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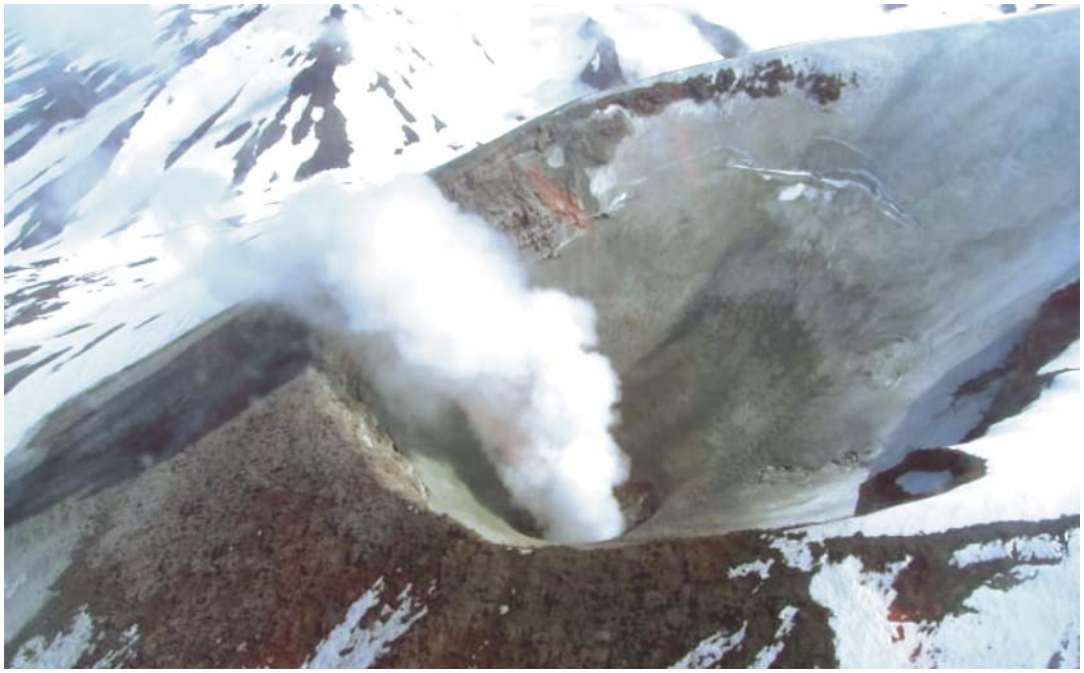

Open-File Report 03-423

U.S. Department of the Interior
U.S. Geological Survey

1998 Volcanic Activity in Alaska and Kamchatka: Summary of Events and Response of the Alaska Volcano Observatory

By Robert G. McGimsey[1], Christina A. Neal[1], and Olga Girina[2]

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Cover photo: Southern summit crater of Korovin Volcano and likely source of ash erupted during 1998. Photograph by Gene Yogodzinski summer 2002.

INTRODUCTION

The Alaska Volcano Observatory (AVO) monitors the more than 40 historically active volcanoes of the Aleutian Arc. Of these, 20 are monitored with short-period seismic instrument networks as of the end of 1998 (fig. 1 a,b). The AVO core monitoring program also includes daily analysis of satellite imagery, overflights, compilation of pilot reports and observations from local residents and ship crews. In 1998, AVO responded to eruptive activity or suspected volcanic activity at or near 7 volcanic centers (fig. 1 a,b; tables 1, 2); Shrub mud volcano, Augustine, Becharof Lake near Ukinrek Maars, Chiginagak, Shishaldin, Akutan, and Korovin.

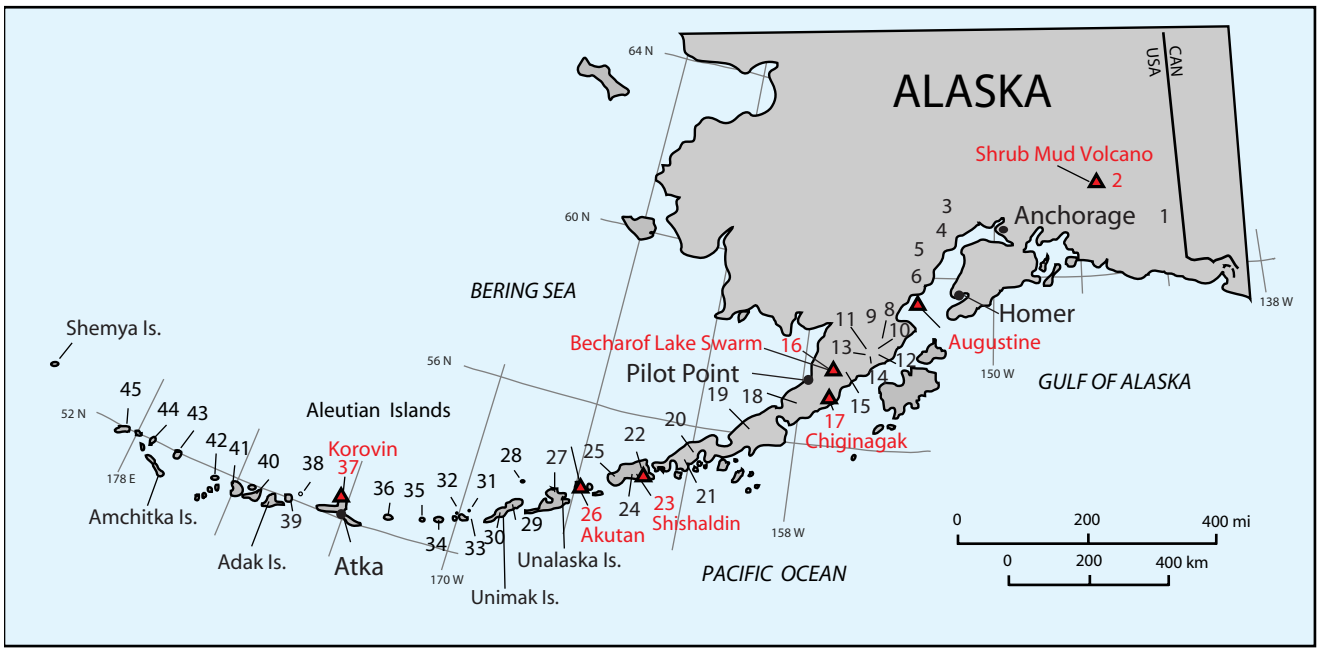
In addition to responding to eruptive activity at Alaska volcanoes, AVO assisted in the dissemination of information for the Kamchatkan Volcanic Eruption Response Team (KVERT) about the 1998 activity of 4 Russian volcanoes—Sheveluch, Klyuchevskoy, Bezymianny, and Karymsky (fig. 10; table 3). Due to prevailing wind directions, Kamchatkan volcanoes pose a serious threat to aircraft in the North Pacific (fig. 11).

This report summarizes volcanic activity and AVO responses during 1998, as well as information on the reported activity at Russian volcanoes. Only those reports or inquiries that resulted in a "significant" investment of staff time and energy (here defined as several hours or more for reaction, tracking, and follow-up) are included. AVO typically receives dozens of reports throughout the year of steaming, unusual cloud sightings, or eruption rumors. Most of these are resolved quickly and are not tabulated here as part of the 1998 response record. On rare occasions, AVO issues an information release to dispel rumors of volcanic activity; an example of this occurred on March 27, 1998, when an unusual weather cloud over Mount Spurr volcano prompted many calls. The phrase "suspect volcanic activity" (SVA), used to characterize several responses, is an eruption report or report of unusual activity that is subsequently determined to be normal or enhanced fumarolic activity, weather-related phenomena, or a non-volcanic event.

The Catalog of Active Volcanoes of the World (CAVW) numbers are provided for referencing the Smithsonian Institute files. Descriptions of volcanic activity and AVO responses are presented 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), or Kamchatkan Standard Time (KST), Kamchatkan Daylight Time (KDT) (see glossary). We have chosen to preserve English units of measurements when used in primary observations of distance or elevation such as those commonly received via pilot reports and aviation authorities in the United States. A summary of volcanic activity is presented in Table 1. SVA that required significant responses are summarized in Table 2. Table 3 summarizes volcanic activity and responses in Kamchatka. Information on 1998 responses is compiled from AVO weekly updates and information releases, internal bimonthly reports, the AVO 1998 "Chron book"--a chronological collection of daily or weekly staff notes for a particular year--and the Smithsonian Institution Global Volcanism Network Bulletin (GVN), which uses AVO as the source for reports on Alaska volcanoes.

AVO's response to reported remote volcanic activity varies depending on the source and content of the observation. After receiving a report and possibly conducting a follow-up investigation of the factual information, AVO usually contacts the National Weather Service (NWS) and Federal

Aviation Administration (FAA) or local residents for corroboration and/or formal notification. For a verified significant eruption or unrest, an established call-down procedure is initiated to formally notify other government agencies, air carriers, facilities at risk, and the media. If an eruption or unrest is no longer suspected, a notation is made in AVO files and no further action is taken. 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.



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. Semisepochnoi
44. Little Sitkin
45. Kiska

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

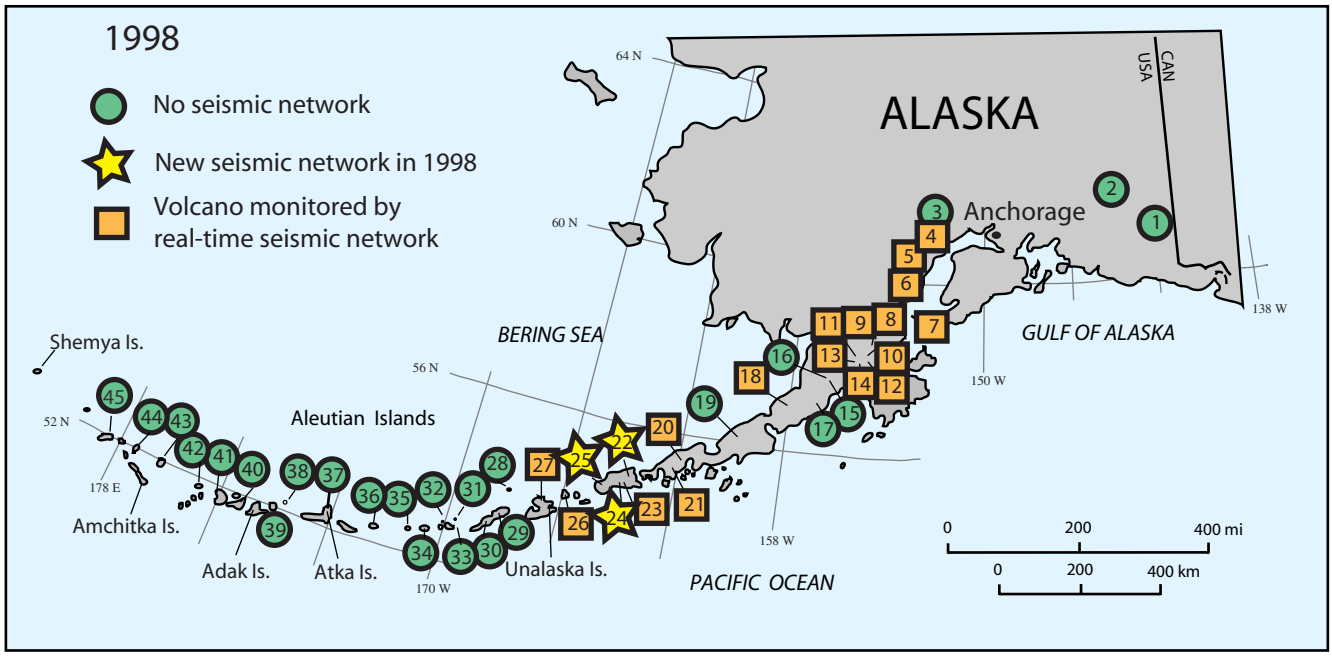


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Figure 1b. Map showing those volcanoes monitored with a seismic network as of the end of 1998. Volcanoes with no documented historical unrest but currently considered hazardous based on late-Holocene eruptive activity are italicized.

VOLCANIC ACTIVITY IN ALASKA

NORTHEAST TO SOUTHWEST ALONG ALEUTIAN ARC

SHRUB MUD VOLCANO
62°08'N 145°02'W
897 m (2,943 ft)

ERUPTION continues.
Emission of warm saline mud and CO_2, but at a reduced rate relative to 1997.

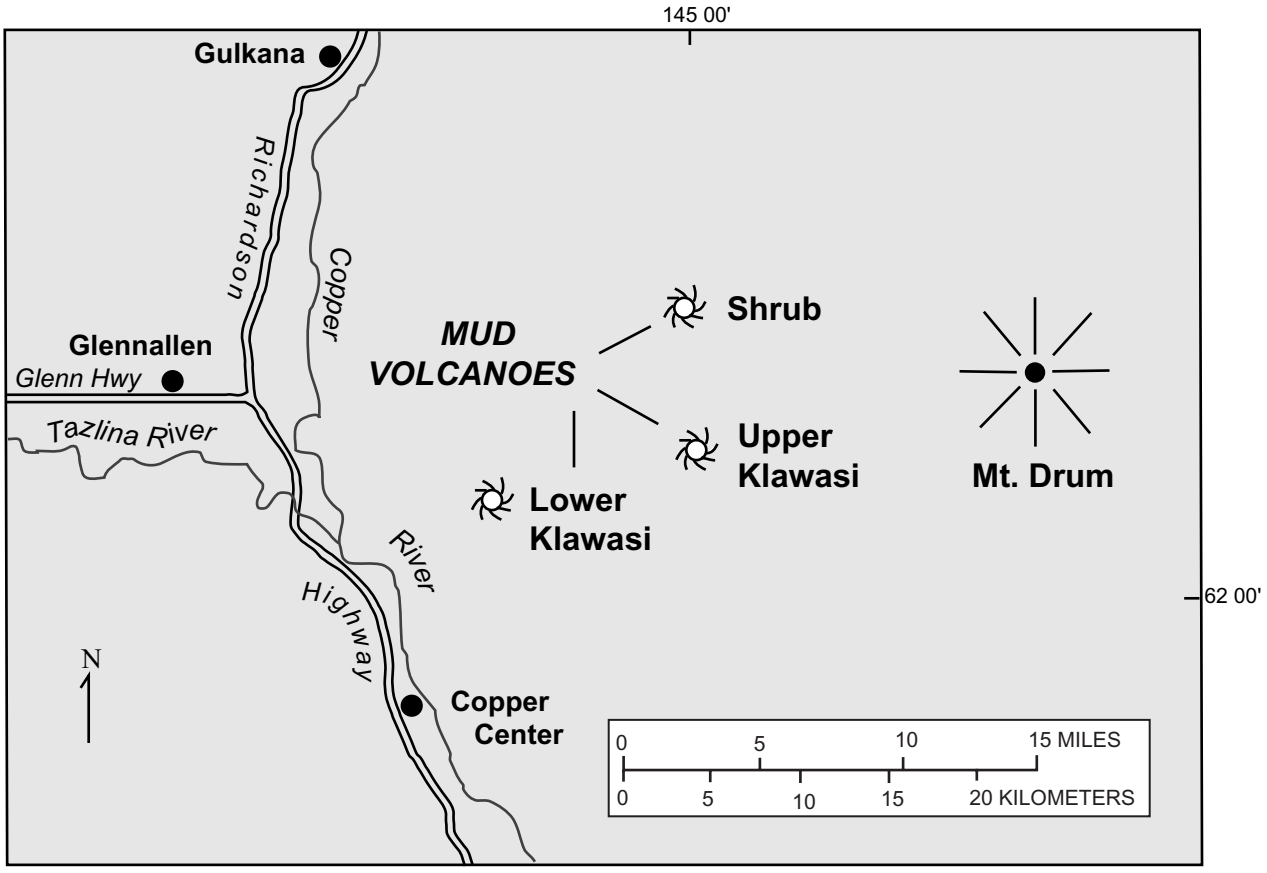

Figure 2. Location Map for Shrub and Klawasi Mud Volcanoes (from Richter and others, 1998a).

Shrub is one of three large mud volcanoes of the Klawasi group located approximately 17 mi (27 km) east of Glennallen near the west slope of Mt. Drum, a Pleistocene volcano in the Copper River Basin of south-central Alaska (fig. 2). The area is within Wrangell-St. Elias National Park and Preserve. Shrub rises 104 m (340 ft) above the surrounding terrain and is composed of deposits derived from underlying glaciolacustrine sediments of the Basin (fig. 3; Richter and others, 1998a). Low-level mud and minor gas emission has historically been almost constant at the other two mud volcanoes. However, Shrub has been virtually inactive for decades, with only some

minor discharge observed in the mid-1950's (Nichols and Yehle, 1961). During the spring of 1997, Shrub began to vigorously erupt CO_2-rich gas and warm saline mud (Richter and others, 1998a). The activity continued throughout 1997 (McGimsey and Wallace, 1999).

Figure 3. Oblique aerial view of Shrub mud volcano, August 13, 1997.

Shrub mud volcano was visited on July 31, 1998, as part of an informal joint National Park Service (NPS) and U.S. Geological Survey project to monitor the activity that began in the spring of 1997. All of the known vent areas were visited and temperatures measured, and several new vents were discovered and documented. The following is an excerpt from an unpublished report by D. Richter describing the 1998 visit to the mud volcano: “The level of activity remains high. Total amount of mud production at the volcano is probably about the same as in August 1997. However, production at the main vent area (fig. 4) is considerably less than the rate observed in 1997. A very noticeable change is the nature of the eruptive activity. The violent discharge of mud and gas that was typical of the 1997 activity was not observed in this visit, rather all presently active vents were quietly discharging mud and gas from bubbling mud pools or ponds. Temperatures as high as 49.9°C-more than 2°C higher than those of June and August 1997-were measured. Approximately 500,000 m^3 of mud have been erupted since activity began in the spring of 1997.” New aerial photography flown on August 14, 1998, was used to more precisely map the extent of mud deposits and vent locations (fig. 4.)

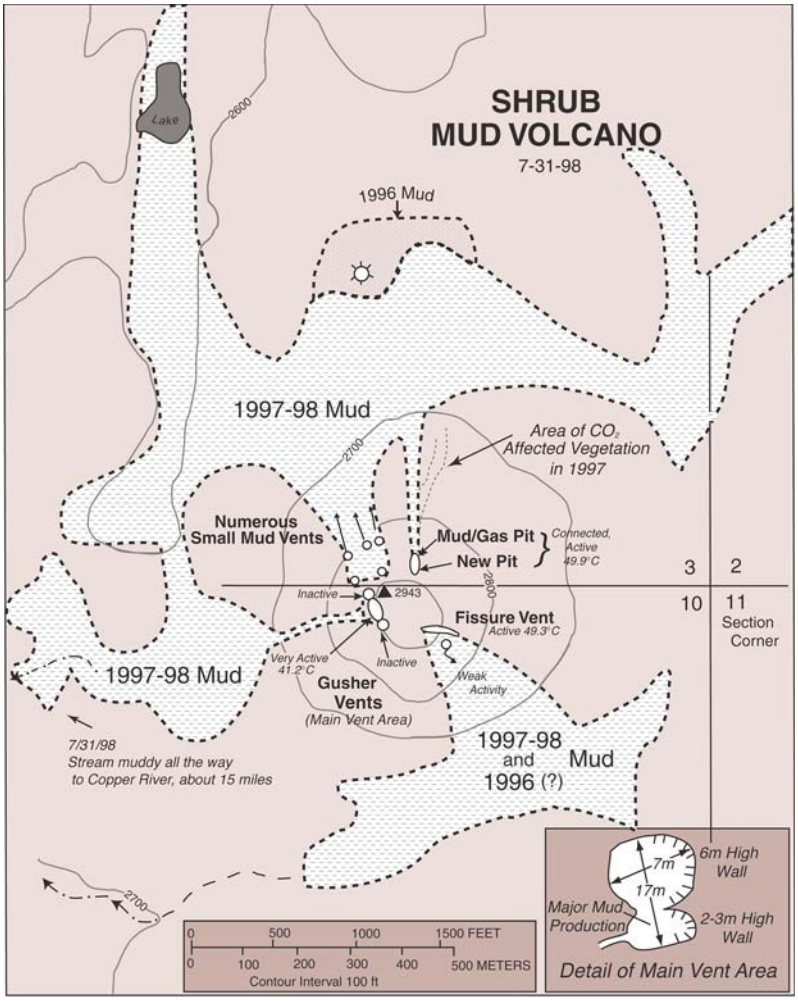

Figure 4. Sketch map showing major CO_2 and mud vents, and distribution of mud deposits (August 14, 1998), and temperature of erupting mud (July 31, 1998). Map made by D.H. Richter using aerial photographs taken on August 14, 1998.

AUGUSTINE VOLCANO
59°23'N 153°26'W
1,260 m (4,134 ft)

SUSPECT VOLCANIC ACTIVITY.
Spine from 1986 summit lava dome collapses and generates mudflow.

On July 12, 1998, charter pilots from Homer who routinely fly by Augustine noted fingers of mud up to about 250 ft wide (76 m) extending down from the cloud-enshrouded summit to snowfields on the upper north-northeastern flank. Other snowfields near the summit were discolored by fine gray ash deposits. One particular flow of pinkish muddy material had reached the sea.

AVO received this information on July 13 and immediately canvassed the seismic, tiltmeter, and temperature sensor data for the previous several days. Rockfall and small avalanches are a common, if not everyday, occurrence on Augustine and have recognizable seismic signatures. The seismic records for July 10 showed a larger than usual avalanche event at 21:23 ADT that lasted at least 30 seconds. On July 14, the same charter pilots flew by Augustine—this time during clear weather—they reported that a portion of the spine that was extruded from the summit dome in 1986 (fig. 5) had collapsed and was the apparent source of the small mudflows observed several days earlier. They also reported that the volcano seemed to be steaming more than usual. AVO geophysicist John Power measured fumarole temperatures near the base of the toppled spine later in July and reported temperatures of 93.8 and 96.9^{o}C, similar to those measured in 1997.

Figure 5. Summit lava dome complex at Augustine Volcano. The aprone of pyroclastic debris extending from the summit lava dome accumulated during the 1986 eruptions. The sharp spine on the 1986 lava dome was last viewed intact by AVO scientists during an observation flight on March 11, 1998. Wispy steam was rising from the base of the spine. View is to the south. Photography by T. Miller, USGS, April 28, 1986. From the collection published online as: http://wrgis.wr.usgs.gov/dds/dds-39/

Augustine volcano forms an island situated at the mouth of Cook Inlet. The stratocone has steep flanks of volcaniclastic debris and is topped with a large dome from the 1986 eruption as well as a cluster of dome remnants from previous historical eruptions. The nearest city is Homer, located approximately 100 km (62 miles) northeast across Cook Inlet.

BECHAROF LAKE AREA
10-20 km (6-12 miles) NW of Ukinrek Maars (57°50'N 156°30'W)

INTENSE SEISMIC SWARM
Swarm of strong, shallow, tectonic earthquakes begins May 8, 1998; earthquakes related to the swarm detected into October. No eruptive activity.

A shallow (less than 5 km or 3 mi) earthquake swarm began beneath the southwestern portion of Becharof Lake on May 8 and continued through mid-June (fig. 6; Lu and others, 2002). The initial event was a M_L 5.2 earthquake felt strongly in nearby communities and at a remote environmental educational field camp operated by the U.S. Fish and Wildlife Service (USFWS). A USFWS overflight on the evening of May 8 noted nothing significant at the surface with the possible exception of a small landslide on an unspecified flank of Mount Peulik.

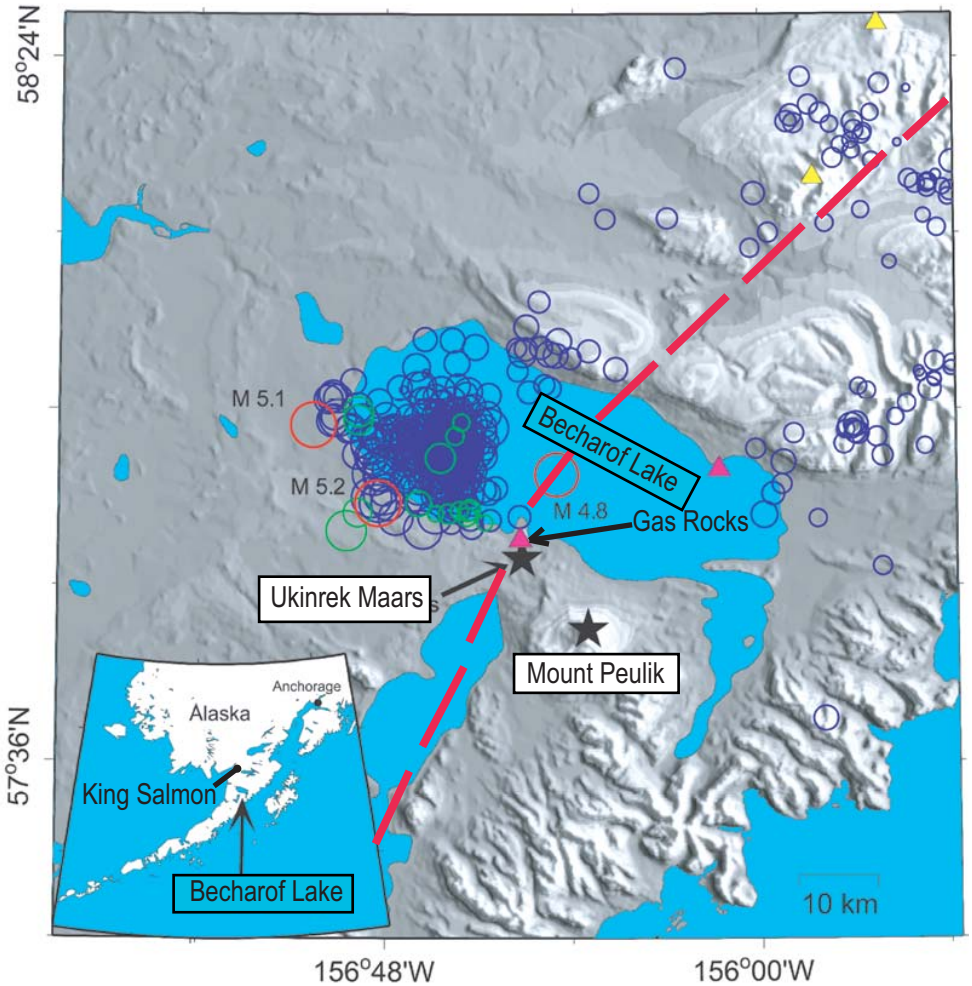

Figure 6. Earthquakes of the Becharof Lake swarm between May 8 and October 19, 1998. Red circles show locations of the three largest events. Pink triangles represent two temporary seismic stations deployed May 14-16, 1998. Yellow triangles represent two seismic stations from the Katmai network. Dashed line shows approximate position of the Bruin Bay Fault (Detterman and others, 1987). Modified from Lu and others (2002).

On May 9, AVO staff conducted an overflight by USFWS fixed wing aircraft. Observers reported slightly discolored water in the larger of the two Ukinrek Maars (fig. 6) and speculated that it was due to influx of debris from the steep crater walls or disruption of sediment in the lake itself during the strong ground shaking. Observers also noted small bank-failures along the southwest shore of Becharof Lake, also likely caused by ground shaking, that produced small sediment plumes extending from the bank. Slightly offshore, observers noted several aquamarine patches of clays (?) exposed on the lake bottom, a few of which had sediment plumes trailing parallel to shore (fig. 7). We do not know if these are new features, or what, if anything, they may signify. No significant changes at Peulik or at the known areas of CO_2 degassing around Gas Rocks, both on and offshore, were observed.

Figure 7. Sediment plume (arrow) just off the southwest shoreline of Becharof Lake. Photograph taken during AVO overflight on May 9, 1998.

The Alaska Earthquake Information Center (AEIC) and AVO deployed two temporary seismic stations in the area on May 14-16 (fig. 6). AVO remote sensing staff examined images of the area throughout the period of concern but did not detect any unusual thermal anomalies. It is likely that this swarm was both tectonic and volcanic in nature; research into the event continues.

The intense portion of the swarm prompted a significant amount of concern in local communities because of the number of felt earthquakes closely spaced in time. AVO received many phone calls from residents as well as land managers of the National Park Service and USFWS. Rumors of an eruption at Peulik persisted for several days. At least one air carrier called for information. A joint information release under the auspices of the AEIC and AVO was prepared on May 12, and AVO issued six of its own information release notices from May 15 – June 12.

Becharof Lake is located on the Alaska Peninsula 80 km (50 mi) south of the Bristol Bay community of King Salmon (figs. 1, 6). Historically active Peulik Volcano rises above the southeastern

shore. The Ukinrek Maars, a pair of phreatomagmatic explosion craters formed in 1977, are located about 1.5 km (1 mi) south of Becharof Lake and 12 km (7.5 mi) northwest of Peulik volcano (fig. 6). Another prominent feature located on the south shore of Becharof Lake, about 3.2 km (2 mi) north of Ukinrek Maars, is Gas Rocks, a rocky volcanic promontory with vigorously degassing CO_2 vents along the lakeshore and in shallow water immediately offshore (Symonds and others, 1996). The lake lies over a major NE-SW tectonic feature--the Bruin Bay Fault—which is inferred to continue south and west of Gas Rocks and the Ukinrek Maars (fig. 6; Determan and others, 1987).

CHIGINAGAK VOLCANO
CAVW #1102-11
57°08'N 157°00'W
2,135 m (7,005 ft)

CONTINUATION OF INCREASED FUMAROLIC ACTIVITY
Steam emissions from new (1997) fumarole field and strong sulfur smell

In October 1997, following pilot reports of increased steaming and the presence of a thermal anomaly on satellite imagery, AVO scientists traveled by fixed-wing aircraft to the volcano and observed an enlarged area of fumarolic activity and new fumaroles on the north flank of the volcano (McGimsey and Wallace, 1999). A second observation flight was conducted on March 11, 1998. Winds were relatively calm but the areas of interest were largely obscured. However, observers noticed an absence of steam emissions from the area where the lower fumaroles had been located. Bulbous white clouds lingered above the area of the new fumaroles. A very strong sulfur smell—much stronger than that from the fall of 1997—was reported, as well as a yellow color to the ice that formed on the plane's windows. AVO received no further reports until August 13, 1998, when USFWS personnel and a resident of Pilot Point (fig. 1a) observed little clouds of "black smoke" accompanied by a "greenish-yellow gas" rising from two point sources to about 500 to 1,000 ft (~150 to 300 m) above the mountain. A dusting of dark material was observed on fresh snow on the upper flanks of the volcano the next morning. On August 15, AVO detected a 30-km-long (19 mi) plume extending east from the volcano. Although the plume contained no ash signal, this was the first time a plume had been observed in satellite imagery of Chiginagak.

On September 29, 1998, AVO conducted an airborne ultraviolet correlation spectrometer (COSPEC) flight to Chiginagak and measured between 200-300 tonnes per day of SO_2 emanating from the fumarolic field. Observers reported a vigorous fumarole at an estimated 1,980 m (6,500 ft) elevation on the north flank, adjacent discolored ice and snow, and a strong sulphur smell (fig. 8). The weaker, second fumarole reported in October 1997 was no longer present.

Figure 8. Oblique aerial view of Chiginigak Volcano showing long term, active fumarolic area and likely source of the SO_2 plume measured by AVO in September, 1998. View to the south. Photograph by S.C. Moran, USGS, September 29, 1998.

AVO described the activity at Chiginagak in the weekly updates of January 2 and 9, 1998 (continued from 1997), and August 14 and 21, 1998. Although no formal call-downs occurred, AVO shared information informally with the FAA following the August activity. AVO maintained contact with local residents and USFWS personnel throughout the year, and AVO closely monitored satellite imagery for signs of increased activity.

Chiginagak is a symmetric stratovolcano located 175 km (110 mi) south of King Salmon on the Alaska Peninsula. The nearest settlement is Pilot Point, 60 km (37 mi) to the northwest (fig. 1a). The upper half of the volcano is snow- and ice-covered, and a prominent fumarole located high on the north flank constantly emits steam and sulfur gases. Historic eruptive activity has been minor and remains poorly documented. However, the volcano is surrounded by late-Holocene pyroclastic deposits and lava flows. Chiginagak is unmonitored by seismic instruments.

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

MINOR ERUPTIVE ACTIVITY
Small steam and possible ash plume November 4, 1998

On November 4, 1998, AVO received word from the U.S. Coast Guard (USCG) of a possible ash plume above the summit crater of Shishaldin Volcano. The report reads, "Ash and smoke extending up to 100 ft above volcano vent; dark in color. Puffs approximately 10 minutes apart." This type of activity is typical of Shishaldin and probably reflects a continuing high-level heat source and intermittent phreatic explosive activity within the summit crater.

Shishaldin Volcano, located about 1,100 km (680 mi) southwest of Anchorage near the center of Unimak Island, 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 last significant eruptive period occurred in 1986-87 and consisted of steam and minor ash emission. Strombolian eruptions and ash and steam emissions characterize most of the documented eruptive activity at Shishaldin Volcano. Nearly constant fumarolic activity within the summit crater produces a steam plume that can occasionally be quite vigorous and typically results in numerous false eruption reports. The nearest community is False Pass, 32 km (20 mi) east-northeast of the volcano.

AKUTAN VOLCANO
CAVW #1101-32
54°08'N 165°58'W
1,303 m (4,275 ft)

SUSPECT VOLCANIC ACTIVITY
Tremor-like seismicity, lightning, March and April, 1998

On March 26, 1998, AVO received phone calls from the Trident seafood processing plant in Akutan reporting lightning and a possible steam cloud over the summit of the volcano. At the same time, an increase in high-frequency seismicity was detected. The tremor-like seismic signal was confined to a single station. A strong storm with high winds was passing through the region and AVO ultimately concluded that the seismic signals were weather-related.

Akutan is a small stratocone on the western portion of Akutan Island. The volcano is truncated by a 2-km-wide summit caldera that contains a small lake, intracaldera cone, and stagnant glacier (Richter and others, 1998b). It is one of the most active of Alaskan volcanoes with more than 20 recorded eruptions since 1790. Its last eruption was in 1992 although an intense seismic swarm in March 1996 was probably the result of a magmatic intrusion (Lu and others, 2000).

KOROVIN VOLCANO
CAVW #1101-16
52°23'N 174°09'W
1,533 m (5,030 ft)

ERUPTION
Small eruption with ash fall on June 30, 1998 closes seafood processing plant; mysterious ash cloud reported over Vancouver Island on July 10, 1998 may have been related to intermittent activity

On the morning of June 30, 1998, AVO received a call from the Village Public Safety Officer (VPSO) in the village of Atka with a report of a dark ash cloud rising to 30,000 feet. The VPSO had observed two separate clouds, the first at approximately 07:30 local (Hawaii-Aleutian Time Zone is one hour behind ADT) and the second at approximately 08:30 local. The second cloud was the larger of the two reaching an estimated 30,000 ft and tinted orange 'as if illuminated from within', according to another observer in Atka. At 11:15 local, AVO received a pilot report from a USCG C-130 aircraft in the vicinity who noted an apparent volcanic cloud reaching about 16,000 feet ASL. At 17:20 local, AVO received a United Airlines pilot report of a cloud to 30,000 feet near the volcano. Coincident satellite imagery did not show an obvious volcanic cloud, however a plume-like meteorologic cloud was evident.

The Atka VPSO stated further that both events produced dustings of ash in Atka, the first coarser-grained than the second. AVO also learned that an individual had observed a dark ash plume over Korovin two days earlier on June 28. In addition, a commercial pilot very familiar with the volcanoes in the Aleutians contacted AVO to report his mid-May observation of the 'southeast slope blackened by ash' during a fly-by on May 10. He had not seen this during the previous week and speculated that it had occurred only a few days prior to May 10 because of weather conditions and wind directions. Thus, the timing of this activity remains poorly constrained; intermittent ash emission may, in fact, have occurred for weeks or prior to June 30.

AVO conducted a call-down after receiving the initial report from Atka and solicited pilot reports from the FAA. FAA officials issued a Significant Meteorological Information statement (SIGMET), a Temporary Flight Restriction (TFR) around the volcano (20 mi radius from sea level to 25,000 ft) and decided to route aircraft well to the north of Korovin. The Atka Pride Seafood processing plant was closed for the day out of concern for the effects of ash on workers and the quality of fish. Reeve Aleutian Airways had an airplane en route from Dutch Harbor to Adak when the late afternoon pilot report of a cloud to 35,000 feet was received. Based on the report, the Reeve plane returned to Dutch Harbor. The Marine Radio Operator issued an ash advisory to mariners in the vicinity of Atka.

Over the next several days, poor weather largely precluded any good views of the volcano. One Atka observer reported a 'rusty' cloud estimated to reach 16,000 feet ASL moving southeast from the volcano on the evening of July 2. On July 3, a pilot familiar with the volcano reported profuse

steaming from the summit crater, typical of the past few months (cover photo). He noted new ash on the south, southeast, and east flanks. A thin trail of ash extended to the southwest, towards the village of Atka. On July 8, AVO noted minor, weakly ash-bearing clouds over Korovin on Advanced Very High Resolution Radiometer (AVHRR) satellite images. On July 10, Environment Canada contacted AVO to relay a pilot report of a possible ash cloud over the general vicinity of Vancouver Island; a number of SIGMETs and other official notices were released. Several additional pilot reports of possible ash were logged by Canadian aviation authorities who also recorded many aircraft diversions in Canadian airspace. It remains possible that this cloud was related to an undetected Korovin eruption several days prior to the pilot report. A more likely scenario, however, is that smoke from numerous fires in the heavily forested area of western Canada and even Siberia generated a far-traveled haze mistaken for volcanic ash (Little and others, 1999).

Over the course of this episode of unrest, AVO issued Information Releases on June 30 and July 1, and mentioned Korovin in the Weekly Updates of July 3 and July 10.

Figure 9. Korovin Volcano, Atka Island. 1,533 m high, Korovin is a historically active stratovolcano that has grown within an older caldera. This oblique aerial view is to the south. Photograph by Gene Yogodozinski, summer, 2002.

Korovin is an historically active stratovolcano (fig. 9) that forms the northern peninsula of Atka Island in the Central Aleutians, 1,760 km (1,100 miles) southwest of Anchorage and 540 km (330 mi) west of Dutch Harbor. The village of Atka lies 21 km (13 mi) south of Korovin. The summit of the volcano is marked by two summit craters. The more active of the two is south of the main summit (cover photo). Fumarolic activity from vents in the bottom of this crater, presumed to be the source of the 1998 activity, is common. Prior to its 1998 unrest, the last reported eruption at Korovin was in March 1987.

VOLCANIC ACTIVITY IN KAMCHATKA, RUSSIA

NORTH TO SOUTH

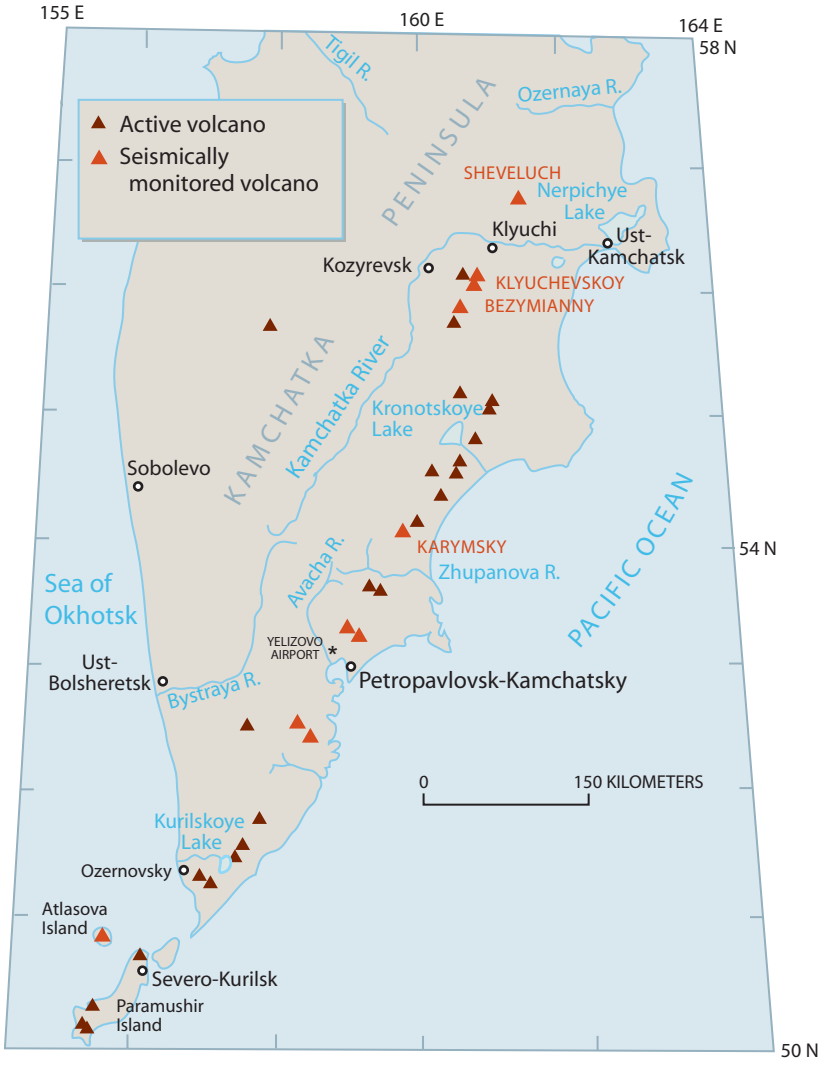

Figure 10. Location map for Kamchatkan volcanoes. Volcanoes discussed in this report are labeled in red text.

Twenty-nine active volcanoes on Russia's Kamchatka Peninsula pose a serious threat to aircraft in the North Pacific (figs. 10, 11). By agreement with the Institute of Volcanic Geology and Geochemistry (IVGG) and the Kamchatka Experimental and Methodical Seismology Department (KEMSD), 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 which AVO posts to our internet website and disseminates via facsimile and email to recipients of our Alaska Volcanoes weekly updates.

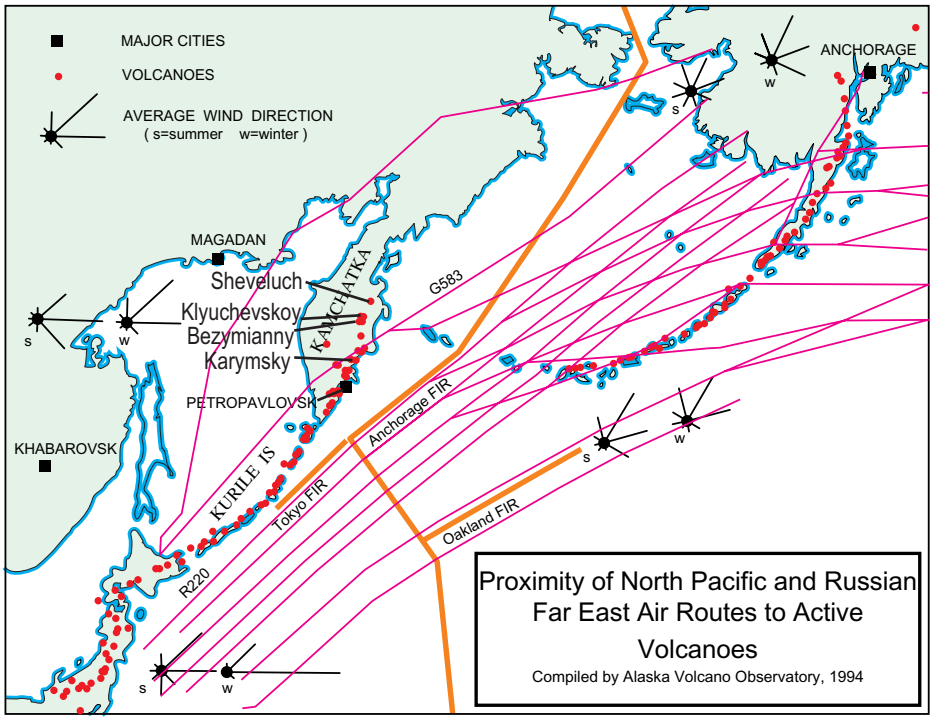

Figure 11. Location map for Sheveluch, Klyuchevskoy, Bezymianny, and Karymsky volcanoes on Kamchatka Peninsula and their proximity to North Pacific and Russian Far East air routes and Flight Information Region (FIR) boundaries for Anchorage, Tokyo, and Oakland Air Route Traffic Control Centers.

In 1998, AVO processed information about eruptions and volcanic unrest at 4 Kamchatkan volcanoes (Sheveluch, Kluchevskoy, Bezymianny, and Karymsky). The following summaries contain reported events according to 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 21 hours ahead of Alaska time. This compilation of summary descriptions is derived from a number of sources including KVERT weekly updates (available online at: http://www.avo.alaska.edu/avo4/updates/kvertarch.htm), AVO internal files and documentation, AVO bimonthly reports, and the Activity Reports of the Smithsonian Global Volcanism Program.

SHEVELUCH VOLCANO
CAVW #1000-27
56°38'N 161°21'E
3,283 m (10,768 ft)
elevation of active dome ~2,500 m

ERUPTON CONTINUES
Lava dome growth continued intermittently through 1998. Occasional fumarolic plumes over the volcano, periods of shallow seismicity and tremor. Three explosive episodes sent ash as high as 7.6 km (~25,000 ft) ASL and 135 km (~80 mi) downwind. One observation of pyroclastic flows.

Instability related to possible growth of the lava dome at Sheveluch Volcano continued at a low level throughout 1998. With the exception of a brief period following an explosion on May 30, KVERT maintained Level of Concern Color Code GREEN for most of the year.

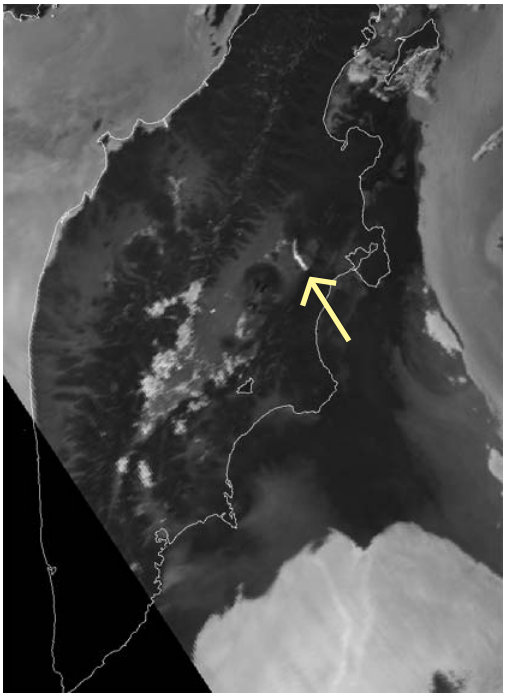

Figure 12. Small eruption plume (arrow) from Sheveluch Volcano on May 30, 1998, as captured in AVHRR Band 4 (thermal infrared). Plume is ~60 km long. Band 4-5 analysis indicated ash was present in this plume. Image courtesy Steve Smith, University of Alaska Fairbanks Geophysical Institute (UAFGI).

The late May event was first recognized by the Japanese Meteorological Agency (JMA) using satellite data from 0702 UTC on May 30. They noted an apparent ash cloud extending southeast in a

narrow, well-defined plume from the volcano (fig. 12). Both JMA and the NWS issued SIGMETs. Retrospective satellite image analysis by AVO showed first evidence of an ash cloud on a 0500 UTC GMS image. By 0630 UTC, the cloud was detached from the volcano, extended ~130 km (80 mi) downwind to the southeast, and contained some ash based on Band 4-5 subtraction. No thermal anomaly was noted at the volcano. The National Oceanic and Atmospheric Administration Synoptic Analysis Branch (NOAA/SAB) estimated the initial cloud height at 12 km (~40,000 ft ASL), however this was not confirmed and was likely an overestimate. KVERT reported an ash cloud height of 4 km (~13,000 ft) ASL based on visual observations. As noted in the May 30 KVERT Information Release, this short-lived explosive episode was characteristic of this period of dome growth at Sheveluch. Pilot reports the next day from the vicinity of the volcano and the ash cloud trajectory indicated no ash remaining in the atmosphere.

A second, short-lived explosive episode at Sheveluch in 1998 began at 1347 UTC on June 15. Since this was the middle of the night in Kamchatka, visual confirmation of an eruption cloud was impossible. However, based on the amplitude of seismicity, KVERT estimated a potential cloud height of 5 km (~16,000 ft) ASL. Satellite imagery from this time did not detect an ash cloud, however weather clouds may have obscured any low level ash.

A third explosive episode occurred at Sheveluch on September 3. JMA detected a small ash cloud in satellite imagery from about 0300 UTC and notified the Anchorage Volcanic Ash Advisor Center (VAAC) who then called AVO. The cloud was ~100 km (~60 mi) long and 20 km (~12 mi) wide and drifted to the northeast at an estimated altitude of 7.6 km (~25,000) feet ASL based on comparing the cloud motion with available wind field data. The cloud gradually dissipated and was no longer visible on imagery by 0130 UTC on September 4. KVERT and AVO received no pilot reports of any ash cloud sightings. No SIGMET was issued by NWS as the cloud dissipated prior to reaching US airspace. KVERT reported that this explosion was accompanied by a 9-minute long series of shallow earthquakes and tremor. Pyroclastic flows were shed across the growing debris fan that extends southwest from the active dome.

Low-level gas and steam emissions usually a few hundred meters but up to 1 km (~3300 ft) above the dome and trailing downwind for as much as several km characterized activity at the volcano for the remainder of the year. Seismicity oscillated between background and above-background levels, with periods of tremor and temporary increases in shallow activity noted. Some of these episodes may have been accompanied by explosions or minor ash-eruptions, however such activity was often obscured by poor weather.

Throughout 1998, AVO closely monitored satellite imagery and disseminated weekly KVERT updates and eruption information to the FAA and NWS. AVO also contacted KVERT by phone for clarification and information on a number of occasions.

Sheveluch Volcano is one of the largest and most active volcanoes in Kamchatka, with at least 60 large eruptions during the Holocene (Ponomerava and others, 1989; Belousov and others, 1999). The northernmost active volcano on the Peninsula, historical eruptive activity has been characterized by lava dome growth and explosive collapse, often producing debris avalanches. 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)

ERUPTION CONTINUES
Elevated seismicity, explosive events recorded at distant stations, persistent fumarolic plume from summit crater.

Klyuchevskoy Volcano remained restless in 1998 with brief periods of elevated seismicity, occasional ash explosions, and strong fumarolic emissions from the summit crater. KVERT changed the Level of Concern Color Code from GREEN to YELLOW 9 times during the course of the year, largely on the basis of sudden increases in seismicity.

Date of Color Code Change GREEN to YELLOW	Number of days subsequently at YELLOW before returning to GREEN
January 5, 1998	7
February 2, 1998	28
April 20, 1998	28
May 25, 1998	14
July 20, 1998	14
August 10, 1998	7
August 24, 1998	7
September 8, 1998	13
December 24, 1998	38

Throughout the year, earthquakes detected at Klyuchevskoy formed two spatial groups; deeper events clustering between 25-30 km below the volcano and shallow events as large as M2 near the summit. Volcanic tremor was also reported by KVERT on several occasions.

Two episodes of explosive activity at Klyuchevskoy produced ash plumes and localized ash fall deposits. The first occurred in late July when gas and ash explosions were observed over the summit reaching several hundred meters in elevation. A more powerful explosion that sent ash 4-5 km (13,000-16,000 ft) above the crater was observed on September 2. Ash fall occurred on the northeast slope of the volcano, extending about 2 km (~1.2 mi) from the summit. At other times, a fumarolic plume extended tens of meters to as high as 1 km (3,300 ft) above the summit and trailed downwind as much as 10 km (~6 mi).

Routine satellite analysis on September 22 revealed a minor ash-bearing plume extending 350 km (~220 mi) east from the Klyuchevskoy/Bezymianny area. A cloud height could not be determined

and no verification of activity could be obtained from KVERT. As a precaution, Tokyo VAAC issued a Volcanic Ash Advisory. Subsequent communication with KVERT revealed no related seismicity and AVO scientists concluded that this may have been a dramatic resuspension of fine ash by strong local winds.

Throughout 1998, AVO closely monitored satellite imagery of the Klychevskoy area and disseminated weekly KVERT updates and eruption information to the FAA and NWS. AVO also contacted KVERT by phone for clarification and information on a number of occasions.

Figure 13. Klyuchevskoy Volcano, July 19, 2001. Used with permission of Kamchatka Experimental and Methodical Seismological Department and Institute of Volcanic Geology and Geochemistry.

Klyuchevskoy is a classic stratovolcano and, at 4,850 m (15,913 ft), the highest of the active European and Asian volcanoes (fig. 13). It is frequently active with vulcanian explosions and occasional lava flow production from the main vent in the summit crater. Explosive eruptions have occurred in nearly every decade and at multiple times during most years since the early 1700s (Simkin and Siebert, 1994). Prior to 1998, the last significant eruption was September 30-October 1, 1994. Elevated seismicity and occasional explosive eruption of ash possibly as high as 9 km (~30,000 ft) ASL characterized the 1996 and 1997 activity (Neal and McGimsey, 1997; McGimsey and Wallace, 1999).

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

ERUPTION CONTINUES
Degassing and minor spalling of new lava dome, probable continuation of dome growth. Increasing size of thermal anomaly in early June, seismicity, small avalanches and visible incandescence. No explosive events.

During the first six months of 1998, Bezymianny was quiet. KVERT reported no significant seismicity. Observers recorded an intermittently visible fumarolic plume rising 50-500 m (160 – 1640 ft) above the volcano, occasionally drifting up to 20 km (12 mi) downwind. AVO noted a thermal anomaly in the vicinity of the summit lava dome and occasional minor plumes intermittently throughout the year. In early June, the size of the anomaly grew to more than 5 km^2 (fig. 14). KVERT reported no changes in seismicity, but did note an increase in visible fumarolic gas emissions. Based on a similar pattern prior to an explosive eruption in December 1997, KVERT elevated the Level of Concern Color Code to YELLOW on June 10. Between June 20-22, KVERT reported avalanches and incandescence at the active lava dome accompanied by weak shallow seismicity. No explosive dome collapse ensued. By late June, all significant activity had ceased and the volcano remained quiet for the remainder of the year.

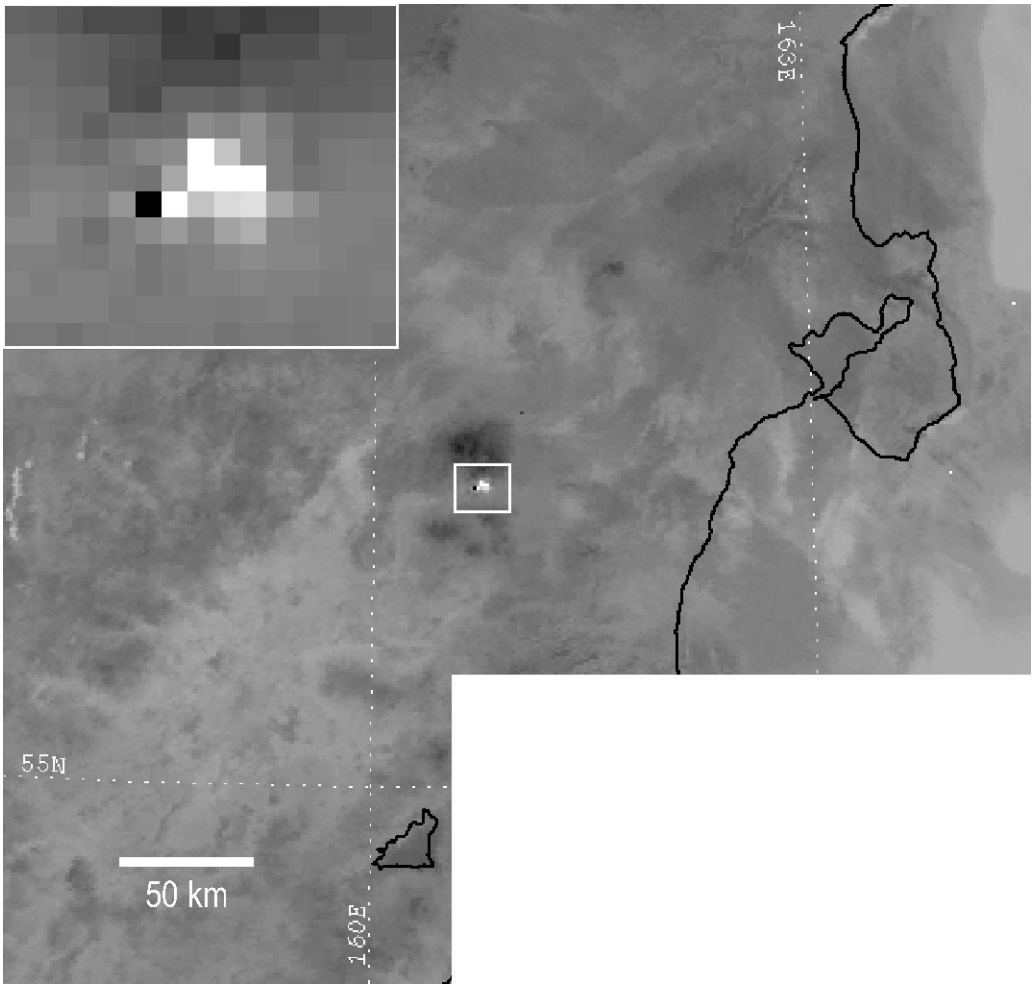

Figure 14. Band 3 AVHRR image of Bezymianny Volcano, Kamchatka, June 12, 1998. White pixels show thermal anomaly in the vicinity of the active lava dome; black pixel reflects sensor saturation. Pixels are ~1.2 x 1.2 km. Inset shows enlarged area. Figure courtesy of Ken Dean and Jon Dehn, UAFGI.

In October 1955, Bezymianny Volcano emerged from a 900-1000 year period of quiescence with an explosive eruption that culminated on March 30, 1956, with the catastrophic failure of the eastern flank and debris avalanche and lateral blast similar to what occurred at Mount St. Helens in 1980 (Voight and others, 1981). 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). Bezymianny is one of the most active volcanoes on the Kamchatka Peninsula.

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

ERUPTION CONTINUES
Continuation of 1996-97 activity; low-level strombolian eruptions, explosions, and localized ash fall.

Low-level strombolian eruptive activity continued at Karymsky Volcano throughout 1998. KVERT maintained a Level of Concern Color Code of YELLOW the entire year. Observers near the volcano reported intermittent explosions of gas and ash rising hundreds of meters to as much as 900 m (~3,000 ft) above the summit crater and, on at least two occasions, sighting of ash fall on the snow within several km of the volcano. Seismicity remained above background with periods of tremor and deep seismicity below the volcano. Based on seismic records, tens to hundreds of explosive events occurred each day. At times, a quiescent steam and gas plume rose above the volcano and trailed as far as 100 km (~60 mi mi) downwind. At other times, gas emission was quite vigorous and may have been more correctly described as 'jetting'. On November 24, a pilot reported a more vigorous explosion sending ash to an altitude of 6 km (~20,000 ft) ASL. On December 16, a satellite image showed an ash-poor plume extending 200 km (~125 mi) to the east.

Using AVHRR images, AVO tracked thermal anomalies at Karymsky related to the still warm lava flow(s) and the adjacent Karymsky Lake throughout the year. Minor plumes were also noted on occasional images extending up to 140 km (~90 mi) from the volcano.

Explosive and effusive-explosive eruptions of andesitic tephra and lava flows alternating with periods of repose are typical of eruptive activity Karymsky (Ivanov and others, 1991). The current phase of unrest began with increasing seismicity below the volcano in mid-April, 1995, culminating in an explosive eruption that began on January 1, 1996, at the north end of Karymsky Lake and then shifted to the volcano's summit (Belousov and Belousova, 2001). For the remainder of 1996, periods of explosive eruptions of ash and small blocks alternated with periods of lava flow production (Neal and McGimsey, 1997). The eruption continued through 1997 with activity characterized by 50 to 100 small explosions of gas and steam per day (McGimsey and Wallace, 1999). Seismicity remained above background levels throughout the year, and AVO satellite analysis tracked a persistent thermal anomaly at the summit and intermittent emission of low-level ash plumes. Karymsky usually issues a continuous steam plume and is the most active volcano on the Kamchatkan Peninsula (Simkin and Siebert, 1994).

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Table 1. Summary of 1998 VOLCANIC ACTIVITY in Alaska, including actual eruptions, possible eruptions, and unusual increases in fumarolic activity. Location of volcanoes shown in Figure 1.

Volcano	Date of Activity	Type of Activity
Shrub Mud Volcano	spring 1997 through 1998	Eruption of warm saline mud and CO_2 from multiple vents continues although at a reduced rate.
Chiginagak Volcano	October 1997 - 1998	Continuation of vigorous steaming from fumarole field on north flank.
Becharof Lake area	May 8 – mid June, 1998	Strong volcano-tectonic swarm, followed inflationary episode at nearby Peulik Volcano. No ensuing eruptive activity.
Shishaldin Volcano	November 4, 1998	Pilot report of ash 'puffs' over the summit crater.
Korovin Volcano	June 30 – July 8[a], 1998	Intermittent ash explosions, possibly hydrovolcanic, from summit crater.

[a] Beginning and end of this unrest poorly constrained.

Table 2. Summary of SUSPECT VOLCANIC ACTIVITY (SVA) in 1998. SVA is defined as a report of eruption or possible eruption that is found to be normal fumarolic activity or non-volcanic phenomena, such as weather related. Location of volcanoes shown in Figure 1.

Volcano	Date of Activity	Type of Activity
Akutan Volcano	March 26 – early April, 1998	Reports of lightning and a cloud over the volcano from Akutan. High-frequency tremor-like signal on a single station turns out to be storm noise.
Augustine Volcano	July 12, 1998[a]	Mudflows reach the sea from the summit dome complex; caused by partial collapse of 1986 spine.

[a] Exact date of collapse and mudflow uncertain

Table 3. Summary of VOLCANIC ACTIVITY on Kamchatka Peninsula, Russia, 1998. Location of volcanoes shown in Figure 10.

Volcano	Date of Activity	Type of Activity
Sheveluch Volcano	Intermittent throughout 1998. Significant explosions on May 30, June 15, September 3, 1998	Possible continued lava dome growth and occasional explosions; ash 13,000 – 25,000 ft (~4,000 – 8,000 m) ASL.
Klyuchevskoy Volcano	July 23, September 2, 1998	continuation of 1996-97 eruption; explosive events
Bezymianny Volcano	June 1998	thermal anomaly, minor dome collapses, incandescence
Karymsky Volcano	Intermittent throughout 1998	continuation of 1996-97 strombolian eruption, localized ash fall

Table 4. 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.

FOR PHOTOGRAPHIC IMAGES OF VOLCANOES IN THIS REPORT:

Duplicate 35-mm slides and prints of some volcanoes discussed in this report are available from:
The Photo Library
U.S. Geological Survey
MS 914 Box 25046 Federal Center
Denver, CO 80225-0046
303-236-1010

Also, for digital images of Alaskan and Russian volcanoes, please see the following web sites:
www.avo.alaska.edu
http://volcanoes.usgs.gov/
http://www.volcano.si.edu/gvp/

PHOTOGRAPHS OF THE 1989-90 ERUPTIONS OF REDOUBT VOLCANO, ALASKA, USGS Open-file Report 96-689, 20 slides, 10 p. text and glossary, by A.L. Roach, C.A. Neal, and R.G. McGimsey.

PHOTOGRAPHS OF THE 1992 ERUPTIONS OF CRATER PEAK, SPURR VOLCANO, ALASKA, USGS Open-file Report 93-707, 20 slides, 8 p. text and glossary, by Christina A. Neal, Robert G. McGimsey, Michael P. Doukas, and Inyo Ellerseick, 1993. 20-slide set illustrating aspects of the 1992 eruptions. Includes captions and glossary.

VOLCANOES OF THE WRANGELL MOUNTAINS AND COOK INLET REGION, ALASKA - SELECTED PHOTOGRAPHS, U.S. Geological Survey, Digital Data Series 96-039, 1996, CD-ROM. **Also available for download via the internet: http://wrgis.wr.usgs.gov/dds/dds-39/**

VOLCANOES OF THE ALASKA PENINSULA AND ALEUTIAN ISLANDS, ALASKA - SELECTED PHOTOGRAPHS, U.S. Geological Survey, Digital Data Series 96-040, 1996, CD-ROM. **Also available for download via the internet: http://wrgis.wr.usgs.gov/dds/dds-40/**

The publications listed above are available from:

U.S. Geological Survey ESIC-Open-File Report Section
Box 25286, MS 517
Denver, CO 80225-0046
303-236-7476

OTHER MULTI MEDIA PRODUCTS OF INTEREST

"VIDEO OF THE AUGUST 18,1992, ERUPTION OF CRATER PEAK VENT ON SPURR VOLCANO, ALASKA", by Robert G. McGimsey and Joseph M. Dorava, 1994, USGS Open-File Report 94-614. This 25-minute, narrated video presents dramatic scenes of the second of three 1992 eruptions of Crater Peak, a satellite vent on Spurr volcano, Alaska. Favorable weather conditions permitted scientists from the Alaska Volcano Observatory to photograph the eruption from a fixed-wing aircraft flying as close as 2 km to the vent. The video includes close-up views of the roiling, 18-kilometer-high eruption column, shockwaves emanating from the column base, ash clouds from pyroclastic flows on the southeast flank, and ash fallout downwind.

"10 YEARS OF VOLCANIC ACTIVITY IN ALASKA: 1983 TO 1992: A VIDEO", by Michael P. Doukas, Robert G. McGimsey, and Joseph M. Dorava, 1995, USGS Open-File Report 95-61. This 28-minute video presents eruption images from eight Alaskan volcanoes during the ten-year period: Veniaminof (1983-84), Augustine (1986), Redoubt (1989-90), Akutan (1991), Bogoslof (1992), Westdahl (1992), Spurr (1992), and Seguam (1992). Classic volcanic phenomena are documented, including meltwater lakes formed when lava flows advanced into an ice- filled caldera (Veniaminof), nighttime views of explosive strombolian activity (Veniaminof), pyroclastic flows descending steep flanks during plinian- and peleean- style eruptions (Augustine), hawaiian-style lava fountaining through glacial ice (Westdahl), island building in the Aleutians (Bogoslof), shock waves and close-up views of a roiling, sub-plinian eruption column rising more than 18 kilometers (Mount Spurr volcano-Crater Peak vent).

The videotapes are available from:

U.S. Geological Survey
ESIC-Open-File Report Section
Box 25286, MS 517
Denver, CO 80225-0046
(303) 236-7476
US or Canada 1-800-684-3368
FAX (907) 273-9192

AND

Action Video
Attn: Karl Augestad
430 W. 7th Ave., Suite 100
Anchorage, AK 99501
(907) 277-8115
FAX (907) 274-8115
e-mail: actvid@alaska.net

GLOSSARY OF SELECTED TERMS

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 45 to 52 percent silica (SiO_2, 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 less than 52 weight percent silica (SiO_2, 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"

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 last 10,000 years to present

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"

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

KEMSD:
: Russian “Kamchatka Experimental and Methodical Seismology Department”

KVERT:
: Russian “Kamchatkan Volcano Eruption Response Team”

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

magma:
: molten material below the surface of the earth

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

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 FAA

stratovolcano:

(also called a stratocone or composite cone) a steep-sided volcano, usually conical in shape, built of 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

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:
: "U.S. Coast Guard"

USGS:
: "U.S. Geological Survey"

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

VAAC:
: "Volcanic Ash Advisory Center"

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"