

EARTHQUAKE COUNTS FROM HELICORDER RECORDS

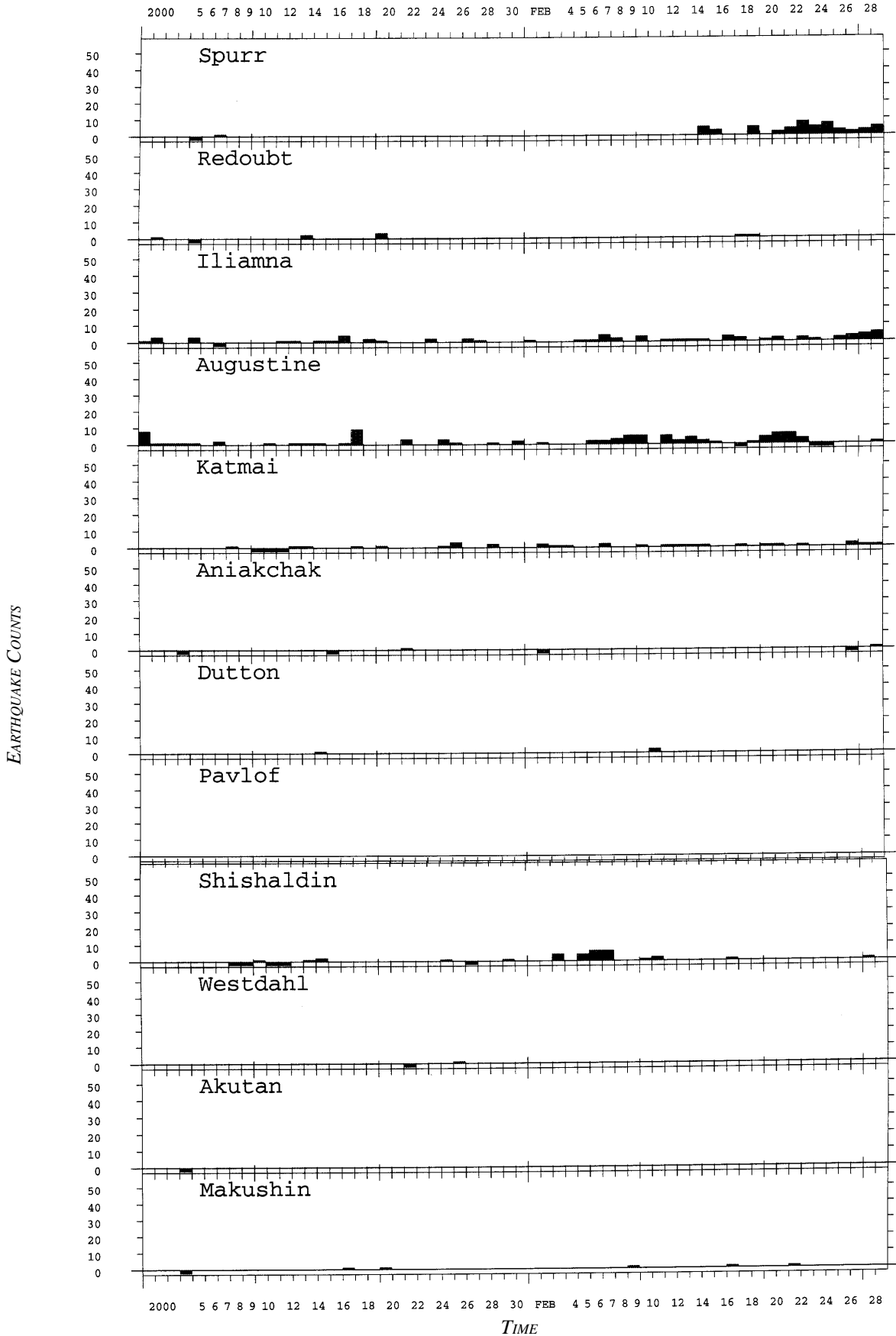


Figure 20: Histogram of computer-detected ("Willie system") seismic events during January through February.

## Observed Mean Seismicity Rates: 1999 Edition

Mean seismicity rates are determined from time to time to obtain a sample of background seismicity at Alaska volcanoes. Identification of a stable background then, in turn, helps to recognize earthquake swarms on other anomalous patterns. New data from 1999 have been evaluated, and, where appropriate, have been incorporated into the mean seismicity calculations.

**Spurr:** Short term station and circuit outages plagued the Spurr network during September-October and November-December. Also a "swarm" of activity occurred during January-February with 29 event located (about twice the usual value). Inclusion of these data results in a total of 539 earthquakes located within 10 km of the summit and a mean seismicity rate of 7.9 earthquakes per month (Table 1). Exclusion of these data would reduce the seismicity rate to 7.7 located earthquakes per month.

**Redoubt:** Much of the Redoubt network was out during July due to a circuit outage resulting from a lightning strike at a repeater site. Therefore, data for July-August are not included in the mean rate calculation. There also appears to have been a number of station outages during September-December. Data for that time period were also excluded from the rate computation. Data from January-June 1999 were, however, included in the calculation which resulted in 6.8 events located within 10 km of the summit of Redoubt.

**Iliamna:** Data for entire year were included, which added an additional 47 events to the total of 132 Iliamna earthquakes and resulted in a mean seismicity rate of 5.5 located events per month. Events relatively far away (~15 km or so) from Iliamna were excluded from the rate computation.

**Augustine:** Station outages in the Augustine seismic network resulted in few earthquakes being located in this region during January-June 1999. Data for these months were thus not included in the rate calculation. Station maintenance during August greatly improved the detection threshold at Augustine. However, since several of the Augustine stations were still not operating reliably during July and some of August, these data were also

not included in the mean rate computation. Additional data from 1999 for the rate estimate were restricted to only September-December. A total of 76 earthquakes were located in this region during this 4-month period. The addition of the 1999 data resulted in a somewhat lower estimate of the Augustine mean seismicity rate than the previous value (37.6 events per month). The new estimate of the Augustine seismicity rate was found to be 32.3 located earthquakes per month. The number of events located during September-December was less than half the number of events predicted from the 1998 estimate of the Augustine seismicity rate. This suggests that perhaps the previous estimate was too high (e.g. included data from a swarm) or the 1999 data were low due to either an actual lull in the activity at Augustine or minor station outages (e.g. one summit station out) which suppressed the detection threshold. The continued accumulation of data should eventually indicate which of the above are most likely.

**Katmai:** Outages of several key stations during January-April resulted in much fewer located events than usual. Although several stations starting operating or at least became more reliable during May-June, a number of stations were still out. There was also a small swarm of activity in the Martin/Mageik region during this time. For these reasons, data from January-June were not included in the mean seismicity rate computations. Data from the July-December 1999 were included in the estimation of the mean seismicity rate for the Katmai/Valley of Ten Thousand Smokes region. A total of 532 earthquakes were located in the region during this 6-month period. On the basis of epicentral distances, earthquakes have been assigned to each of the various earthquakes in the Katmai region. Earthquakes located within 5 km of a volcano were designated as being associated with that volcano. In those cases in which earthquakes were located within 5 km of multiple volcanoes, the events were simply assigned to the closest volcanic center. The resultant revised mean seismicity rates for the Katmai volcanoes are summarized in Table 2.

TABLE 1:

### RECALCULATED MEAN RATES OF SEISMICITY FOR MONITORED VOLCANOES

VOLCANOES	NUMBER OF EVENTS	SEISMICITY RATE (EVENTS/MONTH)	TIME PERIOD OF AVERAGE
<b>Akutan</b>	88	2.7	2.75 years (33 months) <sup>A</sup>
<b>Aniakchak</b>	14	0.5	2.4 years (29 months) <sup>B</sup>
<b>Augustine</b>	452*	32.3	1.17 years (14 months) <sup>C</sup>
<b>Dutton</b>	15	0.4	3 years <sup>D</sup>
<b>Iliamna</b>	132	5.5	2 year <sup>E</sup>
<b>Katmai region</b>	1852	85.1	1.83 years (22 months) <sup>F</sup>
<b>Makushin</b>	151	4.6	2.75 years (33 months) <sup>G</sup>
<b>Pavlof</b>	30	0.8	3 years <sup>H</sup>
<b>Redoubt</b>	421 <sup>+</sup>	6.8 <sup>+</sup>	5.17 years (62 months) <sup>I</sup>
<b>Shishaldin</b>	2	0.2	1 year <sup>J</sup>
<b>Spurr</b>	539 <sup>+</sup>	7.9 <sup>+</sup>	5.67 years (68 months) <sup>K</sup>
<b>Unimak Island</b>	50	4.2	1 year <sup>J</sup>
<b>Westdahl</b>	4	0.3	1.17 years (14 months) <sup>L</sup>

\*This value does not include events believed to be regional tectonic earthquakes and those events which appear to be related to shore-ice or are in some way related to cold weather.

<sup>A</sup>Values reflect seismicity located within 10 km of the respective summits.

<sup>B</sup>Data from the time period of 1997-1998, 01/99-06/99 and 08/99-10/99.

<sup>C</sup>Data from the time period of 08/97-12/99.

<sup>D</sup>Data from the time periods of 01/98-10/98 and 09/99-12/99.

<sup>E</sup>Data from the time period of 1997-1999.

<sup>F</sup>Data from the time period of 1998-1999.

<sup>G</sup>Data from the time period of 01/97-03/97, 08/97-12/97, 01/98-03/98, 06/98-10/98, and 07/99-12/99.

<sup>H</sup>Data from the time period of 1997-1998, 01/99-6/99 and 08/99-10/99.

<sup>I</sup>Data from the time period of 1997-1999.

<sup>J</sup>Data from the time period of 1994-1997, 01/98-04/98, 09/98-12/98, and 01/99-06/99.

<sup>K</sup>Data from the time period of 09/97-12/97-06/98 and 11/98-12/98. The rate has not been updated using 1999 data (see text for explanation).

<sup>L</sup>Data from the time period of 1994-1998 and January-August 1999.

<sup>M</sup>Data from the time period of 11/98-12/99.

TABLE 2:

## MEAN RATES OF SEISMICITY FOR INDIVIDUAL KATMAI REGION VOLCANOES

VOLCANOES	NUMBER OF EVENTS*	SEISMICITY RATE (EVENTS/MONTH)*
<b>Total Katmai Area</b>	1852	85.1
<b>Griggs</b>	3	0.1
<b>Katmai</b>	178	8.1
<b>Mageik</b>	341	15.5
<b>Martin</b>	666	30.3
<b>Martin/Mageik</b>	1007	45.8
<b>Novarupta</b>	277	12.6
<b>Snowy Mountain</b>	12	0.6
<b>Stellar</b>	2	0.1
<b>Trident</b>	81	3.7

\*Data for the time period of 01/97-03/97, 08/97-12/97, 01/98-03/98, 06/98-10/98, and 07/99-12/99 (total of 22 months).

**Aniakchak:** The 1998 mean seismicity rate estimates did not include data from the Aniakchak network. Except for the time periods immediately following station maintenance, the Aniakchak data have never had a one hundred percent record of operation. Bears and hostile environment quickly took their toll on the network. This fact, combined with the region's low level of background seismicity did not readily allow one to estimate the reliability and relative "health" of the Aniakchak network. This was also the case for the 1999 data. The situation is unlikely to change soon. Rather than ignore all of the Aniakchak data for both 1998 and 1999, these data were combined with the five months of data from 1997 to estimate the mean seismicity rate. During these 29 months of operation a total of 14 earthquakes were located in the Aniakchak region. The mean seismicity rate for Aniakchak was found to be 0.5 events per month, which is only slightly greater than the previous five month mean rate of 0.4 events per month. This mean rate estimate must be taken to be poorly constrained.

**Pavlof:** Seven earthquakes were located in the Pavlof region during 1999 bringing the total number of earthquakes located in this area since 1997 up to 30. The 3-year mean seismicity rate for Pavlof is, therefore, 0.8 earthquakes per month.

**Dutton:** An additional three earthquakes were located in the Dutton region during 1999. Fifteen such events were located in this region since 1997. The revised Dutton mean seismicity rate is 0.4 events per month.

**Unimak Island/Shishaldin:** Shishaldin erupted during 1999. Low level tremor started in mid-January 1999. Evidence that an eruption was in progress via satellite imagery was observed on February 9. During February 3-12 there was a swarm of nine earthquakes, six of which were in the summit region, near Shishaldin. It is unclear whether this seismicity is actually related to the eruption but the timing suggests that this was the case. Tremor at Shishaldin continued until early-mid June. Seismicity may be elevated not only during an eruption but after following it as well; earthquakes often occur after an eruption as the stresses within the region reach a new equilibrium. Therefore, Shishaldin seismicity located during 1999 may not necessarily be representative of the actual background seismicity but rather may have been generated as part of the eruption process. Such data would skew the mean seismicity rate resulting in an overestimation of the actual rate. To make matters worse in this regard, on March 4, 1999 a magnitude  $M_L=5.0$  earthquake occurred about 16 km west of the summit of Shishaldin. This earthquake generated hundreds of aftershocks as part of an aftershock sequence which continued through the remainder of the year. Aftershocks therefore, would also greatly skew the mean seismicity rate if they were included in mean rate calculation. Both the eruption of Shishaldin and the aftershock sequence precluded the addition of 1999 data in the mean seismicity rate calculation.

Because the 1998 Shishaldin mean seismicity rate was based upon the events located within the map region of the base map used at that time, a change in base maps necessitates a re-evaluation of the mean seismicity rate. Guy Tytgat has since

produced maps for the entire Unimak Island area as well as more detailed maps for Shishaldin and Westdahl. The previous Shishaldin map encompassed much of the seismic active region of Unimak Island. The newer, the expanded Unimak Island includes a little more of this area. As a result, the Unimak Island data for the same time period (i.e. 09/97-06/98 and 11/98-12/98) include 50 located events whereas the previous Shishaldin map had 46 events. The Unimak Island mean seismicity rate was, therefore, found to be 4.2 earthquakes per month. For the same time period the more detailed Shishaldin map included only two earthquakes. Based upon these two events the revised mean seismicity rate for the Shishaldin area was found to be only 0.2 events per month. The above mean seismicity rates for Unimak Island and Shishaldin will continue to be employed until sufficient data are accumulated that are more representative of normal (i.e. non-eruption) conditions.

**Westdahl:** Data from the Westdahl network was recorded beginning in late October 1998. For the 14 month period of November 1998-December 1999, only four earthquakes were located in the Westdahl region. The mean seismicity rate for Westdahl is, therefore, estimated to be only 0.3 earthquakes per month.

**Akutan:** There were major outages of both of the Akutan circuits during much of July 1999. Because of the relative scarcity of data for July, the July data were not included in the mean rate calculation. The operation of the Akutan network appears to have also been quite unreliable during November-December 1999. Data from this two-month period was not employed in the Akutan mean seismicity rate calculation. The mean seismicity rate for Akutan was determined for a 33 month (2.75 year) time period and was found to be 2.7 located earthquakes per month.

**Makushin:** A combination of circuit and hardware problems resulted in a lack of data from the Makushin seismic network during about half of July 1999. Data for July was, thus not included in the mean rate calculation. As was the case with the Akutan data, the Makushin data were also fairly intermittent during November-December 1999. Data from these two months were excluded from the mean seismicity rate computation. Therefore, nine months of additional data from 1999 included in the rate calculation. The mean seismicity rate for Makushin was found to be 4.6 earthquakes per month.

*Great Sitkin:* Although the Great Sitkin seismic data have been recorded since September 1999, the usual event detection and acquisition system employed by AVO was not applied to the Great Sitkin data until mid-January 2000 as discussed previously. Due to this change in the method of data acquisition a mean seismicity rate was not determined for Great Sitkin.

*Scott Stihler, Steve McNutt, Gordon Bower, Guy Tytgat, John Power, and Art Jolly*

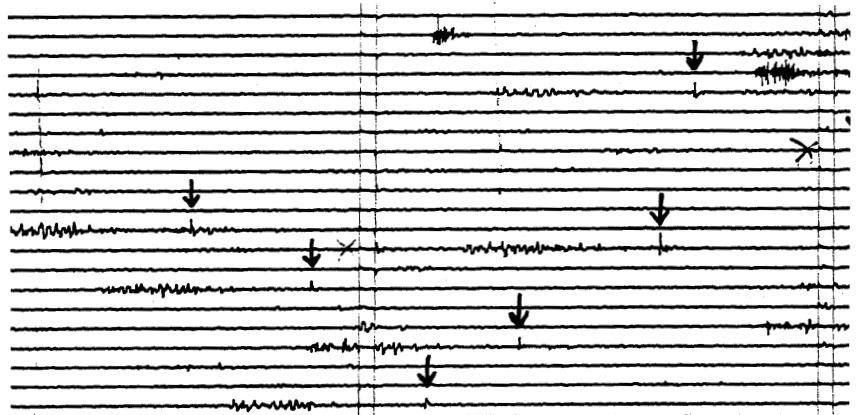


Figure 21: Portion of helicorder record from station SSLW. Tick marks are one minute apart. Arrows point to air waves from volcanic explosions.

## Augustine Deformation

January through February 2000:

Sometimes no news isn't so good. We lost communications with the Homer computer in January. There is nothing to report.

*Gene Iwatsubo*

Figure 22. Number of explosions per day from September 1, 1999 to February 15, 2000. Data are from station SSLW.

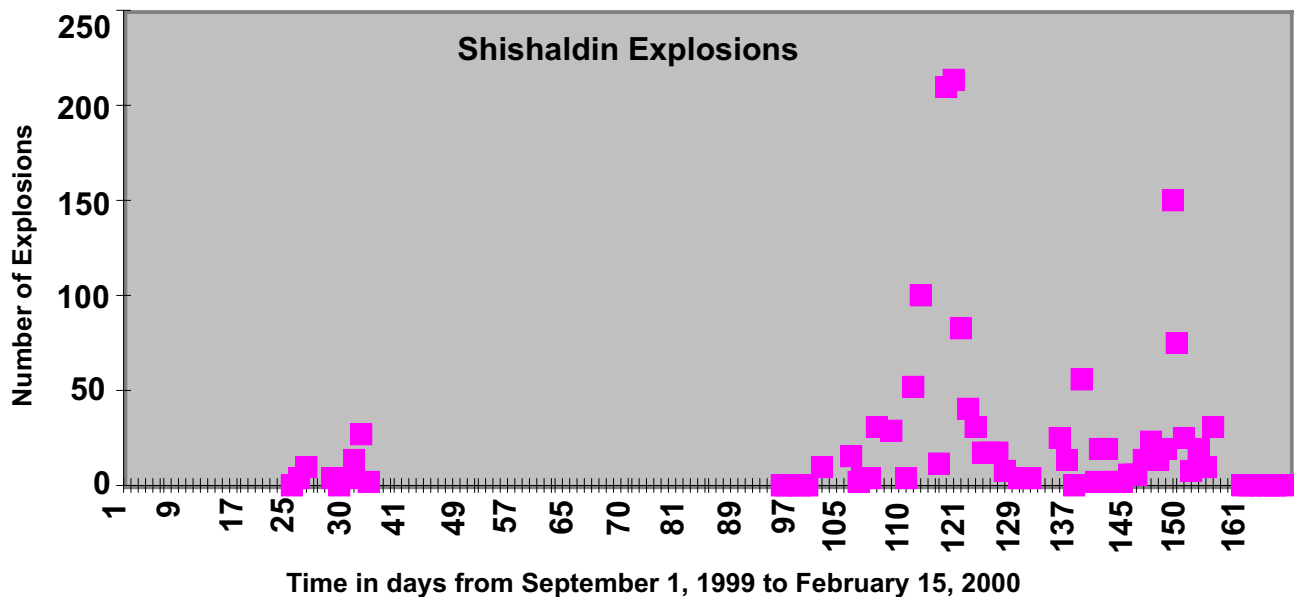
## OnGoing Investigations

### Explosions recorded on Shishaldin seismograms September 1999 to February 2000

Volcanic explosions occurring at the summit vent of Shishaldin were observed on January 15, 2000. This day had low background noise so that the explosions could be plainly seen on helicorder records for station SSLW, located 10.1 km west of the summit (see Shishaldin seismicity report for map of the volcano and stations). The key diagnostic was the presence of an air-wave arrival on the records approximately 28 seconds

after the first ground waves. This separation occurs because air waves travel slowly (330 m/sec) whereas ground waves travel much faster (about 3 km/sec). The air wave appears as a sharp spike in the late coda of the event. A portion of a helicorder record with several explosions visible is shown as figure 21.

Once the explosions were identified and confirmed, a systematic effort was made to review past records to find all occurrences. All station SSLW helicorder records were scanned for the period August 1999 to March 2000. Explosions were noted from September 25-27, October 1-6, and December 10 to February 4 (figure 22). The highest numbers of events occurred on December 28-29 with over 200 explosions per day each and January 29 with 150 explosions. The daily counts are somewhat unreliable because of greatly varying background noise levels. However, the peak rates are probably representative and the dates of onset and cessation of explosions are within 1 or 2 days.



The maximum size of the explosions was estimated to be  $M_L=1.1$  and most were  $M_L=0.5$  to  $0.7$ . These estimates were made by forcing a reference event location to be at the volcano's summit and measuring the amplitudes and periods at four stations. The explosions were smaller than most of the explosions observed at Pavlof in the fall of 1996.

Event counts based on filtered digital data from station SSLS reached their peak rate on February 4, indicating an increase in the rate of large events (the SSLS threshold is fairly high), hence energy output. After this there was a week long decline to background levels. The last explosions were observed on February 4. This suggests a causal relation, and we speculate that an influx of new material and heat caused the larger events on SSLS and disrupted the delicate conditions that led to the small explosions.

Based on the small size of the events and the lack of any known deposits or satellite thermal anomalies, we conclude that the explosions were phreatic. They probably represent a local hazard in the vicinity of the volcano's summit, but do not pose a hazard to commercial jet aircraft. Further analyses based on digital data from one week are given in a companion report.

Steve McNutt

## Size and spacing of low-frequency events and explosions at Shishaldin, January-February, 2000

Low-frequency events have occurred at Shishaldin ever since the seismic network was installed in 1997. Most are too small to be located, but the larger ones have been located at shallow depths under the summit region. From September 1999 to February 2000 several hundred events occurred per day, including explosions with distinct air waves in September, October, and December through February (see companion report). Here we report on detailed study of five days of data from January 29 to February 4, 2000, which coincided with the highest level of activity and with AVO's level of concern as expressed by use of its color code. Our purpose is to better understand the size and space distributions of the seismic events and their implications for the source or sources.

We examined 3 or 4 hours of continuous data for each of the five days. For each event we measured 1) the time at station SSLN, 2) the ground wave amplitude of the largest upward motion at SSLN and SSLW, 3) the air wave amplitude of the largest upward motion at SSLW, and 4) the event duration at SSLN (elapsed time with amplitude  $> \_$  maximum). Data were not used from stations ISTK or BRPK because of poor signal-to-noise ratio. Data from station SSLS had poor ground/air wave separation, and station ISSN was not working. An example explosion is shown in Fig.23.

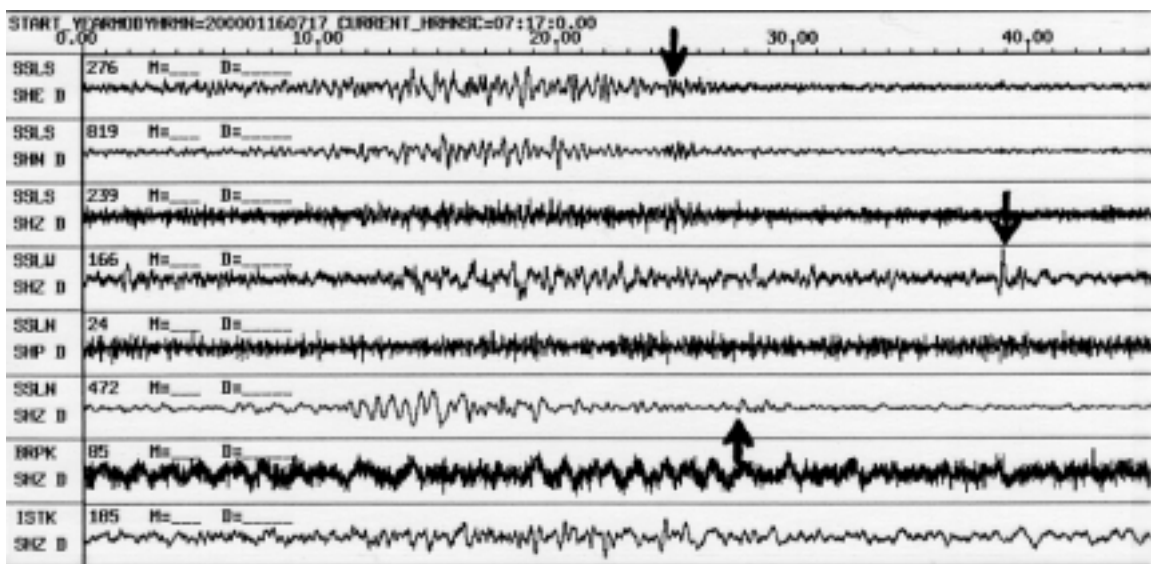
Magnitudes were assigned based on SSLN amplitude data from five events on January 29 that showed  $M_L=1.0$  corresponded to an amplitude of 700 counts. Energy release was determined from a simplified version of Richter's formula:  $\log_{10} E = 9.9 + 1.88M_L$  ( $E$  in Joules). To compare energy release for the discrete events to that of volcanic tremor, a standard formula for tremor power was used (Nishimura and McNutt, unpublished report). Descriptive statistics are shown in Table 1, including: number of events, time between events, size, duration,  $M_L$ , energy, equivalent energy flux, and extrapolations to the number of events per day.

### Principal results of analyses are:

A) The events are too evenly spaced through time to have been generated by a Poisson process. In seismology, a homogeneous Poisson process is generally assumed, which means that the timing of each event is not influenced by any of the other events. Intervals between events generated by such a process are exponentially distributed, with a standard deviation equal to the mean. The low standard deviations observed for the Shishaldin events show that the events are more uniformly spaced than would be expected. The expected distribution and data are shown in Figure 24. Note that short and long intervals are underrepresented while average intervals are overrepresented.

B) The frequency-magnitude distribution does not follow the Gutenberg-Richter relation. Most earthquakes follow the relation  $\log_{10} N = a - bM$ , which implies a power law distribution for amplitude of earthquakes or a truncated exponential distribution in terms of magnitude. The standard deviation of observed

Figure 23: Seismograms from an explosion at Shishaldin, January 16, 2000. Forty-five seconds of data are shown. Arrows mark the air wave arrival at SSLS (top 3 traces), SSLW, and SSLN.



magnitudes was near 0.2, while the difference between the mean and minimum magnitudes was at least 0.4 each day. If the events obeyed the Gutenberg-Richter relation, the mean magnitude and standard deviation should be equal (both approximately  $b^{-1}$ ). The conclusion is that there was a strong tendency for events of a fixed size to occur. A histogram of magnitudes is shown in Figure 25.

C) Amplitudes of ground and air waves are positively correlated. Events for which the air wave was visible, as a group, were significantly larger than those for which the air wave was absent. A best fit curve was  $(\text{SSLW air-wave amplitude}) = 3.14 (\text{SSLN ground-wave amplitude})^{0.526}$ . The correlation coefficient  $r=0.49$  is highly significant. Air waves visible at SSLW, 10.1 km from the summit, accompanied 65-70 percent of the seismic events.

D) The time series have no discernible moderate time scale (hours to days) structure. The Shishaldin data set shows no significant correlation between the length of one interval and the length of the next interval, the duration of one event and the duration of the next, or the amplitude of one event and the amplitude of the next. Successive observations of the same variable are for practical purposes independent.

E) The size of an event partially controls the time until the next event. There is a positive correlation between the amplitude and duration of an event and the interval following it. The lines of best fit were:

interval =  $58.39 + 0.223 (\text{SSLN amplitude})$   $r=0.40$   
 interval =  $52.23 + 0.620 (\text{SSLW amplitude})$   $r=0.45$   
 interval =  $-28.2 + 32.3 (\text{duration})$   $r=0.37$

TABLE I

Period Analyzed	29 Jan 0000-0400	30 Jan 0000-0400	31 Jan 0000-0400	01 Feb 0000-0300	04 Feb 0000-0300	All events
# events	86	100	105	63	66	420
Air waves: present	45	63	49	37	--	194
absent	28	27	20	15	--	90
undetermined	13	10	36	11	66	136
Mean time between events	2m48±9s	2m25±10s	2m17±10s	2m53±15s	2m48±14s	2m36±5s
SD	95s	97s	101s	119s	108s	104s
Mean max counts @ SSLN	403±18	377±16	418±19	520±27	528±22	438±9 (not constant)
SD	163	157	191	213	176	188
Mean max counts @ SSLW	--	130±6	146±6	185±9	214±11	162±4
Mean duration @ SSLN	--	5.51±.15	5.37±.13	5.93±.16	5.85±.15	5.62±.08
SD	--	1.38	1.10	1.24	1.21	1.31
Mean air-wave counts @ SSLW	52±6	58±5	54±4	75±7	---	58±3
Mean $M_L$	0.72±.02	0.69±.02	0.72±.02	0.81±.03	0.88±.02	0.74±.01
Mean energy per event (GJ)	242±18	215±15	269±19	393±30	477±44	---
Mean seismic energy flux (GW) equivalent to continuous 2Hz tremor at $D_R$ of	1.44±.13	1.48±.15	1.96±.20	2.28±.26	2.84±.35	---
Seismic events per day	514±31	596±44	631±50	500±47	514±45	---
Explosions per day	317±35	417±42	448±50	356±41	---	---

Distribution of intervals between events  
 Shishaldin, 29 Jan - 04 Feb 00

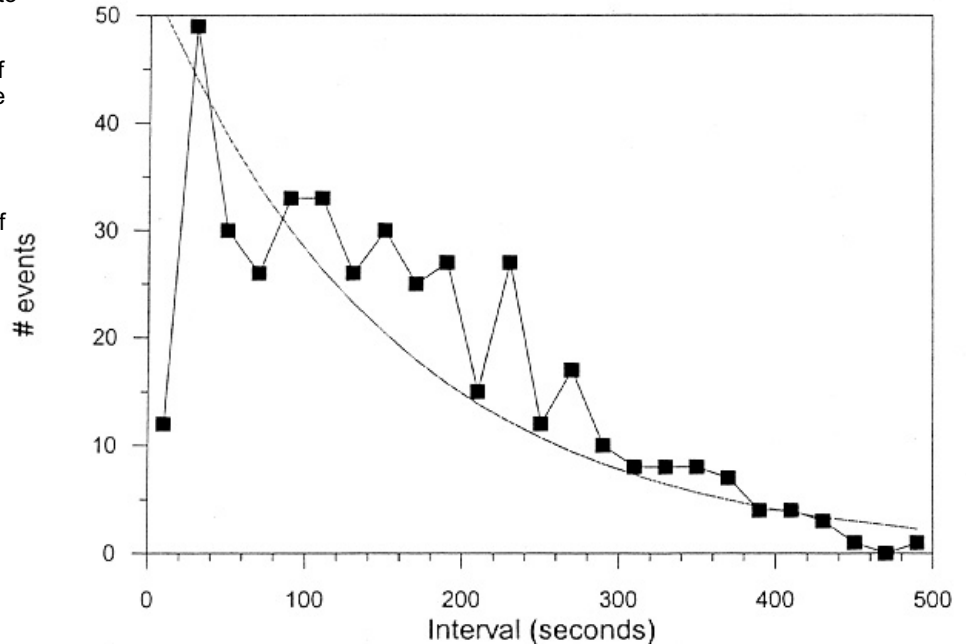


Figure 24: Distribution of intervals between events. The exponential distribution is shown as the smooth curve, and observational data as solid squares.

A scatter plot for SSLW amplitude versus interval is shown in Figure 26. Slight improvement to  $r=0.47$  can be obtained by using both amplitude and duration simultaneously.

These results carry important implications for the source processes of the seismic events at Shishaldin. The system produced several thousand events of essentially the same character over a period of several weeks or longer. This suggests that the source was non-destructive, and remained intact for long periods. The process is statistically almost stationary. A reasonable conceptual model consists of some sort of energy reservoir, such as a fluid-filled cavity, that repeatedly is charged until it suddenly releases some of the stored energy and begins refilling. The system is simple enough that it has no "memory" beyond the most recent event, and it returns to the same state repeatedly. However, the size of one event does influence how long it takes before another event occurs. This is strong evidence for the reservoir having a fixed maximum capacity, for which an event occurs immediately as soon as this maximum is reached. In contrast, the discharge appears to terminate randomly, as opposed to always draining to a fixed level. It is quite common in hydrothermal systems for the size of an event to determine the time until the next event. In some cases, the filling of the system to a maximum level prior to every event is directly observable.

The intervals between events at Shishaldin are too regular to be completely random, but are still much more irregular than the classic "predictable" systems following published models. The closest analog to Shishaldin appears to be mud pots. These are characterized by a fixed condition for the onset of activity (heat supply just sufficient to bring the surface to boiling) and a random event size (bubble burst). Larger bubbles mean greater heat loss and a longer interval until the next event. Although the basic activity is similar, it is clear that additional data are needed to resolve the details of the source mechanism at Shishaldin.

*Gordon Bower and  
Steve McNutt*

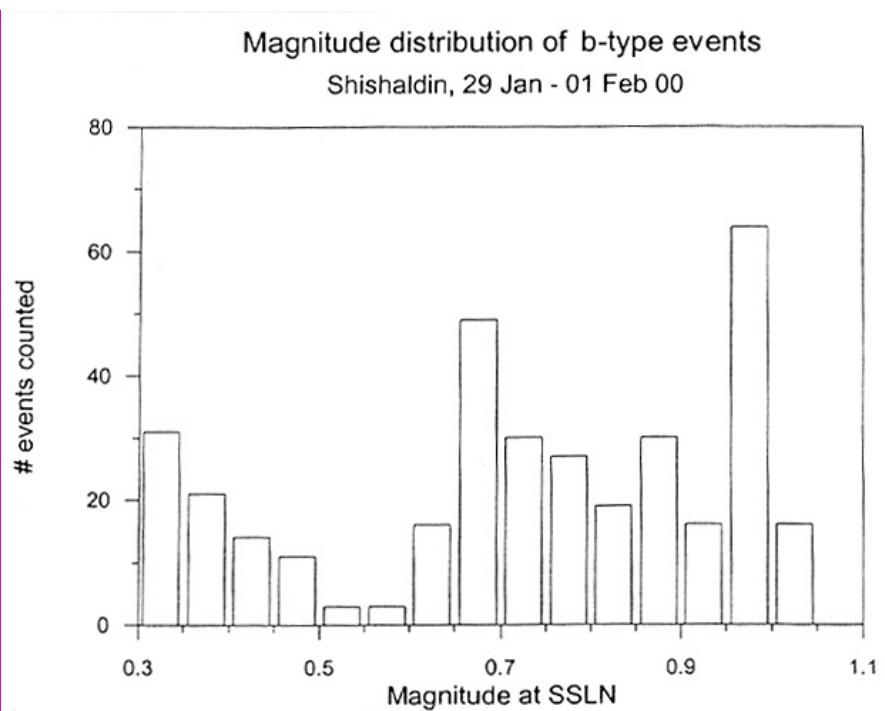


Figure 25: Histogram of magnitude distribution for seismic events at Shishaldin, station SSLN.

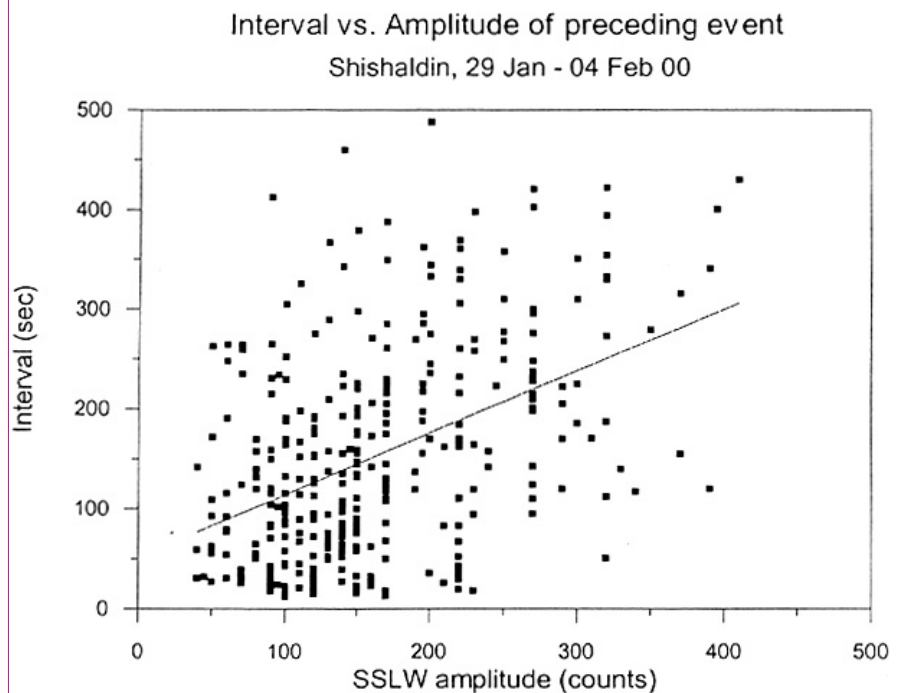


Figure 26: Scatter plot of time interval versus SSLW amplitude of preceding event. A least squares linear fit to the data is shown. The correlation coefficient  $r=0.45$ .

## Outreach

Steve McNutt sent a reply to a New Trier HS student named Laura who asked: What is the Alaska Volcano Observatary?

Pavel responded to the following:

Hello-  
I'm doing a project on the Bezymianny Volcano, and I was wondering if you knew the folklore for the volcano and any additional information. Thank you.  
Christina

Hello, Christina!  
Folklore for Bezymianny? This is great!!! Sorry, Bezy was silent for centuries before it reawakened in 1955-56, so if folklore existed before, it's gone and there are no new stories yet. However I can supply you with songs of geologists (in Russian, if you would like :))) Useful information on geology etc. of Bezy can be found at [www.avo.alaska.edu](http://www.avo.alaska.edu) and <http://www.volcano.si.edu/gvp/volcano/region10/kamchat/bezymian/var.htm>. You may want to use the Radarsat-1 image of Bezymianny from my Web Page: <http://www.avo.alaska.edu/input/pavel/SARmosaic/kluch.jpg>. Thank you for your interest! And good luck with your project!

Pavel Izbekov

## Publications

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- Eichelberger, J.C., 2000, *Silicic magma and crustal storage in arc systems: State of the Arc 2000: in proceedings: Processes and timescales Extended Abstracts*, Smith I.E.M., Davidson, J.P., Gamble, J.A., Price, R.C. (eds), p. 66-70.

- Eichelberger, J.C., Chertkoff, D.G., Dreher, S.T., Nye, C.J., 2000. *Magma in Collision: Rethinking Chemical Zonation in Silicic Magma Bodies*, Geology, in press.
- Garcés, M.A., S.R. McNutt, R.A. Hansen, and J.C. Eichelberger, *Application of wave-theoretical seismoacoustic models to the interpretation of explosion and eruption tremor signals radiated by Pavlof Volcano, Alaska*, JGR, 105, no. B2, p. 3039-3058, 2000.
- George, R, Turner, S, Hawkesworth, C, Evans, C, Nye, C, Perfit, M., 2000, *Along-arc U-Th-Ra disequilibria in the Aleutians: Rapid Timescales of Fluid Transfer. State of the Arc 2000, in proceedings:: Processes and Timescales. Extended Abstracts. Royal Society of New Zealand Smith, IEM, Davidson, JP, Gamble, JA, Price, RC, (eds), p. 89-91.*
- Moran, S. C., D. R. Zimelman, and S. D. Malone, "A model for the magmatic-hydrothermal system at Mount Rainier, Washington, from seismic and geochemical observations", *Bull. Volc.*, v. 61(7), p. 425-436, 2000.
- Nakada, S., K. Uto, J.C. Eichelberger and H. Shimizu, *Unzen Volcano Scientific Drilling Project, presented at the International Geodynamics Conference, Rio de Janeiro, 2000.*
- Nye, C.J, 2000, *Magmatic Diversity in Aleutian Arc Magmas.: State of the Arc 2000: in proceedings: Processes and Timescales. Extended Abstracts. Royal Society of New Zealand Smith, IEM, Davidson, JP, Gamble, JA, Price, RC, (eds), p. 137-138.*

## Addendum

### log of Updates for the Current Period

**KAMCHATKAN VOLCANIC ACTIVITY INFORMATION RELEASE 00-1**  
Friday, January 7, 1999, 12:00 KST (0000 UTC)  
The following Release was received by e-mail from KVERT (Kamchatkan Volcanic Eruptions Response Team). All times are

Kamchatkan Standard Time (KST), 21 hours ahead of AST.  
**Klyuchevskaya Group of Volcanoes Klyuchevskoy Volcano:**  
56°03' N, 160°39' E; Elevation 4,750 m  
**CURRENT LEVEL OF CONCERN COLOR CODE IS GREEN**  
During the past week (December 31-January 6), seismicity at the volcano was at background levels. Shallow earthquakes and volcanic tremor were registered. On January 1,3 and 6, a fumarolic plume rose 50-200 m above the crater and extended 1-3 km to the west. On other days, the volcano was obscured by clouds.

**Bezymianny Volcano:**  
55°58'N, 160°36'E; Elevation 2,895 m  
**CURRENT LEVEL OF CONCERN COLOR CODE IS GREEN**  
No seismicity was registered beneath the volcano. On January 1,3, and 6, weak fumarolic activity was observed. On other days, the volcano was obscured by clouds.

**Sheveluch Volcano:**  
56°38' N, 161°19' E; Elevation 2,447 m  
**CURRENT LEVEL OF CONCERN COLOR CODE IS GREEN**  
Seismicity under the volcano was at background levels. On January 5-6, a weak fumarolic plume rose 50 m above the volcano. On other days, the volcano was obscured by clouds.

**Karymsky Volcano:**  
54°03'N, 159°27'E; Elevation 1,486 m  
**CURRENT LEVEL OF CONCERN COLOR CODE IS GREEN**  
No data on activity at this volcano is available because the nearest seismic station KRY was out of order during the past week. According to the regional seismic net, no strong events occurred.

**Avachinskaya Group of Volcanoes:**  
53°15'N, 158°51'E;  
**CURRENT LEVEL OF CONCERN COLOR CODE IS GREEN**  
Seismicity at Avachinsky and Koryaksky volcanoes is at normal levels.

**ALASKA VOLCANOES UPDATE**  
Friday, January 07, 2000, 11:00 AM AST (2000 UT)

**Alaska Volcanoes:**  
Seismic activity is monitored in real time at 21 volcanoes in Alaska. Some of these volcanoes may currently display anomalous seismicity, but they are not considered to be at a dangerous level of unrest.  
Spurr, Redoubt, Iliamna, Augustine, Snowy, Griggs, Katmai, Novarupta, Trident, Mageik, Martin, Aniakhak, Pavlof, Dutton, Isanotski, Shishaldin, Fisher, Westdahl, Akutan, Makushin, and Great Sitkin volcanoes are all at



or near normal levels of background seismicity.

**ABBREVIATED COLOR CODE KEY**  
(contact AVO for complete description)

- GREEN** volcano is dormant; normal seismicity and fumarolic activity occurring
- YELLOW** volcano is restless; eruption may occur
- ORANGE** volcano is in eruption or eruption may occur at any time
- RED** significant eruption is occurring or explosive eruption expected at any time

Volcano Information on the Internet:  
<http://www.avo.alaska.edu>  
Recording of the Status of Alaska's Volcanoes (907) 786-7478

**ALASKA VOLCANOES UPDATE**

Friday, January 14, 2000, 10:00 AM  
AST (1900 UT)

*Alaska Volcanoes:*  
No Change.

**KAMCHATKAN VOLCANIC ACTIVITY INFORMATION RELEASE 00-2**

Friday, January 14, 2000, 12:00 KST  
(0000 UTC)

*Klyuchevskaya Group of Volcanoes Klyuchevskoy Volcano:*  
56°03' N, 160°39' E; Elevation 4,750 m  
**CURRENT LEVEL OF CONCERN COLOR CODE IS GREEN**

During the past week (Jan. 7-13), seismicity at the volcano was at background levels. Small shallow earthquakes were registered. On the morning of January 7, a fumarolic plume rose 1000 m above the crater and extended to the east. After 14:30 KST Jan 7 and on Jan. 8, a fumarolic plume rose 50-100 m above the crater extending to the east. On other days, the volcano was obscured by clouds.

*Bezymianny Volcano:*  
55°58'N, 160°36'E; Elevation 2,895 m  
**CURRENT LEVEL OF CONCERN COLOR CODE IS GREEN**

No seismicity was registered beneath the volcano. On January 7-8, a fumarolic plume rose 50-100 m above the volcano and extended to the east. On Jan. 11, only weak fumarolic activity was observed. On other days, the volcano was obscured by clouds.

*Sheveluch Volcano:*  
56°38' N, 161°9' E; Elevation 2,447 m  
**CURRENT LEVEL OF CONCERN COLOR CODE IS GREEN**

Seismicity under the volcano was at background levels. At 3:29 KST, on Jan. 9, seismic data indicated a short-lived ash explosion probably occurred. An 81-minute-

long series of shallow events were recorded. No ash plume could be seen on the nearest satellite images at 5:13 KST. On Jan. 11, weak fumarolic activity was observed. On other days, the volcano was obscured by clouds.

*Karymsky Volcano:*  
54°03'N, 159°27'E; Elevation 1,486 m  
**CURRENT LEVEL OF CONCERN COLOR CODE IS GREEN**

According to the regional seismic net, no strong events occurred during the past week. The nearest seismic station KRY operated only one day during the past week. No local seismic events were registered.

*Avachinskaya Group of Volcanoes:*  
53°15'N, 158°51'E;  
**CURRENT LEVEL OF CONCERN COLOR CODE IS GREEN**  
Seismicity at Avachinsky and Koryaksky volcanoes is at normal levels.

**ALASKA VOLCANOES UPDATE**

Friday, January 21, 2000 2:55 PM ADT  
(2355 UT)

*Shishaldin Volcano:*  
54°45.33' 163°58.00'Summit Elevation 9,373 ft (2,857 m)  
**LEVEL OF CONCERN COLOR CODE IS GREEN**

Investigations of recent seismic data from Shishaldin volcano reveal the presence of small explosions over the past few weeks. The numbers of explosions have varied from several to over 200 per day, but no steam or ash plumes have been observed by airborne and ground observers. Also, no thermal anomaly has been observed in satellite imagery, indicating that lava has not reached the surface. It is likely that the explosions are phreatic, caused by the flashing of water to steam. These events may represent a local hazard within a few hundred meters of the vent but do not pose a hazard to aircraft. The occurrence of these events does not suggest that the likelihood of a large explosive eruption has increased. Therefore, we are staying at Color Code GREEN.

AVO is monitoring the situation closely and will issue further updates as the situation warrants.

Shishaldin volcano is one of the most active volcanoes in the Aleutian arc, erupting at least 29 times since 1775. The most recent eruptive period occurred in April-May 1999. The April 19th eruption sent an ash plume to over 45,000 ft (13,900 m) ASL. Shishaldin volcano is located near the center of Unimak Island in the eastern

Aleutians. The cone has a base diameter of approximately 10 miles (16 km) and a small summit crater that typically emits a steam plume with occasional small amounts of ash.

*Alaska Volcanoes:*  
Seismic activity is monitored in real time at 21 volcanoes in Alaska. Some of these volcanoes may currently display anomalous seismicity, but they are not considered to be at a dangerous level of unrest.  
Spurr, Redoubt, Iliamna, Augustine, Snowy, Griggs, Katmai, Novarupta, Trident, Mageik, Martin, Aniakhak, Pavlof, Dutton, Isanotski, Fisher, Westdahl, Akutan, Makushin, and Great Sitkin volcanoes are all at or near normal levels of background seismicity.

**KAMCHATKAN VOLCANIC ACTIVITY INFORMATION RELEASE 00-3**

Friday, January 21, 2000, 10:00 KST  
(2200 UTC)

*Klyuchevskaya Group of Volcanoes Klyuchevskoy Volcano:*  
56°03' N, 160°39' E; Elevation 4,750 m  
**CURRENT LEVEL OF CONCERN COLOR CODE IS GREEN**

During the past week (Jan. 14-20), seismicity at the volcano was at background levels. Shallow earthquakes were registered. On January 14, 16-17, and 19, a fumarolic plume rose 50-200 m above the crater and extending 2-5 km to the north and east-southwest on Jan. 17 and 19. On other days, the volcano was obscured by clouds.

*Bezymianny Volcano:*  
55°58'N, 160°36'E; Elevation 2,895 m  
**CURRENT LEVEL OF CONCERN COLOR CODE IS GREEN**

No seismicity was registered beneath the volcano. On January 14, 16-17, and 19, weak fumarolic activity was observed. On other days, the volcano was obscured by clouds.

*Sheveluch Volcano:*  
56°38' N, 161°19' E; Elevation 2,447 m  
**CURRENT LEVEL OF CONCERN COLOR CODE IS GREEN**

Seismicity under the volcano was at background levels. At 6:19 KST, on Jan. 20, seismic data indicated a short-lived ash explosion probably occurred as a 45-minute-long series of shallow events was recorded. On Jan. 17, weak fumarolic activity was observed. On the morning of Jan. 19, a plume rose 100 m above the volcano and extended 5 km to the east. In the afternoon, the fumarolic plume rose 500 m above the crater. On other days,

the volcano was obscured by clouds.

*Karymsky Volcano:*

54°03'N, 159°27'E; Elevation 1,486 m  
**CURRENT LEVEL OF CONCERN  
COLOR CODE IS GREEN**

According to the regional seismic net, no strong events occurred during the past week. The seismic station KRY was restored to operation on Jan. 18. About 1-2 small local earthquakes occur every day.

*Avachinskaya Group of Volcanoes:*

53°15'N, 158°51'E;

**CURRENT LEVEL OF CONCERN  
COLOR CODE IS GREEN**

Seismicity at Avachinsky and Koryaksky volcanoes is at normal levels.

ALASKA VOLCANO ES UPDATE

Friday, January 28, 2000 2:00 PM ADT  
(2300 UT)

*Shishaldin Volcano:*

54°45.33'N 163°58.00'W Summit  
Elevation 9,373 ft (2,857 m)

**LEVEL OF CONCERN COLOR CODE  
IS GREEN**

The small explosions described in the January 21, 2000, update are continuing at a similar rate. These events are presumably phreatic (caused by the flashing of water to steam) and may represent a local hazard within a few hundred meters of the vent, but do not pose a hazard to aircraft. The occurrence of these events does not suggest that the likelihood of a large explosive eruption has increased. Therefore, we are staying at Color Code GREEN.

AVO is monitoring the situation closely and will issue further updates as the situation warrants.

*Alaska Volcanoes:*

No Change.

KAMCHATKAN VOLCANIC ACTIVITY  
INFORMATION RELEASE 00-4

Friday, January 28, 2000, 12:00 KST  
(0000 UTC)

*Klyuchevskaya Group of Volcanoes*

*Klyuchevskoy Volcano:*

56°03' N, 160°39' E; Elevation 4,750 m

**CURRENT LEVEL OF CONCERN  
COLOR CODE IS GREEN**

During the past week (Jan. 21-28), seismicity at the volcano was at background levels. Shallow earthquakes and tremor were registered. On January 21, a fumarolic plume rose 1500 m above the crater and extending 5 km to the east. On Jan. 22-23, a plume rose 200-500 m above the crater and extended 10 km to the northwest. On Jan. 26, a plume rose 50 m above the crater and extended 5 km to the southeast.

On other days, the volcano was obscured by clouds.

*Bezymianny Volcano:*

55°58'N, 160°36'E; Elevation 2,895 m  
**CURRENT LEVEL OF CONCERN  
COLOR CODE IS GREEN**

No seismicity was registered beneath the volcano. On January 21, a fumarolic plume rose 300 m above the volcano and extended to the east. On Jan. 22, weak fumarolic activity was observed. On other days, the volcano was obscured by clouds.

*Sheveluch Volcano:*

56°38' N, 161°19' E; Elevation 2,447 m  
**CURRENT LEVEL OF CONCERN  
COLOR CODE IS YELLOW**

**PREVIOUS LEVEL OF CONCERN  
COLOR CODE WAS GREEN**

Seismicity under the volcano was mainly at background levels. On Jan. 21, a fumarolic plume rose 400 m above the crater and extended >5 km to the east. At 01:00 AM KST, on Jan. 23, and at 4:28 AM KST, on Jan. 26, seismic data indicated a short-lived gas-ash explosions probably occurred as two 20-minute-long episodes of shallow earthquakes and tremor were registered. The volcano was obscured by clouds on January 23-26. On the morning of Jan. 27, the volcano was quiet, but the western flanks of the volcano were covered with gray ash that may have been associated the explosions on the dome.

*Karymsky Volcano:*

54°03'N, 159°27'E; Elevation 1,486 m  
**CURRENT LEVEL OF CONCERN  
COLOR CODE IS GREEN**

According to seismic station KRY data, about 1-2 small local earthquakes occur every day.

*Avachinskaya Group of Volcanoes:*

53°15'N, 158°51'E;

**CURRENT LEVEL OF CONCERN  
COLOR CODE IS GREEN**

About 5-20 local events with magnitude not more than M0 were recorded during the past week at Avachinsky; a fumarolic plume rose 100-500 m above the crater. Seismicity at Koryaksky was at normal levels.

INFORMATION RELEASE

ALASKA VOLCANO OBSERVATORY

Thursday, February 3, 2000 11:00 AM  
AST (2000 UT)

*Shishaldin Volcano:*

54°45.33'N 163°58.00'W (CAVW  
#1101-36)

Summit Elevation 9,373 ft (2,857 m)  
**LEVEL OF CONCERN COLOR CODE  
IS YELLOW**

**PREVIOUS LEVEL OF CONCERN  
COLOR CODE WAS GREEN**

Small low-frequency seismic events, present at Shishaldin volcano since June of last year, have gradually increased in amplitude over the last week, with a noticeable increase occurring over the last 24 hours. Seismic data also continues to show the presence of small explosions, which we interpret to be phreatic (caused by the flashing of water to steam). Reports of steam plumes have been received over the last week, with heights reaching as high as ~3,000 feet above the summit. However, no thermal anomaly has been observed in satellite imagery and no seismic tremor has been identified; both were seen prior to the last eruptive episode in April and May of 1999. For these reasons, we are raising the Level of Concern Color Code to YELLOW at Shishaldin.

AVO is monitoring the situation closely with real-time satellite and seismic data and will issue further updates as the situation warrants.

*Alaska Volcanoes:*

No Change.

ALASKA VOLCANOES UPDATE

Friday, February 4, 2000 11:30 AM  
AST (2030 UT)

*Shishaldin Volcano:*

54°45.33'N 163°58.00'W (CAVW  
#1101-36)

Summit Elevation 9,373 ft (2,857 m)  
**LEVEL OF CONCERN COLOR CODE  
IS YELLOW**

Small low-frequency seismic events, present at Shishaldin volcano since last summer, continue to have elevated amplitudes. Seismic data also continue to show the presence of small explosions, which we interpret to be phreatic (caused by the flashing of water to steam). Reports of steam plumes have been received over the last week, with heights reaching as high as ~3,000 feet above the summit. However, no thermal anomaly has been observed in satellite imagery and no seismic tremor has been identified; both were seen prior to the last eruptive episode in April and May of 1999. Due to the elevated seismicity, we are maintaining the Level of Concern Color Code for Shishaldin at YELLOW.

AVO is monitoring the situation closely with real-time satellite and seismic data and will issue further updates as the situation warrants. over 45,000 ft (13,900 m) ASL. Shishaldin volcano is located near the center of Unimak Island in the eastern Aleutians. The cone has a

base diameter of approximately 10 miles (16 km) and a small summit crater that typically emits a steam plume with occasional small amounts of ash.

*Alaska Volcanoes:*

No Change.

KAMCHATKAN VOLCANIC ACTIVITY INFORMATION RELEASE 00-5

Friday, February 4, 2000, 12:00 KST (0000 UTC)

*Klyuchevskaya Group of Volcanoes Klyuchevskoy Volcano:*

56°03' N, 160°39' E; Elevation 4,750 m  
**CURRENT LEVEL OF CONCERN  
COLOR CODE IS YELLOW**

**PREVIOUS LEVEL OF CONCERN  
COLOR CODE WAS GREEN**

During the past week (January 29-February 3), seismicity at the volcano was above background levels. Shallow earthquakes and tremor were registered. On January 29, a fumarolic plume rose 1500 m above the crater extending 30 km to the southeast. On Jan. 30 - Feb. 1, a plume rose 50-500 m above the crater and extended up to 15 km to the south. According to Northwest Airlines and Reeve Aleutian pilot reports, and an Alaska Volcano Observatory observer on the Reeve flight, a gas-steam plume was observed on January 30, 14:40 KST, rising as high as 8,000 - 10,000 m ASL. In the morning of Feb. 3, the volcano was quiet. According to visual reports from Klyuchi town and pilot reports, on Feb. 3 at 17:08 KST, a short-lived explosive eruption sent an ash-poor plume to heights of 8,000-9,000 m ASL; an accompanying increase in seismic activity occurred. According to a satellite image on Feb. 3 at 18:25 KST, the plume extended 40 km south-southeast and had a large amount of water or ice. Seismic activity continues to be above background levels.

*Bezymianny Volcano:*

55°58'N, 160°36'E; Elevation 2,895 m  
**CURRENT LEVEL OF CONCERN  
COLOR CODE IS GREEN**

No seismicity was registered beneath the volcano. On January 28, 30, and February 1,3, a fumarolic plume rose 50-200 m above the volcano and extended 15 km to the south on Jan. 30. On other days, the volcano was obscured by clouds.

*Sheveluch Volcano:*

56°38' N, 161°19' E; Elevation 2,447 m  
**CURRENT LEVEL OF CONCERN  
COLOR CODE IS GREEN  
PREVIOUS LEVEL OF CONCERN  
COLOR CODE WAS YELLOW**

Seismicity under the volcano was mainly at background levels. On January 29-31, and February 2, a fumarolic plume rose 50-200 m above the volcano. On February 3, the volcano was quiet. On other days, the volcano was obscured by clouds.

*Karymsky Volcano:*

54°03'N, 159°27'E; Elevation 1,486 m  
**CURRENT LEVEL OF CONCERN  
COLOR CODE IS GREEN**

According to seismic station KRY data, about 1-5 small local earthquakes occur every day.

*Avachinskaya Group of Volcanoes:*

53°15'N, 158°51'E;  
**CURRENT LEVEL OF CONCERN  
COLOR CODE IS GREEN**

Seismicity at Avachinsky and Koryaksky volcanoes is at normal levels.

ALASKA VOLCANOES UPDATE

Friday, February 11, 2000 12:30 PM AST (2130 UT)

*Shishaldin Volcano:*

54°45.33'N 163°58.00'W (CAVW #1101-36)

Summit Elevation 9,373 ft (2,857 m)  
**LEVEL OF CONCERN COLOR CODE  
IS YELLOW**

Small low-frequency seismic events, present at Shishaldin volcano since last summer, continued this past week at a slower rate and slightly lower amplitude. Seismic data also continue to show the presence of small explosions, which we interpret to be phreatic (caused by the flashing of water to steam). No thermal anomaly has been observed in satellite imagery and no seismic tremor has been identified; both were seen prior to the last eruptive episode in April and May of 1999. Due to the elevated seismicity, we are maintaining the Level of Concern Color Code for Shishaldin at YELLOW.

AVO is monitoring the situation closely with real-time satellite and seismic data and will issue further updates as the situation warrants.

*Alaska Volcanoes:*

No Change.

KAMCHATKAN VOLCANIC ACTIVITY INFORMATION RELEASE 00-6

Friday, February 11, 2000, 11:00 KST (2300 UTC)

*Klyuchevskaya Group of Volcanoes Klyuchevskoy Volcano:*

56°03' N, 160°39' E; Elevation 4,750 m  
**CURRENT LEVEL OF CONCERN  
COLOR CODE IS GREEN  
PREVIOUS LEVEL OF CONCERN  
COLOR CODE WAS YELLOW**

During the past week (Feb.4-10), seismicity at the volcano was above background levels. Shallow

earthquakes and tremor were registered. At 18:15 KST on Feb. 8, seismic data indicated a short-lived explosion probably occurred as a series of shallow events was recorded. On Feb. 4-5, a fumarolic plume rose 200-500 m above the crater and extended 3-40 km to the west and southwest. On Feb. 10, the volcano was obscured by clouds.

*Bezymianny Volcano:*

55°58'N, 160°36'E; Elevation 2,895 m  
**CURRENT LEVEL OF CONCERN  
COLOR CODE IS GREEN**

No seismicity was registered beneath the volcano. On Feb. 4, weak fumarolic activity was observed. On Feb. 5-8, and 10, a fumarolic plume rose 100-800 m above the volcano. On Feb. 9, the volcano was obscured by clouds.

*Sheveluch Volcano:*

56°38' N, 161°19' E; Elevation 2,447 m  
**CURRENT LEVEL OF CONCERN  
COLOR CODE IS GREEN.**

Seismicity under the volcano was mainly at background levels. On Feb. 4-5, a fumarolic plume rose 50-300 m above the volcano. On the morning of Feb. 6, the volcano was quiet but after 14:00 KST and on the morning of Feb. 7, a fumarolic plume rose 700 m above the crater. According to visual reports from Klyuchi town, on Feb. 7 at 16:53 KST, a short-lived explosive eruptions sent an ash-poor plume to heights of 1500 m above the dome (~4,000m ASL); an accompanying increase in seismic activity occurred. At 18:00 KST a plume rose 700 m above the dome and extended 5 km to the northwest. Satellite images from 18:30 KST on Feb. 7 and 04:30 on Feb. 8 did show any plume or thermal anomaly. On Feb. 8-9, the volcano was obscured by clouds.

*Karymsky Volcano:*

54°03'N, 159°27'E; Elevation 1,486 m  
**CURRENT LEVEL OF CONCERN  
COLOR CODE IS GREEN**

According to seismic station KRY data, seismicity at the volcano was at background levels.

*Avachinskaya Group of Volcanoes:*

53°15'N, 158°51'E;  
**CURRENT LEVEL OF CONCERN  
COLOR CODE IS GREEN**

Seismicity at Avachinsky and Koryaksky volcanoes is at normal levels.

KAMCHATKAN VOLCANIC ACTIVITY INFORMATION RELEASE 00-7

Sunday, February 13, 2000, 12:30 KST (0030 UTC)

*Karymsky Volcano:*

54°03'N, 159°27'E; Elevation 1,486 m

**CURRENT LEVEL OF CONCERN  
COLOR CODE IS YELLOW  
PREVIOUS LEVEL OF CONCERN  
COLOR CODE WAS GREEN**

After two months of quiescence, seismic activity beneath the volcano has been renewed. At 06:35 AM KST, on February 12, seismic data indicated a short-lived gas-ash (or gas) explosion probably occurred as a 5-minute-long seismic signal was recorded by the nearest seismic station KRY. Following this event, about 100 explosive earthquakes and gas blowouts were registered per day. Seismic activity is continuing.

**KAMCHATKAN VOLCANIC ACTIVITY  
INFORMATION RELEASE 00-8**

Friday, February 18, 2000, 12:00 KST  
(0000 UTC)

*Klyuchevskaya Group of Volcanoes  
Klyuchevskoy Volcano:*  
56°03' N, 160°39' E; Elevation 4,750 m  
**CURRENT LEVEL OF CONCERN  
COLOR CODE IS GREEN**

During the past week (Feb. 11-17), seismicity at the volcano was at background levels. Shallow earthquakes were registered. On Feb. 11, a fumarolic plume rose 100 m above the crater. On other days, the volcano was obscured by clouds.

*Bezymianny Volcano:*  
55°58' N, 160°36' E; Elevation 2,895 m  
**CURRENT LEVEL OF CONCERN  
COLOR CODE IS GREEN**

Seismicity under the volcano was slightly above background levels as seven shallow earthquakes were registered beneath the volcano. On Feb. 16, a fumarolic plume rose 50 m above the volcano and extended >50 km to the southwest. On other days, the volcano was obscured by clouds.

*Sheveluch Volcano:*  
56°38' N, 161°19' E; Elevation 2,447 m  
**CURRENT LEVEL OF CONCERN  
COLOR CODE IS GREEN**

Seismicity under the volcano was at background levels. On Feb. 11-12, a fumarolic plume rose 200-500 m above the volcano. On other days, the volcano was obscured by clouds.

*Karymsky Volcano:*  
54°03' N, 159°27' E; Elevation 1,486 m  
**CURRENT LEVEL OF CONCERN  
COLOR CODE IS YELLOW**

After two months of quiescence, seismic activity beneath the volcano has been renewed. At 06:35 AM KST, Feb. 12, seismic data indicated a short-lived gas-ash (or gas) explosion probably occurred as a 5-minute-long seismic signal was recorded by the nearest seismic station KRY. Following this event, about 5-10

seismic events per hour on average mainly corresponding to the explosions were registered along with a few blowouts and pyroclastic flow (?) signals. Since noon of Feb. 15, seismic activity has increased up to 40 events per hour. A continuous series of seismic events (pyroclastic flows?) were registered from 16:20-18:10 KST on Feb. 15. Satellite images from 17:15 KST and 18:55 KST on Feb. 15 did not show any plume rising above the tops of the weather clouds, about 4 km ASL.

**ALASKA VOLCANOES UPDATE**

Friday, February 18, 2000 1:30 PM  
AST (2230 UT)

*Shishaldin Volcano:*  
54°45.33' N 163°58.00' W (CAVW  
#1101-36)

Summit Elevation 9,373 ft (2,857 m)  
**LEVEL OF CONCERN COLOR CODE  
IS GREEN**

**PREVIOUS LEVEL OF CONCERN  
COLOR CODE WAS YELLOW**

Seismic activity has declined significantly at Shishaldin volcano. February 4th marked the last day that appreciable numbers of seismic events were detected. This was also the last day that the presence of small explosions was observed. No thermal anomaly has been observed in satellite imagery and no pilot or ground observations of unusual activity have been reported. The Level of Concern Color Code has therefore been changed to GREEN.

*Alaska Volcanoes:*  
No Change.

**ALASKA VOLCANOES UPDATE**

Friday, February 25, 2000 11:30 AM  
AST (2030 UT)

*Shishaldin Volcano:*  
54°45.33' N 163°58.00' W (CAVW  
#1101-36)

Summit Elevation 9,373 ft (2,857 m)  
**LEVEL OF CONCERN COLOR CODE  
IS GREEN**

The small low-frequency seismic events have continued over the last week at Shishaldin volcano. Very low-level tremor has also been detected during the past week, although at or below levels observed months prior to the April 19th, 1999, eruption. No thermal anomaly has been observed in satellite imagery and no pilot or ground observations of unusual activity have been reported. Because the nature of the seismic activity is very low, the absence of a thermal anomaly, and no reports of unusual activity, we are staying at Color Code GREEN.

*Alaska Volcanoes:*  
No Change.

**KAMCHATKAN VOLCANIC ACTIVITY  
INFORMATION RELEASE 00-9**

Friday, February 25, 2000, 12:00 KST  
(0000 UTC)

*Klyuchevskaya Group Of Volcanoes  
Klyuchevskoy Volcano:*  
56°03' N, 160°39' E; Elevation 4,750 m  
**CURRENT LEVEL OF CONCERN  
COLOR CODE IS GREEN**

During the past week (Feb. 18-24), seismicity at the volcano was at background levels. Shallow earthquakes were registered. On Feb. 23 and 24, a fumarolic plume rose 100 m above the crater, extending 1-3 km to the south. On other days, the volcano was obscured by clouds.

*Bezymianny Volcano:*  
55°58' N, 160°36' E; Elevation 2,895 m  
**CURRENT LEVEL OF CONCERN  
COLOR CODE IS GREEN**

Seismicity under the volcano was slightly above background levels. On Feb. 23 and 24, a fumarolic plume rose 50 m above the volcano and extended >10 km to the south. On other days, the volcano was obscured by clouds.

*Sheveluch Volcano:*  
56°38' N, 161°9' E; Elevation 2,447 m  
**CURRENT LEVEL OF CONCERN  
COLOR CODE IS GREEN**

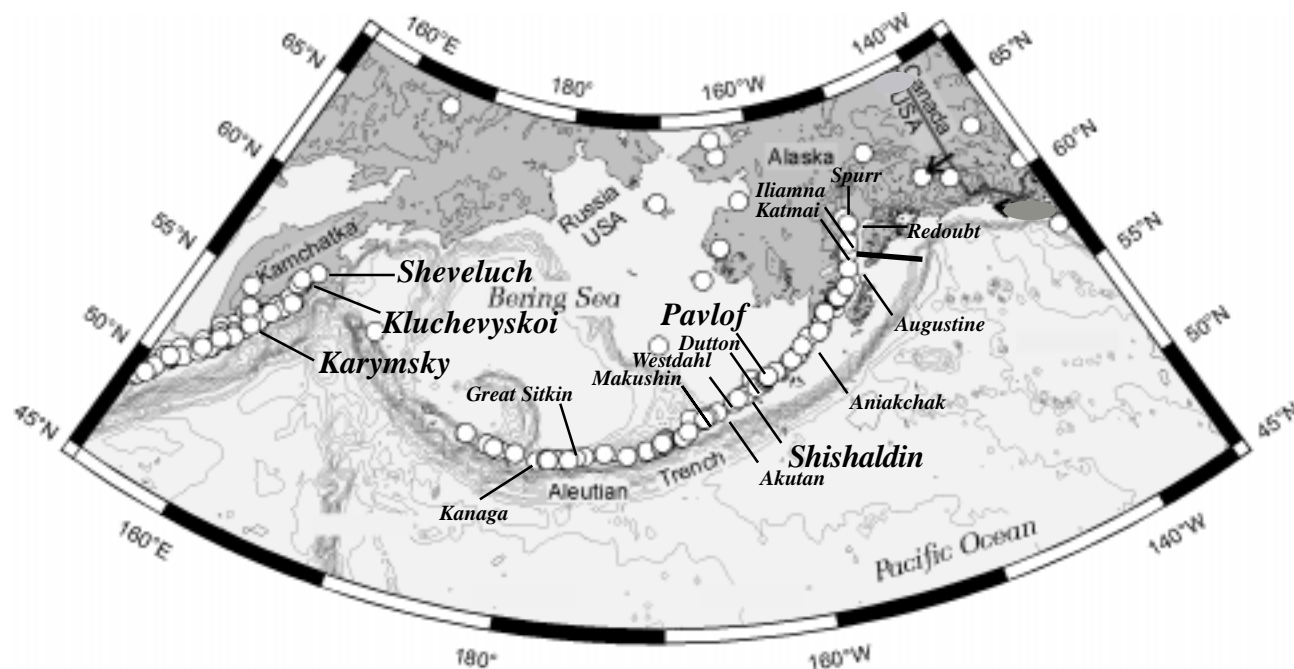
Seismicity under the volcano was at background levels. On Feb. 20 at 18:53 KST, there was a possible weak gas-steam plume. On Feb. 24, a fumarolic plume rose 100 m above the volcano. On other days, the volcano was obscured by clouds.

*Karymsky Volcano:*  
54°03' N, 159°27' E; Elevation 1,486 m  
**CURRENT LEVEL OF CONCERN  
COLOR CODE IS YELLOW**

The low-level strombolian eruptive activity that has characterized the volcano for much of the past four years continues. During the past week, the number of gas and ash explosions decreased from 600 per day to 25. On Feb. 18 from 12:30 until 16:20 KST, a weak volcanic tremor was registered. According pilot reports on Feb. 20 and 21, these explosions sent material to 1500 m above the volcano.

*Avachinskaya Group of Volcanoes:*  
53°15' N, 158°51' E;  
**CURRENT LEVEL OF CONCERN  
COLOR CODE IS GREEN**

Seismicity at Avachinsky and Koryaksky volcanoes is at normal levels.



Map showing Alaska Peninsula, Aleutian arc and Kamchatka Peninsula and subregions of study. White circles are volcanoes. Names are given for all monitored volcanoes, including Kamchatkan volcanoes mentioned in this report.

For further information and/or contributions to this newsletter please contact:

U.S. Geological Survey  
Alaska Volcano Observatory  
4200 University Ave.  
Anchorage, AK 99508  
(907) 786-7497

Alaska Volcano Observatory  
Geophysical Institute  
University of Alaska Fairbanks  
P.O. Box 757320  
Fairbanks, AK 99775-7320  
(907) 474-5681



Alaska Division of Geological and  
Geophysical Surveys  
Alaska Volcano Observatory  
794 University Ave., Suite 200  
Fairbanks, AK 99709  
(907) 451-5010

U.S. Geological Survey  
Cascades Volcano Observatory  
5400 MacArthur Blvd.  
Vancouver, WA 98661  
(360) 993-8942

U.S. Geological Survey  
Alaska Volcano Observatory  
345 Middlefield Rd.  
Menlo Park, CA 94025  
(650) 329-5228