) describing “steam from a large crater offset on the southwest side of Pavlof.” Based on the position of the reported activity, it appears likely that the source was also a crater at the summit of Hague. This same observer got a better look from the air on April 18 and confirmed that the crater was still steaming and releasing notable amounts of sulfur-bearing gas. On May 1, USFWS personnel in Cold Bay shared photographs of steaming from the vicinity of Hague (fig. 8) and noted that this was the first such observation in at least three years.

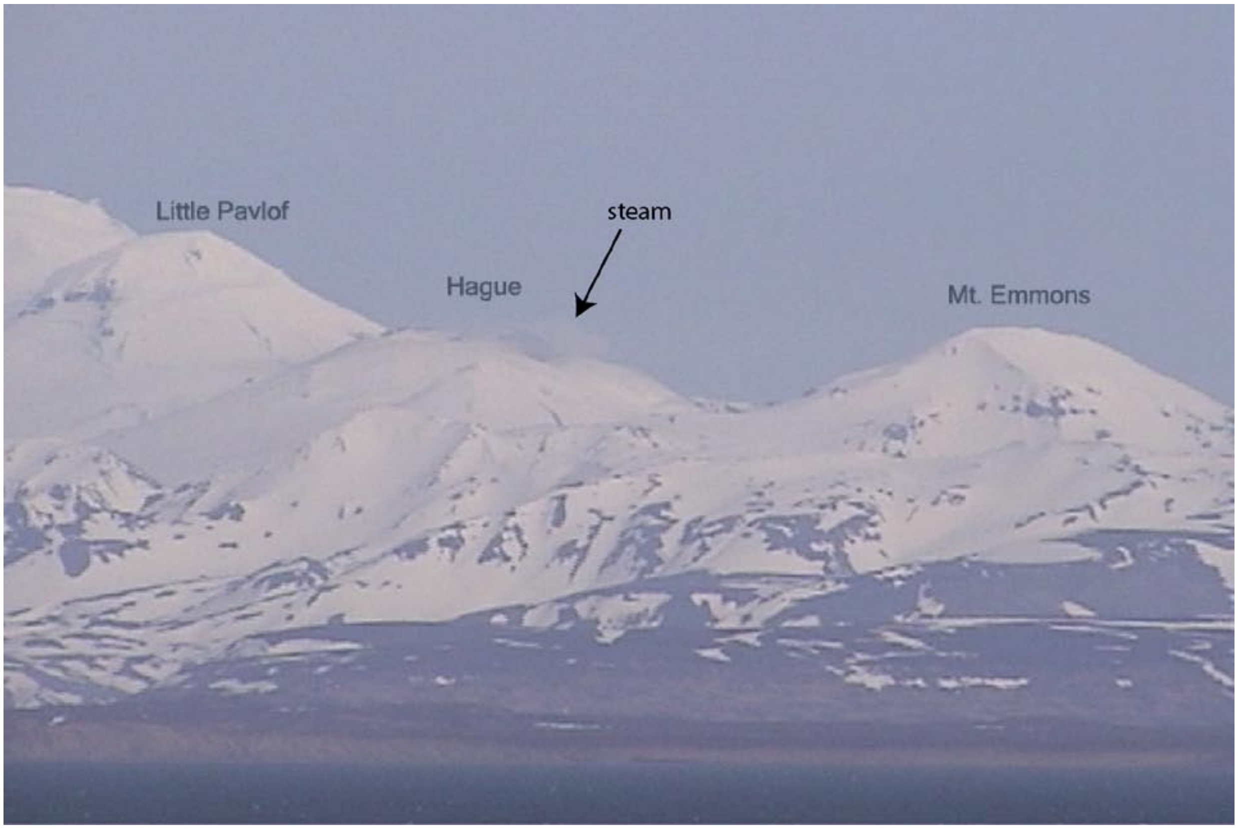

Figure 8. Telephoto view of Pavlof area volcanoes from Cold Bay, approximately 50 km (30 mi) southwest of Hague. Location of steaming shown with arrow. According to the photographer, the steaming was far more pronounced prior to the time of the image and had diminished in visibility due to high winds. Photograph May 1, 2002, courtesy of Rick Poetter, U.S. Fish and Wildlife Service, Izembek National Wildlife Refuge, Cold Bay.

In mid-April, AVO seismologists examined records from the adjacent Pavlof Volcano network and noted that a family of shallow long-period events had been recorded in the general vicinity of Hague (J. Caplan-Auerbach, written. comm., 2002). A second swarm of similar events occurred in May. While the significance of this seismicity remains unclear, its coincidence in time with reports of increased steaming from the Hague crater does suggest a transient increase in heat flux and resulting hydrothermal activity.

Hague is a 1,460-m-high (4,400 ft) stratocone with two distinct peaks. It is a post-caldera vent located in the eastern portion of Emmons Lake Caldera about 50 km (30 mi) northeast of Cold Bay (fig. 1). No historical eruptions other than a 'steam' eruption in 1990 are documented for Hague, although Kennedy and Waldron (1955) and Motyka and others (1993) suggest that several lava flows from Hague are less than a few hundred years old based on their youthful appearance. A ~500-m-diameter (150 ft) crater indents the eastern of the two peaks that together form Mt. Hague; the crater is funnel shaped and 100-200 m (320- 640 ft) across at the bottom. Fumaroles exist beneath a shallow lake that occasionally disappears (fig. 9) exposing native sulfur deposits. On a 1947 geologic map (Kennedy and Waldron, 1955), this crater is shown as ice-filled. Although AVO has occasionally received reports of steaming from the Hague area in the past, the history and extent of lake level change and variations in hydrothermal activity are not known.

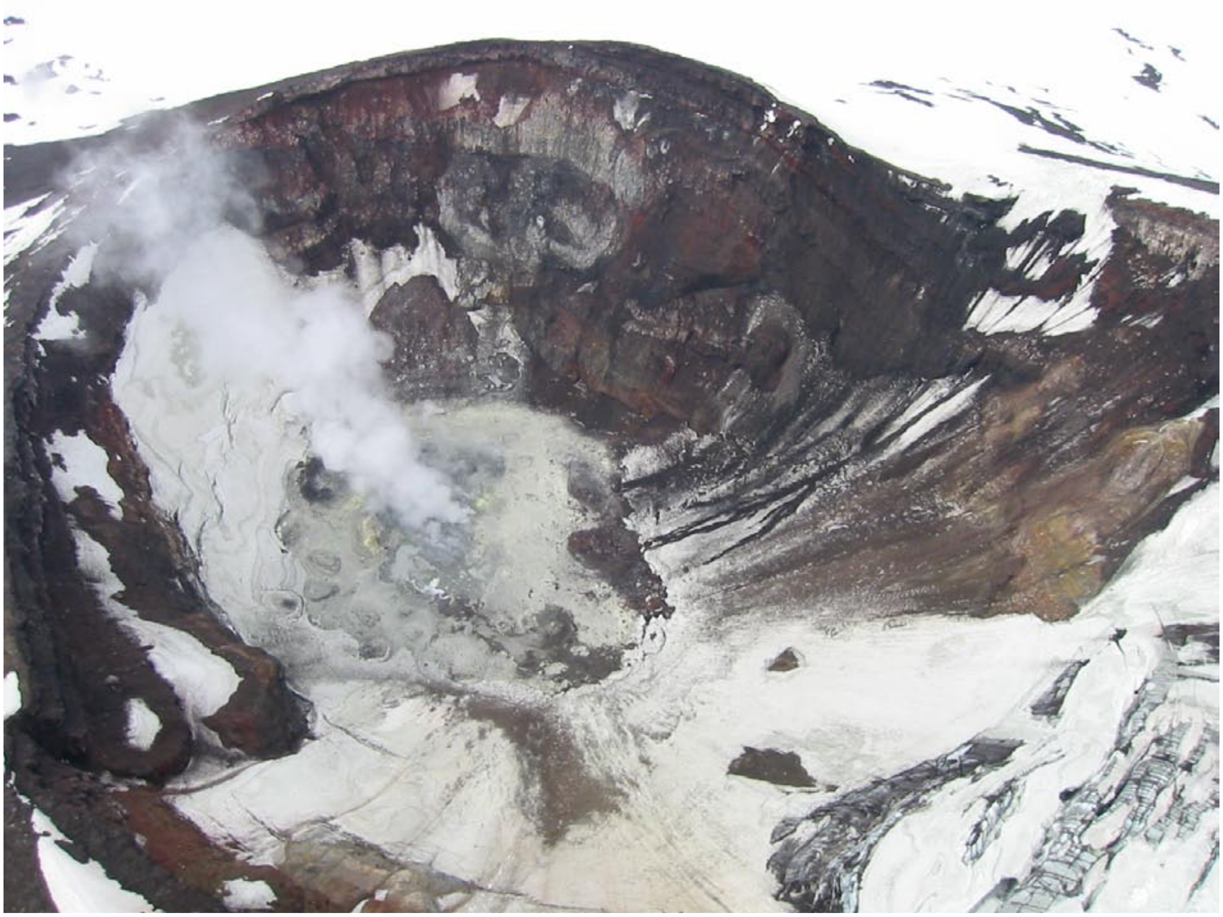

Figure 9. Aerial view of Hague Crater taken in the summer of 2003, more than a year following the flurry of reports to AVO regarding steaming from the area. Crater is approximate 500 by 800 m across at the rim. No standing water is visible in this image, however within a month, a small, shallow lake had re-formed in the crater, burying fumaroles and native sulfur deposits (C. Waythomas, written commun., 2003). South is towards the top. Photograph by G. Tytgat, UAFGI, July 7, 2003.

SHISHALDIN VOLCANO
CAVW #1101-36
54°45' N 163°58'W
9,373 ft (2,857 m)

SUSPECT VOLCANIC ACTIVITY
Shallow seismicity at the volcano in mid-May. Pilot report of possible eruption prompts SIGMET August 16

In mid-May 2002, AVO detected an increase in the number of shallow, low-frequency seismic events at Shishaldin. In addition, a number of 2-3 minute-long tremor-like signals were recorded. No correlative thermal anomalies or other observations of unusual activity were reported to AVO. AVO mentioned the activity in its weekly update of May 17. On May 24, AVO reported in its weekly update that the numbers of locatable low-frequency seismic events had decreased to background levels. Based upon this observation and the lack of correlative satellite-detected thermal anomalies or ground observer reports of anomalous activity, AVO concluded that the seismicity was probably typical of ongoing phreatic activity in the central crater and did not reflect significant restlessness. AVO made no further mention of Shishaldin in May or June weekly updates.

On August 16, AVO received notification of a pilot report of possible volcanic activity at Shishaldin via the NWS Alaska Aviation Weather Unit (AAWU). The pilot report indicated: "Shishaldin Volcano appears to be erupting. Steam and dark clouds rising to 10,500 [feet] moving NW-SE". During a follow up phone call to the area, AVO learned that a NWS weather observer in Cold Bay, about 100 km (60 miles) east of the volcano, reported a steam plume above Shishaldin. According to operational protocols, the AAWU issued an eruption SIGMET advising the aviation community of the possibility of airborne volcanic ash.

Upon receiving the pilot report, AVO examined seismic and satellite data and determined that Shishaldin was at a normal background state and had not erupted. Further discussions with the NWS weather observer in Cold Bay indicated that the observed steam plume was not unlike those commonly seen at Shishaldin.

Shishaldin Volcano, located about 1,100 km (~680 mi) southwest of Anchorage near the center of Unimak Island (fig. 1), is a spectacular, symmetric stratocone that forms the highest peak in the Aleutian Islands. Shishaldin is one of the most active volcanoes in the Aleutian arc with at least 27 eruptions since 1775 (Miller and others, 1998). The most recent eruptive period began in mid-February 1999, producing a sub-plinian ash cloud to at least 45,000 ft ASL on April 19, 1999 (Nye and others, 2002; McGimsey and others, 2004). Subsequently, during strombolian eruptions, ash plumes as high as 20,000 ft (6,100 m) extended as far as 500 miles (800 km) from the volcano. The last eruptive activity occurred on May 27, 1999, however, continued phreatic activity giving rise to intermittent seismicity and significant steam plumes containing minor amounts of ash persists. Even during non-eruptive periods, a steam plume emanating from the summit crater is quite common. This plume can occasionally be quite vigorous and often results in a false eruption report. The nearest community is False Pass, 32 km (20 mi) east-northeast of the volcano (fig. 1).

GREAT SITKIN VOLCANO
CAVW #1101-12
52°05'N 176°08'W
1,740 m (5,710 ft)

SEISMIC SWARM, TREMOR
Two periods of volcanic tremor and two earthquake swarms in late May

On May 27 and May 28, 2002, AVO detected anomalous seismicity at Great Sitkin Volcano in the Aleutians (fig. 1). Two periods of volcanic tremor occurred on May 27 lasting for 20 and 55 minutes and two earthquake swarms occurred on May 28 beginning at 1306 and 2228 UTC. The earthquake swarms each began with a local earthquake (local magnitude 2.2 and 4.7) followed by tens to hundreds of smaller aftershocks, most located 5-6 km (3-4 mi) southeast of the summit crater at depths of 0-5 km (0-3 mi).

This tremor and subsequent earthquake swarms represented significant changes from background seismicity established for Great Sitkin following installation of a 5-station seismic network around the volcano in 2000. However, seismicity declined significantly during the night of May 28-29 reaching background levels within about 24 hours. Satellite imagery showed no sign of volcanic activity at the surface, and AVO received no pilot or other reports of anomalous activity. Therefore, AVO did not elevate the Level of Concern Color Code in a special information release issued on May 29. On the following Friday (May 31), AVO mentioned that seismicity had declined significantly and no further information releases were anticipated unless activity intensified.

Great Sitkin Volcano is a basaltic-andesite volcano that comprises most of the northern half of Great Sitkin Island, in the Andreanof Islands group of central Aleutian Islands. The volcano consists of an older collapsed volcano and a younger parasitic cone with a 2-3-km-diameter summit crater (fig. 10). A steep-sided dome occupies the center of the crater. Great Sitkin erupted at least three times in the 20th century, most recently in 1974 when a lava dome formed in the crater accompanied by at least one ash cloud that reached ~10,000 ft (3 km) ASL (Miller and others, 1998). A poorly documented eruption occurred in 1945, also produced a lava dome that was partially destroyed by the 1974 eruption. Within the past 280 years, a large explosive eruption produced pyroclastic flows that partially filled a valley on the southwest flank (Waythomas and Miller, 2003). Similar earthquake swarms accompanied by tremor were also recorded at Great Sitkin in 2001 (McGimsey and others, 2005).

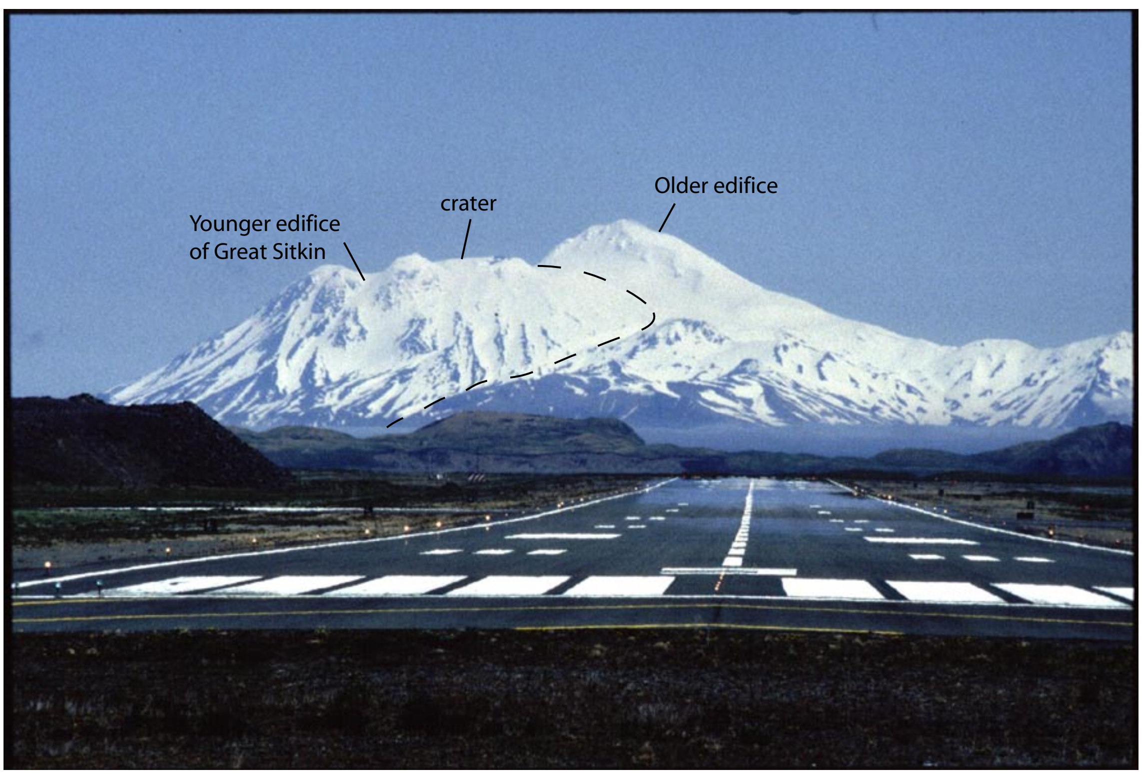

Figure 10. Photograph of Great Sitkin Volcano looking east from the runway on Adak Island. Dashed line shows boundary between the young Great Siktin Volcano and older volcanic rocks (Waythomas and Miller, 2003). Photograph by C. Nye, Alaska Division of Geological and Geophysical Surveys, July 2000.

VOLCANIC ACTIVITY, KAMCHATKA PENINSULA, and the NORTHERN KURILE ISLANDS, RUSSIA

Active volcanoes on Russia's Kamchatka Peninsula pose a serious threat to aircraft in the North Pacific. By agreement with the Institute of Volcanic Geology and Geochemistry (IVGG) and the Kamchatka Experimental and Methodical Seismology Department (KEMSD), Geophysical Service, both Institutes of the Russian Academy of Sciences, AVO assists with global distribution of information about eruptions in Russia (Kirianov and others, 2002). The Kamchatkan Volcanic Eruption Response Team (KVERT), consisting of scientists from both IVGG and KEMSD, issues a weekly information release that is rebroadcast by AVO to our web site and to hundreds of recipients by facsimile and email. When volcanic activity intensifies at any Kamchatkan volcano requiring notification of aviation and other interests, KVERT sends additional updates as needed.

Scientists with the KEMSD portion of KVERT monitor most of the frequently active volcanoes in Kamchatka with one or more short-period seismometers (table 4; fig. 11). In addition, KVERT receives visual reports and photographs of activity from scientific observers in the communities of Klyuchi (pop. ~10,000-15,000, ~45 km southwest of Sheveluch) and Kozyrevsk (pop. ~2,000-3,000, ~30 km west of Klyuchevskoy; fig. 11). On occasion, KVERT also receives reports from observers near Karymsky Volcano, and pilot reports are increasingly available from the local Civil Aviation Meteorological Center at Yelizovo Airport near Petropavlovsk (fig. 11). In mid-2002, KVERT added Alaid Volcano on Atlasova Island in the northern Kuriles to its list of seismically monitored volcanoes (however, subsequent equipment problems prevented data acquisition for several months in late 2002). In May 2002, near real-time web camera images of Sheveluch volcano became available as part of the routine monitoring data used by KVERT and AVO (see: http://data.emsd.iks.ru/videosvl/videosvl.htm).

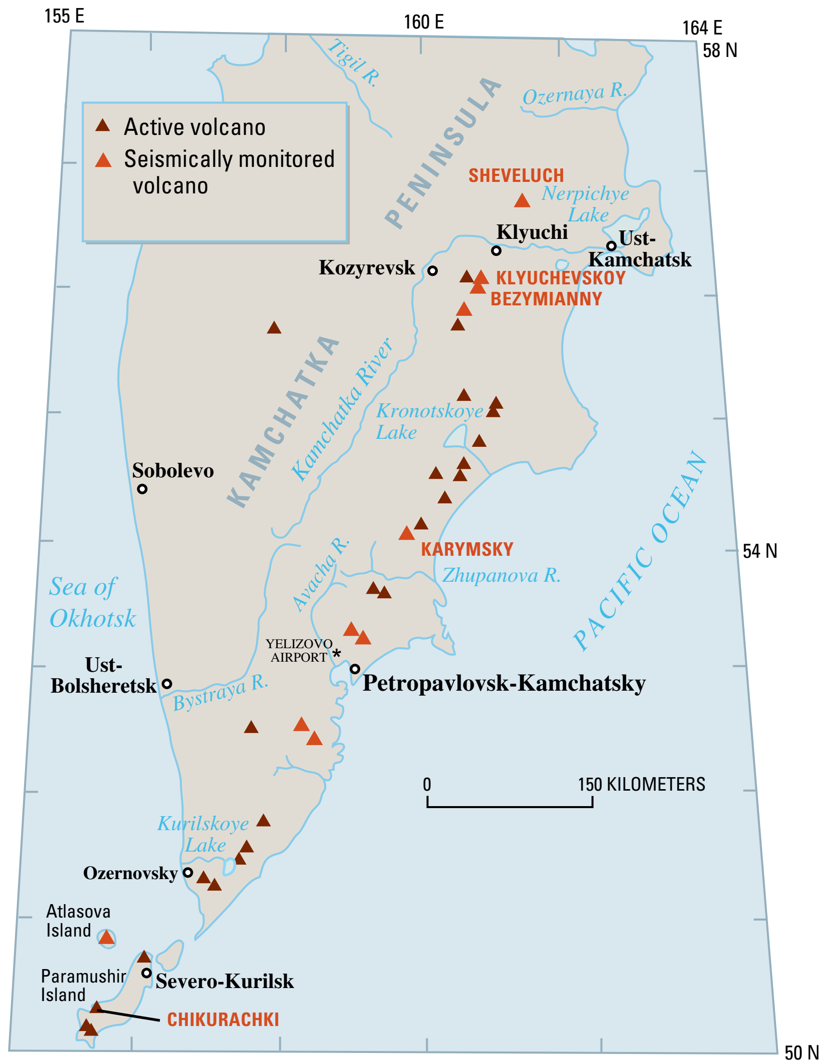

Figure 11. Active volcanoes of the Kamchatka Peninsula and northern Kurile Islands. Volcanoes discussed in this report are labeled in red.

Since the late 1990s, AVO satellite remote sensing scientists have made available to KVERT selected images of Kamchatkan volcanoes as well as AVO internal reports on analysis of these images. Beginning in 2002, KEMSD scientists obtained access to NOAA 16 images in Petropavlovsk-Kamchatsky through an agreement between KEMSD and Federal State Unitary Enterprise "Kamchatkan Center of Communication and Monitoring" that manages a satellite receiving station in Petropavlovsk. Also beginning in 2002, KVERT began to receive processed MODIS images from colleagues at the Far East Geological Information Center of the Ministry of Natural Resources in Yuzhno-Sakhalinsk.

In 2002, AVO relayed KVERT information about volcanic unrest at four Kamchatkan volcanoes, all of which are in the midst of protracted eruptions lasting several years or more. Of the four, Sheveluch and Karymsky remained the most restless and prompted the most AVO involvement. KVERT also responded to a brief explosive eruption at Chikurachki Volcano on Paramushir Island in the northern Kuriles (fig. 11). For each of these periods of heightened activity, AVO relayed information from KVERT to aviation and weather authorities and hundreds of other recipients through standard notification procedures. In addition, AVO staff communicated directly with KVERT to clarify and verify information and assist users in interpreting data coming from KVERT. Although not rigorously evaluated, it appears that in 2002 there was an increase in the number of pilot reports of volcanic activity in Kamchatka, including low-level ash emissions from Karymsky. Whether this is due to improving communications within the Russian Far East aviation sector or increasing air traffic in the area is unclear.

The following summaries contain reported events according to Kamchatkan local dates and Coordinated Universal Time (UTC), which equals ADT + 8 hrs and AST + 9 hrs. The equivalent local Kamchatkan time (herein referred to as Kamchatkan Daylight or Standard time) is always 21 hours ahead of Alaska time. This compilation is derived from a number of sources including KVERT weekly updates, unpublished AVO internal files and documentation, and Global Volcanism Program Volcanic Activity reports.

SHEVELUCH VOLCANO
CAVW #1000-27
56°38'N 161°21'E
10,768 ft (3,283 m)

CONTINUED DOME GROWTH AND COLLAPSE
Occasional ash explosions and/or dome collapse and associated pyroclastic flows, ash plumes, ash falls. Sudden, short-lived explosive ash plumes reach altitudes of 8 km (~26,000 ft) ASL on February 22.

Eruptive activity related to growth of the lava dome at Sheveluch Volcano continued intermittently through 2002. During periods of relative quiet, background seismicity consisted primarily of weak, small earthquakes within and just below the volcanic edifice, occasional tremor beneath the lava dome complex, rock falls and avalanche signals. At other times, seismicity varied in intensity as indicated by the number of shallow earthquakes or the amplitude of tremor and frequency of signals indicative of short-lived explosions and rock avalanches. Incandescence in the vicinity of the active lava dome was visible to observers in Klyuchi on several occasions throughout the year when weather and lighting conditions allowed. KVERT reported between a few to as many as 38 separate explosions (detected seismically) per week over the course of the year.

Several periods of significantly elevated eruptive activity were recorded during the year which prompted KVERT to increase the Level of Concern Color Code to ORANGE. In mid-January, there was an increase in the frequency of rock falls and energy of detected earthquakes, however no significant explosive eruption ensued. In mid-February, seismicity and the frequency of explosions from the active dome again increased, sending ash as high as 8 km (26,000 ft) on February 20. [Note: a subsequent report of mixed snow and ash fall on Klyuchi was actually caused by snowfall during fallout of airborne dust from China.] On June 1, seismicity again ramped up coincident with explosive events sending ash as high as 5.5 km (18,000 ft) ASL. Two brief episodes of heightened seismicity, elevated tremor, and explosions occurred beginning July 29 and August 9. A final period of heightened concern began on November 11 and included possible explosions and related ash plumes reaching 8 km (26,000 ft). KVERT reverted to color code YELLOW on November 29 and remained at that level through the year's end. On December 19, two short-lived explosions to 5.5 km (18,000 ft) also produced small pyroclastic flows that traveled up to 3 km (2 mi) from the lava dome.

An important tool used to track activity at Sheveluch during this extended period of dome growth accompanied by short-lived explosions is the combination of measured seismic amplitude and near-real time imagery of activity (fig. 12). Using a large data set of correlative explosion signals from the single seismic station with timed and calibrated visual records of the developing ash plume, KEMSD seismologist Sergey Senyukov has developed an empirical method for estimating plume height when viewing conditions preclude direct observation.

Figure 12. Short-lived explosive plume from Sheveluch Volcano, September 9, 2002 as captured on the remote camera system in Klyuchi, Kamchatka, 46 km south of the volcano. The ash cloud in this image has risen approximately 6 km (~20,000 ft) ASL. Image courtesy KEMSD.

Many of the ash clouds from Sheveluch were captured on satellite images and detected during routine analysis by AVO and by KVERT. Persistent thermal anomalies related to growth and collapse of the lava dome, as well as hot pyroclastic material on the debris apron southwest of the active dome, were also detected by KVERT and reported by AVO through the end of the year.

During periods of lower seismicity and between explosive events, a fumarolic plume was occasionally visible over the lava dome rising typically to altitudes of 50-2,500 m (160-8,200 ft) above the dome (fig.13). These plumes were visible downwind tens of km based on ground observations; some were visible on satellite images when conditions allowed.

Figure 13. a. Active lava dome at Sheveluch Volcano on February 1, 2002. Green circle indicates location of a recent explosion crater near the top of the active lava dome. The dome is approximately 500 m high and contains more than 250 million cubic meters of lava (S. Senyukov, written commun., 2003). Image courtesy Yury V. Demyanchuk, KEMSD. b. Aerial view of the ash covered slopes of Sheveluch Volcano on February 1, 2002. Gas and steam plume (possibly containing a minor amount of ash) drifts downwind from the active lava dome. Image courtesy Yury V. Demyanchuk, KEMSD.

Sheveluch Volcano is one of the largest and most active volcanoes in Kamchatka with at least 60 large eruptions during the Holocene (Bogoyuvlenskaya and others, 1985; Ponomareva and others, 1998). The northernmost active volcano on the Peninsula (fig. 11), its historical eruptive activity has been characterized by lava dome growth and explosive collapse. Its current protracted, episodic phase of lava dome growth began in August of 1980.

KLYUCHEVSKOY VOLCANO
CAVW #1000-26
56°03'N 160°38'E
4,750 m (15,589 ft)

GAS AND STEAM EMISSION, PHREATIC EXPLOSIONS
Periods of elevated seismicity, persistent fumarolic plume from summit crater, short lived phreatic explosions and minor, localized ash fall on the cone. Vigorous gas and steam emission with minor amount of ash on December 24 produced an impressive gas-rich plume.

Klyuchevskoy Volcano remained somewhat restless in 2002 with periods of elevated seismicity including volcanic tremor, appearance of a thermal anomaly, and explosive gas releases during the second half of the year. On April 9, a ground observer reported a plume to about 6 km (19,000 ft), possibly containing minor amounts of ash. This event may have been accompanied by a slight and very temporary increase in seismicity. After five months at Level of Concern Color Code GREEN, KVERT upgraded the volcano to YELLOW on May 31 in response to increasing seismicity. A swarm of earthquakes 30 km below the volcano was recorded in early June. On June 9 during aerial reconnaissance, KVERT staff reported fresh ash high on the flank of the volcano. Seismicity declined and KVERT reverted to GREEN on June 21.

KVERT reinstated YELLOW on November 14 in response to an increase in seismicity including deeper (30 km; 19 mi) events and shallow tremor. On November 24, a light ash fall was observed on the northeast flank of the volcano. Seismicity remained elevated with tens of earthquakes per day at 30 km (19 mi) depth and intermittent spasmodic tremor. On December 24, the remote camera system in Klyuchi captured a dramatic steam, gas, and minor ash explosion from the summit crater at 0010 UTC and KVERT declared ORANGE for the next three days (fig. 14). This plume reached an altitude of ~9 km (29,000 ft) within minutes and drifted to the east-southeast. Tokyo VAAC issued two Volcanic Ash Advisory Statements (VAAS) based on this event, but no ash was detected in satellite images. Seismicity remained above background through year’s end, however, no further explosions were recorded.

Throughout the year, the quiescent fumarolic plume visible on occasion above the summit crater typically reached altitudes of 100-2,000 m (330-6,400 ft) above the summit, trailing downwind as far as 10-12 km (6-7 mi) or more.

Figure 14. Gas and ash plume rises approximately 3 km (10,000 ft) above the summit crater of Klyuchevskoy Volcano on December 24, 2002. View is to the southeast from Klyuchi about 30 km (19 mi) from the volcano (fig. 11). Image courtesy KEMSD.

Klyuchevskoy is a classic, symmetrical stratovolcano and, at 4,750 m (15,580 ft), it is the highest of the active European and Asian volcanoes. Klyuchevskoy is frequently active with vulcanian to strombolian explosions and occasional lava flow production from the steep-walled summit crater or from flank vents (Khrenov and others, 1991). Explosive eruptions are recorded in nearly every decade and at multiple times during most years since the early 1700s (Simkin and Siebert, 1994). Its most recent significant eruption was September 30-October 1, 1994.

BEZYMIANNY VOLCANO
CAVW #1000-25
55°58'N 160°36'E
2,800 m (9,187 ft)

LAVA DOME GROWTH
Energetic explosion and likely dome extrusion in late December.

KVERT reported background or below background seismicity at Bezymianny for the first 11 months of 2002. Weak, shallow earthquakes were recorded intermittently and an occasional fumarolic plume rose several hundred meters above the lava dome, trailing tens of km downwind (fig. 15).

Figure 15. Aerial view of Bezymianny Volcano December 12, 2002. Fumarolic plume visible drifting downwind from the active lava dome. View is to the north; the flank of Kamen volcano is visible at top. Photograph by Yury Demyanchuk, KEMSD.

On November 18, a one-pixel thermal anomaly was noted in the vicinity of the Bezymianny lava dome on a MODIS image from the Far East Geological Information Center of the Ministry of Natural Resources in Yuzhno-Sakhalinsk. Based on the past association of thermal anomalies at Bezymianny and subsequent lava dome collapses, KVERT raised the Level of Concern Color Code to YELLOW. Seismicity at Bezymianny did not change significantly and no collapse or explosive ash-producing eruption ensued. KVERT returned to GREEN on November 22.

A thermal anomaly visible in AVHRR imagery returned to Bezymianny in late December and grew from 1 to 10 pixels in size between December 23 and 25. The reappearance of above-background seismicity and tremor accompanying this increase in thermal anomaly size prompted an upgrade to YELLOW on the morning on December 25. Only a few hours later, KVERT declared ORANGE as a satellite image recorded a 'hot' plume, probably containing some ash, extending more than 15 km (9 mi) west of the volcano. No altitude assignment was given. AVO subsequently detected this plume extending more than 200 km (125 mi) from the volcano but spectral analysis did not detect the presence of ash. Photographs of the event taken by KEMSD scientists document a blue-yellow haze emanating from the volcano.

Later on December 25, seismicity increased abruptly (at 1915 UTC) indicating the onset of an energetic explosive event. KVERT declared color code RED and estimated the altitude of the plume to be 5 km (~16,000 ft) (no visual confirmation was possible due to cloudy conditions). Tokyo VAAC issued a VAAS but no ash was identifiable on satellite imagery. At least one commercial airliner chose a more southerly route over the North Pacific to avoid encountering possible ash. Over the next few hours, ash fall of 3 mm total thickness occurred at Kozyrevsk, 55 km (34 mi) northwest of the volcano. The eruption continued at a lower level for several days as indicated by continuing tremor; KVERT interpreted the activity to reflect effusion of viscous lava from the active dome complex. The color code reverted to YELLOW on December 28 where it remained for the final days of 2002.

In October 1955, Bezymianny Volcano emerged from a 900-1000 year period of quiescence commencing an explosive eruption that culminated on March 30, 1956, with the catastrophic failure of the eastern flank and debris avalanche and lateral blast. Since then, lava extrusion has produced a dome that periodically collapses generating pyroclastic flows and short-lived ash plumes (Girina and others, 1993; Belousov and others, 2002); the most recent, significant ash-producing explosion was in August of 2001.

KARYMSKY VOLCANO
CAVW #1000-13
54°03'N 159°27'E
1,486 m (4,876 ft)

STROMBOLIAN/VULCANIAN ERUPTION CONTINUES
Intermittent explosions, localized ash falls, lava extrusion, rock avalanches, degassing.

Karymsky remained at Level of Concern Color Code YELLOW for the entire year as the eruption that began in mid-1995 continued throughout 2002 (fig. 16). Seismicity remained above background with tens to several hundreds of weak, shallow earthquakes recorded each day. Sudden-onset, high frequency seismic signals that were likely related to short-lived, explosive bursts of ash and ballistics reaching as high as 1 km (3,300 ft) above the summit, as well as avalanches of rock down the steep flank of the cone were common. Five- to ten-minute long signals reflected vigorous gas emission events and were noted daily. A weak thermal anomaly on satellite imagery was detected at Karymsky throughout the year. It varied in size from 1-10 pixels and likely reflected continued heat flux from the summit crater and intermittently active lava flows on its flanks. KVERT received an occasional pilot report of single bursts of ash: 5 km (16,000 ft) on February 13; 4.5 km (15,000 ft) on April 19, July 9, and September 16; 5.5 km (18,000 ft) on October 31 and November 1. Intermittently, a steam and gas plume extending as far as 30-150 km (20-90 mi) downwind of the volcano was noted by observers on the ground as well as on satellite images. The volumetrically small, dilute, rapidly dispersing ash plumes produced at Karymsky did not produce ash signals on AVHRR imagery.

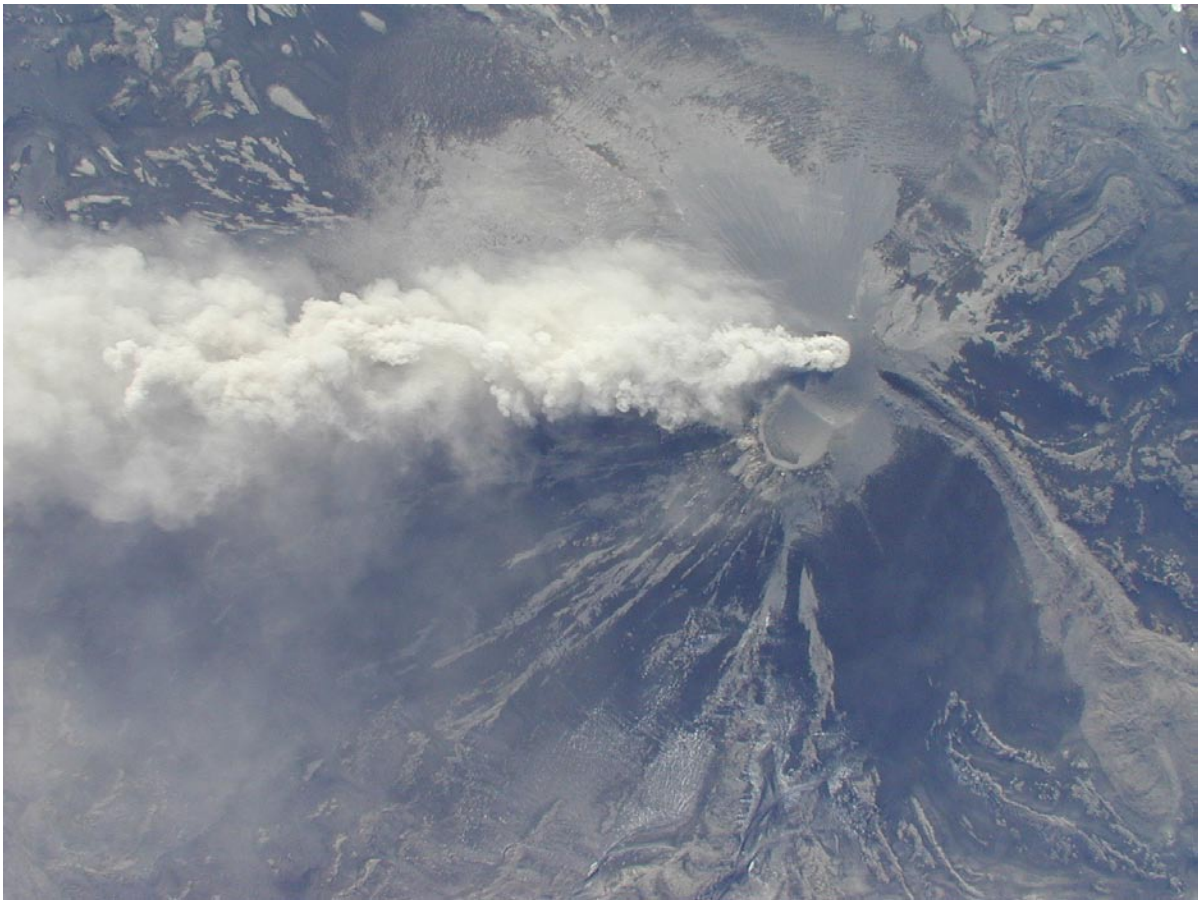

Figure 16. Near-vertical, aerial view of mild eruptive activity at Karymsky Volcano on May 1, 2002. Fresh ash blankets the flanks of the volcano and recent lava flows extend from the summit down the southeast and southwest flank of the cone. North is to the left. Photograph by Nikolai Seliverstov, used with permission.

A MODIS image from April 17 captured five separate radiating ash fall deposits extending up to 25 km (15 mi) from the volcano on the snow-covered landscape around Karymsky. In late April, observers reported a new, ~100-m-high (330 ft) pyroclastic cone inside the summit crater of Karymsky (fig. 17). On May 10, observers also noted an active lava flow about 300 m (1,000 ft) wide extending ~1.3 km (0.8 mi) down the south-southwest slope of the volcano. On September 8, three new small lava flows on the south and southeast slopes were observed from a helicopter.

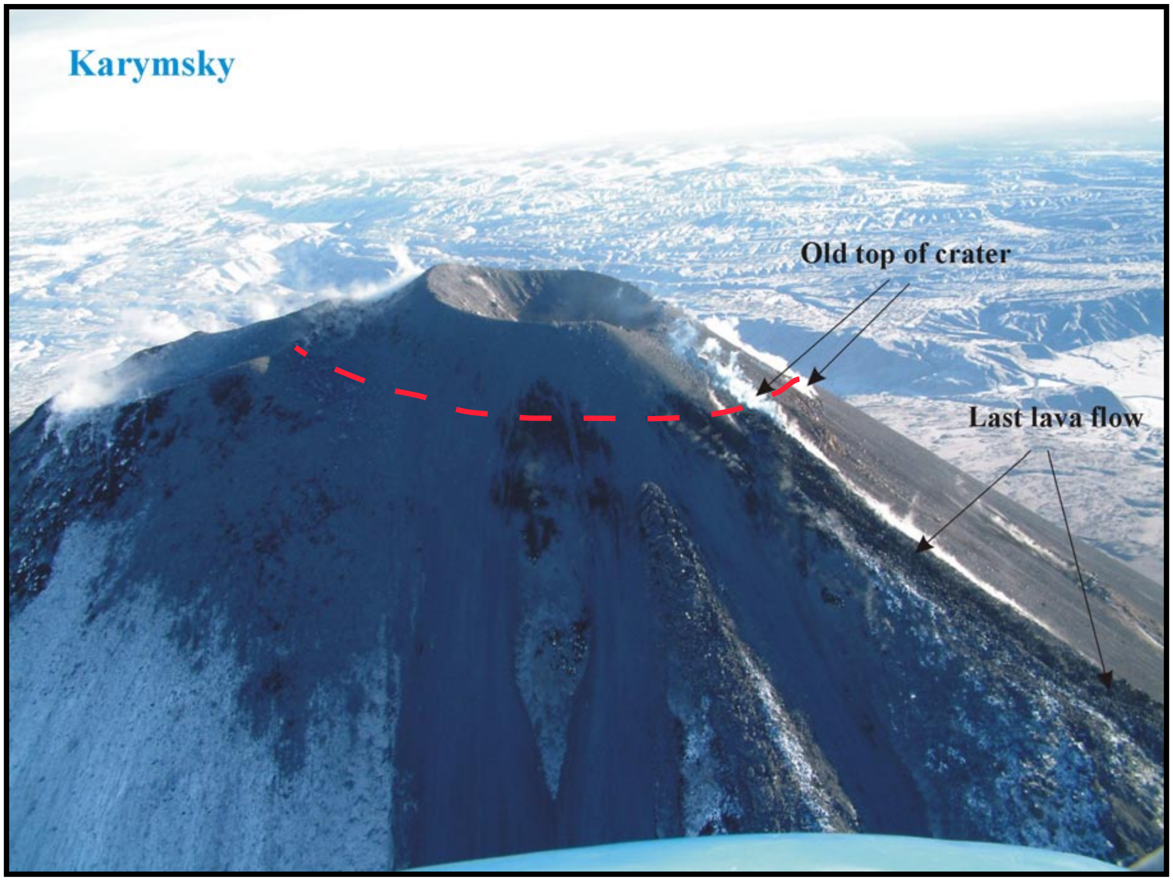

Figure 17. Aerial view of the summit area of Karymsky Volcano on December 1, 2002. The approximate pre-eruption (pre-1996) summit crater rim is shown by dashed line. View is to the northeast. Photograph by Svetlana Droznina, KEMSD.

Seismic signals interpreted to reflect down slope movement of lava were reported intermittently during the late fall.

The current phase of unrest began in mid-April 1995 with increasing seismicity and culminated in an explosive eruption that began on January 1, 1996, simultaneously at Karymsky volcano and from a vent at the north end of Karymsky Lake about 10 km (6 mi) distant (Belousov and Belousova, 2001). Karymsky usually issues a continuous steam plume and is the most active volcano on the Kamchatkan Peninsula (Simkin and Siebert, 1994). Explosive and effusive-explosive eruptions of andesitic tephra and lava flows alternating with periods of repose are typical of Karymsky (Ivanov and others, 1991).

CHIKURACHKI VOLCANO
Paramushir Island, Northern Kuriles, Russia
CAVW #0900-36
50°20'N 155°27'E
1,816 m (5,958 ft)

STROMBOLIAN/VULCANIAN ERUPTION
Short-lived eruption January 25–April or May. Ash fall as far as 130 km from the volcano, ash plumes to an estimated 6 km.

In early February 2002, KVERT learned of an explosive eruption at unmonitored Chikurachki Volcano on Paramushir Island in the northern Kuriles (figs. 11, 18). The eruption began on January 25 when residents of Severo-Kurilsk (population ~ 3,000), located 60 km (~37 mi) northeast of the volcano, reported a three-hour-long ash fall mixed with snow between noon and 3 pm (local time).

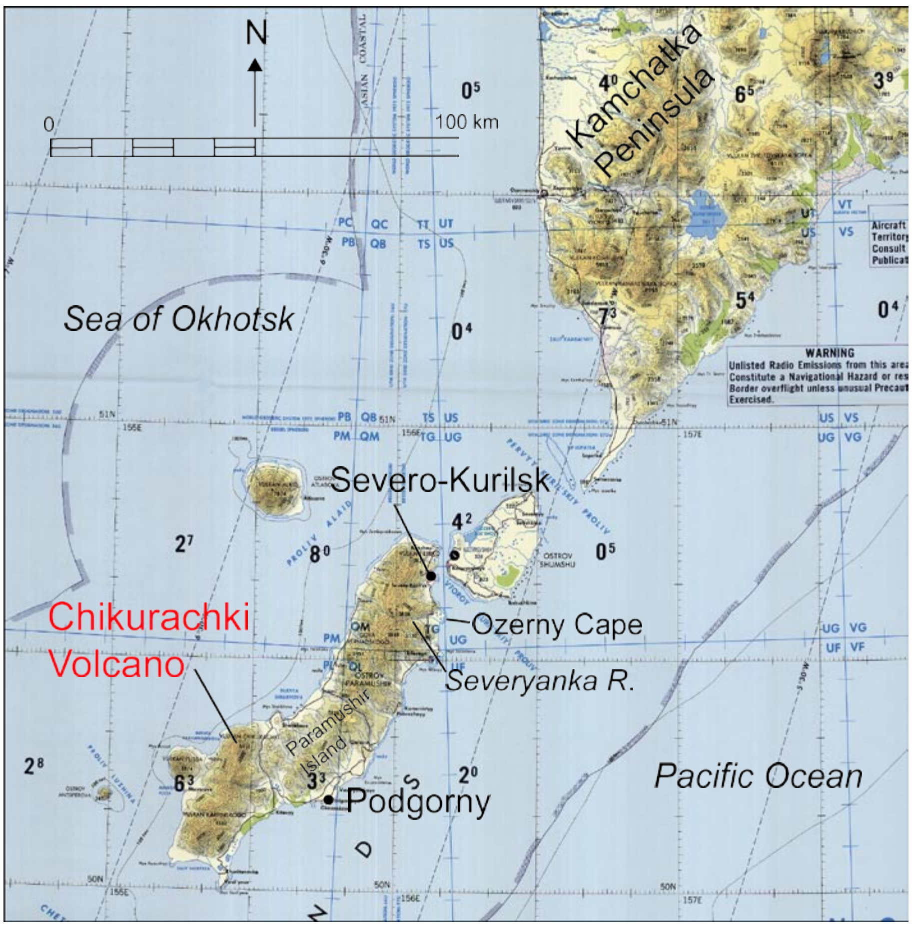

Figure 18. Map of northern Kurile Islands and southern portion of Kamchatka Peninsula. From National Oceanic and Atmospheric Administration Tactical Pilotage Chart ONC-E10C, scale 1:500,000.

On February 2, a helicopter pilot observed an ash column rising 300 m (~1,000 ft) above the summit. An ash plume extended 70 km (~43 mi) to the southeast and additional ash fall was observed downwind of the volcano. On February 7, a hunter heard ‘thunder’ from the vicinity of the volcano and observed an ash cloud rising at least 2,500 m (~8,200 ft) where the ash disappeared into a cloud deck.

By February 20, activity had diminished, according to residents of Severo-Kurilsk. A helicopter over flight on February 18 revealed a new, small crater in the southeast portion of the pre-existing crater. A fumarolic plume rose 150 m (500 ft) above the summit and fresh ash blanketed the east flank of the cone. Between February 25-27, residents of the island reported renewed activity consisting of intermittently visible ash plumes, and ash fall near Podgorny, 19 km (12 mi) southeast of Chikurachki. Additional ash fell at Podgorny throughout the day on March 16, and helicopter observations later that day reported continual gas emission and sustained gas ash explosions up to 200 m (640 ft) above the volcano. A visible plume extended at least 100 km (60 mi) southeast. Ash fall from the late February activity was traced northeast from the volcano as far as Severo-Kurilsk and Ozerny Cape and the Severyanka River on the northeast part of Paramushir Island (fig.18).

The timing of the eruption’s end is not precisely known. KVERT learned on May 6 that fresh ash deposits had been reported by hunters on the southwest flank of the volcano on April 22. Additional ash falls were also reported in Severo-Kurilsk through late April.

No thermal anomaly was detected during the course of this eruption, however poor weather frequently obscured the volcano. According to the Tokyo VAAC, eruptions on February 21 and February 24 may have produced ash clouds that reached about 6 km (20,000). A gas and steam plume was visible on satellite images from February 23 and 27; on February 26, a 120-km-long (75 mi) plume with possible ash content was visible in AVHRR images. MODIS satellite images on February 24 and March 18 recorded eruption plumes despite cloudy conditions in the North Pacific (fig. 19 a, b).

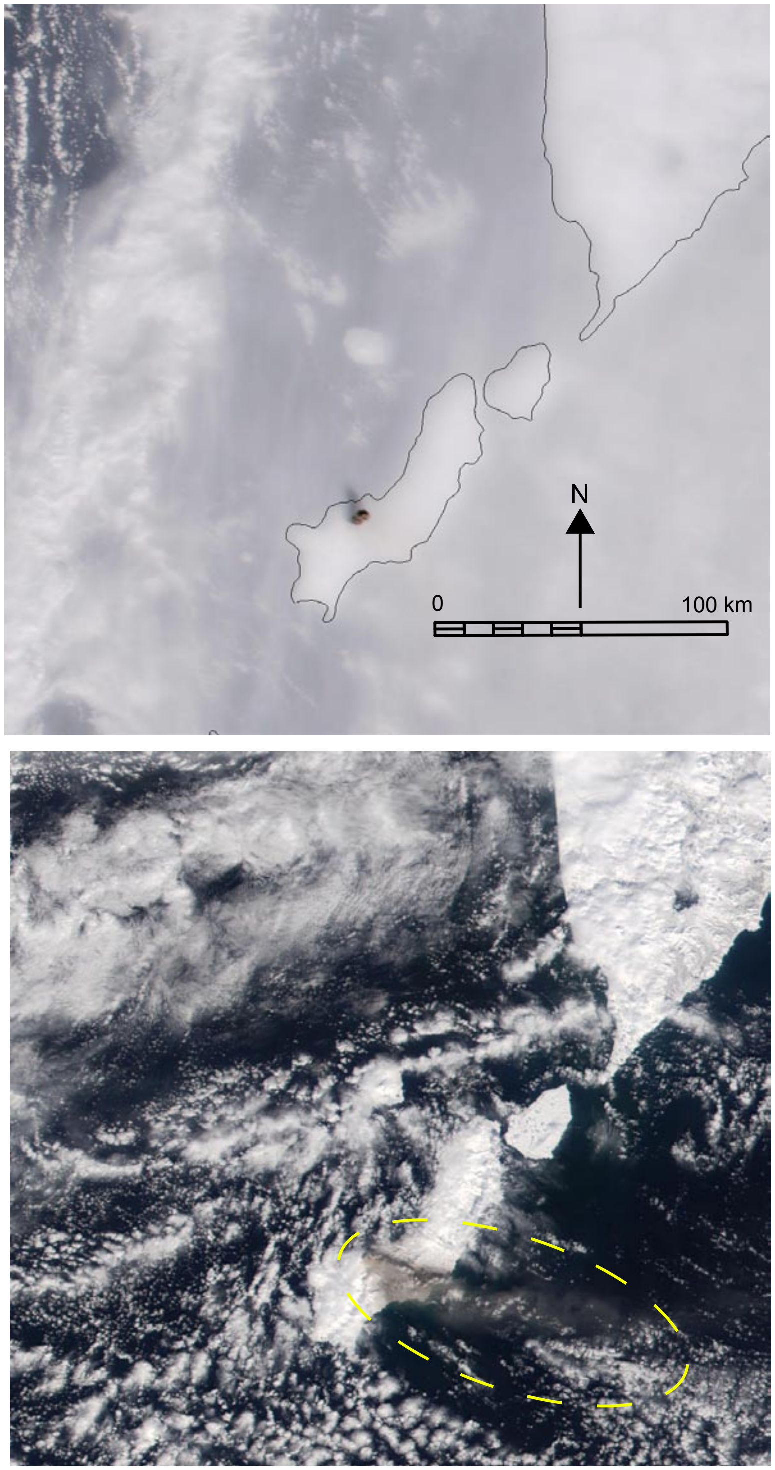

Figure 19. 250-m-resolution MODIS images of the Chikurachki eruption in 2002. a. February 24, 2002 image showing the vertical ash plume rising from Chikurachki, puncturing the regional cloud cover, and casting a dramatic shadow to the north. The southern tip of the Kamchatka Peninsula is visible in the upper right. b. March 18, 2002 image of the northern Kuriles and southern Kamchatka Peninsula. Ash plume from Chikurachki drifting east of Parmushir Island over the Pacific Ocean (dashed circle encloses visible plume). MODIS image courtesy U.S. Air Force.

KVERT issued four information releases about the eruption from February 4 through February 28. AVO relayed this information as it was received, and responded to inquiries for additional information and map data regarding Chikurachki.

Chikurachki is the highest volcano on Paramushir Island in the northern Kuriles. It is not monitored seismically, and few people live nearby, so ground-based information about the volcano is informal and intermittent. Situated 105 km (~65 mi) southwest of the tip of the Kamchatkan Peninsula, the volcanic cone of Chikurachki is distinctively red due to the abundance of oxidized basaltic andesite scoria on its upper flanks (fig. 20; Gorshkov, 1958; Simkin and Siebert, 1994). There are at least six known historical eruptions attributed to Chikurachki, including its largest historical eruption of ~1 km3 in 1853. Prior to 2002, its most recent eruption was in 1986 and included production of lava flows, pyroclastic avalanches, and significant local tephra accumulation (Ovsyannikov and Muraviev, 1992).

Figure 20. Chikurachki Volcano. View of the northwest flank of the 1,816-m-high volcano rising from the Sea of Okhotsk (fig. 18). The Karpinsky range of six volcanic centers is located on the right horizon immediately to the south of Chikurachki. Photo by Yoshihiro Ishizuka, 2000 (Hokkaido University), used with permission.

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Table 1. Summary of 2002 VOLCANIC ACTIVITY in Alaska, including actual eruptions, possible eruptions, and unusual increases in seismicity or fumarolic activity. Location of volcanoes shown in Figure 1.

VOLCANO	DATE OF ACTIVITY	TYPE OF ACTIVITY
Veniaminof Volcano	Early September – late December (?) 2002	Intermittent tremor and low-frequency seismicity, occasional phreatic (?) explosions at the intracaldera cone produce localized ash fall within the summit caldera.
Great Sitkin Volcano	May 27 – 29, 2002	Seismic swarm and tremor episode.

Table 2. Summary of SUSPECT VOLCANIC ACTIVITY (SVA) in 2002. SVA is defined as a report of eruption or possible eruption determined with some degree of confidence to be normal fumarolic activity or other non-volcanic process. Location of volcanoes shown in Figure 1.

VOLCANO	DATE OF ACTIVITY	TYPE OF ACTIVITY
Wrangell Volcano	Early August 2002	Vigorous fumarolic plumes containing minor ash; possible explosive phreatic activity (?).
Katmai Area (Martin, Mageik?)	December 11, 2002	Vigorous fumarolic plume; subsequent pilot report prompts UUA.
Hague Volcano	Late 2001 into 2002	Increased fumarolic activity, steam plumes.
Shishaldin Volcano	Mid-May, August 16, 2002	Shallow seismicity at the volcano. Pilot report of plume and possible eruption prompts SIGMET.

Table 3. Reports from observers and residents near Veniaminof Volcano in 2002, many received via email. Original communications have been condensed and paraphrased slightly. All times are local. See figs. 1 and 5 for map of communities mentioned below.

DATE	COMMENT
9/11	Perryville: Mountain has been visible for the past few days, no activity noted. Other Perryville observer says the intracaldera cone looked darker this morning than usual, but no 'smoke' coming from cone. Port Heiden: No views of the volcano. Chignik: Nothing unusual to report.
9/19	Perryville: "No visible smoke or activity during a fly-by. Last week the rivers (which are normally clearer this time of the year) were muddy. Also, a spring was flooding over which was very unusual. However, when I flew back yesterday the rivers seemed clearer."
9/24 (0900)	Perryville: Clear above volcano right now, but puffing 'white and black' every 5 minutes or so to just above the cone. Haven't seen the volcano for a few days due to weather. This activity is more vigorous than what he saw last week which he said was just white steam; looks like it is 'throwing up balls of black' Perryville: 'Poofing' out the top of the cone, solid white, going straight up a few inches by her eye, high clouds in area.
9/24	Peninsula Airways, King Salmon: None of their pilots have noticed anything at Veni today or in the past few days. 9/24 afternoon Perryville: Volcano was 'shooting black stuff' this morning.
10/2	Alaska State Troopers: Nothing coming up through the clouds at the top of the mountain.

DATE	COMMENT
Table 3 - Continued	
10/2	Perryville: Confirmed reports of smoke last night around 9pm. It was clear today, but the smoke stopped. Several people in the village reported a ‘plume of smoke’ between about 8 and 10 pm on 10/1. One report of audible ‘rumbling’. No reports of red/orange/’fire’.
10/2	Arctic Circle Air: No obvious signs of activity at Veniaminof about midday today when they passed nearby.
10/3	Alaska State Troopers: Flew by it again yesterday on the way back to ANC and all was calm and no activity.
10/9	Alaska State Troopers: The mountain of interest was clear and no activity visible of any kind.
10/15	Sandy River Lodge: Ground shaking felt throughout a ‘day long eruption’ week before last (Oct 5). Black ash and “smoke” to 400-500 ft above the cone, hearing explosions.
10/26	Perryville: Crystal clear morning, no wind in Perryville, and there was definite smoke seen by everyone, drifting east from the main caldron. Students saw ‘smoking’ at volcano at daybreak; again from about 1000-1030 am, then it stopped, then ‘smoking’ again about 12:10. ‘Smoke’ is actually white to whitish gray in color, not brown/black/dark. One student described it as ‘what happens when something hot touches something cold’. No reports of incandescence in pre-dawn, no rumbling, no noise.
10/26	Peninsula Airways, King Salmon: Clear views of the volcano: no activity other than ‘the normal steaming like it always does’. No ash noted.

DATE	COMMENT
Table 3 - Continued	
11/12	Perryville: Nice weather lately, no sounds or sign of activity.
12/15	Perryville: Good visibility the last several days here, occasional smoke, some of which is darker gray than the normal steam. No shaking.
12/18	Perryville: ‘Black smoke’ from the cone.
12/21-23	Perryville: Fairly clear, and the intracaldera cone “was covered with ash and there was darkened snow all around the cone”. It was ‘smoking’ pretty good and they saw a ‘trail of smoke’ in the sky. Described ‘on and off belching.’’ No audible rumbling, no incandescence.
12/23	Perryville: Mid-December, mostly steam, dissipating quickly. This past weekend (Dec 21-22), fairly clear, and the intracaldera cone “was covered with ash and there was darkened snow all around the cone”. It was ‘smoking’ pretty good and they saw a ‘trail of smoke’ in the sky. Described ‘on and off belching’’ No audible rumbling, no incandescence.

Table 4. Kamchatkan and northern Kurile volcanoes considered seismically monitored as of December 2002. Compiled by Sergey Senyukov, Kamchatka Experimental and Methodical Seismology Department (KEMSD), and C. Neal, Alaska Volcano Observatory.

VOLCANO	APPROXIMATE START DATE OF CONTINUOUS SEISMIC MONITORING BY KEMSD	OTHER MONITORING TECHNIQUES USED ROUTINELY
Sheveluch	Seismic station – 12.02.1987; Telemetered data – 1980; Digital format – Sep.1996; Near-real time processing – 1999	Near real-time video system (2002); direct observation from nearby Klyuchi; satellite imagery
Klyuchevskoy	Seismic station – 1961; Telemetered data– 1987; Digital format – Sep.1996; Near-real time processing – 1999	Near real-time video system (2000); direct observation from nearby Klyuchi and Kozyrevsk; satellite imagery
Bezymianny	Seismic station – 1961; Telemetered data – 31.10.1988; Digital format – Sep.1996; Near-real time processing – 1999	Direct observation from nearby Kozyrevsk; satellite imagery
Plosky Tolbachik	Seismic station – 12.01.1977; Telemetered data – 10.11.1990; Digital format – Sep.1996; Near-real time processing – 1999	Direct observation from nearby Kozyrevsk; satellite imagery
Karymsky	Telemetered data – Sep. 1989; Digital format – Jan.1996; Near-real time processing – 1996	Field observation; satellite imagery
Koryaksky	Seismic station – Apr.1963; Telemetered data – 1975; Digital format – Jan.1996; Near-real time processing – 1996	Direct observation from PK; satellite imagery

VOLCANO	APPROXIMATE START DATE OF CONTINUOUS SEISMIC MONITORING BY KEMSD	OTHER MONITORING TECHNIQUES USED ROUTINELY
Table 4 - Continued		
Avachinsky	Seismic station – Apr.1963; Telemetered data – July 1976; Digital format – Jan.1996; Near-real time processing – 1997	Direct observation from PK; satellite imagery
Gorely	Telemetered data – July 1980; Digital format – Jan.1996; Near-real time processing – 1996	Direct observation from PK; satellite imagery
Mutnovsky	Telemetered data – July 1980; Digital format – Jan.1996; Near-real time processing – 1996	Direct observation from PK; satellite imagery
Alaid	Telemetered data – Aug. 2001; Digital format – Aug. 2001; Near-real time processing – Aug. 2001	Satellite imagery

[1]Prior to 1979, other Russian scientific institutes maintained programs of volcano monitoring in Kamchatka (a partial listing includes: 1961-1971, Pacific Seismological Department of Institute of Earth Physics; 1972-1978 – Institute of Volcanology)

Table 5. Summary of VOLCANIC ACTIVITY on Kamchatka Peninsula and the northern Kurile Island of Paramushir, Russia, 2002. Location of volcanoes shown in Figure 11.

VOLCANO	DATE OF ACTIVITY	TYPE OF ACTIVITY
Sheveluch	Intermittently throughout 2002	Lava dome growth, short-lived, explosive episodes send ash as high as 8 km (~26,000 ft), pyroclastic flows, localized ash fall.
Klyuchevskoy	Intermittently throughout 2002	Periods of elevated seismicity, gas-rich burst in late December
Bezymianny	Intermittently throughout 2002; ash production related to lava effusion in late December.	Periods of increased seismicity, accelerated lava dome growth, explosions, ash plumes, pyroclastic avalanches.
Karymsky	Intermittently throughout 2002	Periods of increased seismicity continuation of low-level vulcanian and strombolian explosions, avalanches, degassing.
Chikurachki	January 25 – late April or May, 2002	Strombolian/subplinian eruption, ash plumes, ash fall

Table 6. Level of Concern Color Code for volcanic activity.

LEVEL OF CONCERN COLOR CODE	
To more concisely describe our level of concern about possible or ongoing eruptive activity at an Alaskan volcano, the Alaska Volcano Observatory uses the following color-coded classification system. Definitions of the colors reflect AVO's interpretations of the behavior of the volcano. Definitions are listed below followed by general description of typical activity associated with each color.	
GREEN	**No eruption anticipated.** Volcano is in quiet, "dormant" state.
YELLOW	**An eruption is possible in the next few weeks and may occur with little or no additional warning.** Small earthquakes detected locally and (or) increased levels of volcanic gas emissions.
ORANGE	**Explosive eruption is possible within a few days and may occur with little or no warning. Ash plume(s) not expected to reach 25,000 feet above sea level.** Increased numbers of local earthquakes. Extrusion of a lava dome or lava flows (non-explosive eruption) may be occurring.
RED	**Major explosive eruption expected within 24 hours. Large ash plume(s) expected to reach at least 25,000 feet above sea level.** Strong earthquake activity detected even at distant monitoring stations. Explosive eruption may be in progress.

GLOSSARY OF SELECTED TERMS AND ACRONYMS

AAWU:
"Alaska Aviation Weather Unit" of the National Weather Service

'a'a:
Hawaiian term for lava flows characterized by a rough, jagged, blocky surface, typically difficult to walk upon

ADT:
"Alaska Daylight Time"

AEIC:
"Alaska Earthquake Information Center"

ASL:
"above sea level"

AVO:
"Alaska Volcano Observatory"

AVHRR:
"Advanced Very High Resolution Radiometer"; AVHRR provides one form of satellite imagery

andesite:
volcanic rock composed of about 53 to 63 percent silica (SiO2, an essential constituent of most minerals found in rocks)

ash:
fine fragments (less than 2 millimeters across) of lava or rock formed in an explosive volcanic eruption

basalt:
general term for dark-colored igneous rock, usually extrusive, containing about 45 to 52 weight percent silica (SiO2, an essential constituent of most minerals found in rocks)

bomb:
boulder-size chunk of partly solidified lava explosively ejected from a volcano

caldera:
a large, roughly circular depression usually caused by volcanic collapse or explosion

CAVW:
Smithsonian Institute's "Catalog of Active Volcanoes of the World"

cinder cone:
small, steep-sided conical hill built mainly of cinder, spatter, and volcanic bombs

COSPEC:
"Correlation Spectrometer"; device for measuring sulfur dioxide emissions

FAA:
"Federal Aviation Administration"

fallout:
a general term for debris which falls to the earth from an eruption cloud

fault:
a fracture or zone of fractures along which there has been displacement of the sides relative to one another

FIR:
"Flight Information Region"

FLIR:
"Forward Looking Infrared Radiometer"; used to delineate objects of different temperature

fissure:
a roughly linear or sinuous crack or opening on a volcano; a type of vent which commonly produces lava fountains and flows

fumarole:
a small opening or vent from which hot gases are emitted

glaciolacustrine:
pertaining to sediments deposited in glacial lakes, and resulting landforms

GMS:
"Geostationary Meteorological Satellite"

GVN:
"Global Volcanism Network"

Holocene:
geologic epoch extending from the present to 10,000 years ago

incandescent:
glowing red or orange due to high temperature

intracaldera:
refers to something within the caldera

IVGG:
Russian “Institute of Volcanic Geology and Geochemistry”

JMA:
“Japanese Meteorological Agency”

Ka:
Thousands of years before the present

KDT:
“Kamchatkan Daylight Time”, which = ADT + 21 hrs.

KEMSD:
Russian “Kamchatka Experimental and Methodical Seismology Department”

KVERT:
Russian “Kamchatkan Volcanic Eruption Response Team”

lapilli:
pyroclasts that are between 2 and 64 mm in diameter

lava:
when molten material reaches the earth’s surface, it is called lava

magma:
molten material below the surface of the earth

MODIS:
“Moderate Resolution Imaging Spectroradiometer”

NOAA:
“National Oceanic and Atmospheric Administration”

NOPAC:
“North Pacific Air Corridor”

NOTAM:
“Notice to Airmen”, a notice containing information [not known sufficiently in advance to publicize by other means] concerning the establishment, condition, or change in any component [facility, service, or procedure of, or hazard in the National Airspace System] the timely knowledge of which is essential to personnel concerned with flight operations

NWS:
"National Weather Service"

phreatic activity:
an explosive eruption caused by the sudden heating of ground water as it comes in contact with hot volcanic rock or magma

phreatic ash:
fine fragments of volcanic rock expelled during phreatic activity; this ash is usually derived from existing rock and not from new magma

PIREP:
"Pilot Weather Report - A report of meteorological phenomena encountered by aircraft in flight

pixel:
contraction of "picture element". A pixel is one of the many discrete rectangular elements that form a digital image or picture on a computer monitor or stored in memory. In a satellite image, resolution describes the size of a pixel in relation to area covered on the ground. More pixels per unit area on the ground means a higher resolution

Pleistocene:
geologic epoch extending from 2-3 million years ago to approximately 10,000 years before present

pumice-rich lapilli:
particles ejected during a volcanic eruption that are composed mostly of pumice and between 2 and 64 mm in size

pyroclast:
an individual particale ejected during a volcanic eruption; usually classified by size, e.g. ash, lapilli

regional earthquake:
earthquake generated by fracture or slippage along a fault; not caused by volcanic activity

RFE:
"Russian Far East"

SAB:
"Synoptic Analysis Branch" of NOAA

SAR:
"Synthetic Aperture Radar"

satellite cone:
a subsidiary volcanic vent located on the flank of a larger volcano

seismic swarm:
a flurry of closely spaced earthquakes or other ground shaking activity; often precedes an eruption

shield volcano:
a broad, gently sloping volcano usually composed of fluid, lava flows of basalt composition (e.g. Mauna Loa, Hawaii)

SIGMET:
"Significant Meteorological information statement", issued by NWS

stratovolcano:
(also called a stratocone or composite cone) a steep-sided volcano, usually conical in shape, built of interbedded lava flows and fragmental deposits from explosive eruptions

strombolian:
type of volcanic eruption characterized by intermittent bursts of fluid lava, usually basalt, from a vent or crater as gas bubbles rise through a conduit and burst at the surface

subplinian:
style of explosive eruptions characterized by vertical eruption columns and widespread dispersal of tephra

SVA:
"suspect volcanic activity"

tephra:
a general term covering all fragmental material expelled from a volcano (ash, bombs, cinders, etc.)

TFR:
"Temporary Flight Restriction", issued by FAA

USCG:
"United States Coast Guard"

USGS:
"United States Geological Survey"

UUA:
"Urgent pilot report"

UTC:
"Coordinated Universal Time"; same as Greenwich Mean Time (GMT)

VAAC:
"Volcanic Ash Advisory Center"

VAAS:
"Volcanic Ash Advisory Statement"

vent:
an opening in the earth's surface through which magma erupts or volcanic gasses are emitted

volcano-tectonic earthquakes:
earthquakes generated within a volcano from brittle rock failure resulting from strain induced by volcanic processes

UAFGI:
"University of Alaska Fairbanks Geophysical Institute"