Table 1. Satellite Observations of Alaska and Kamchatka Volcanoes for the Months of January - April, 1998

January	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
Bezymianny		X	X			X							X		X	X				X			X							X	
Katmai Lake		X		X									X				X	X	X												
Karymsky Lake														X																	
Karymsky																X						X									
Kenai			X								X	X	X			X	X	X	X												
Okmok								X														X	X		X	X	X				X

February	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
Bezymianny			X					X	X			X	X																		
Katmai Lake														X	X	X						X					X				
Kenai																						X									
Karymsky			X						X		X	X	X		X					X	X	X	X				X	X			
Okmok	X			X	X																										

March	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
Bezymianny																															
Karymsky	X	X		X	X						X	XP	X			X	XP	XP					X				XP	X		X	X
Kenai		X		X	X																										
Katmai Lake																															
Okmok																															

April	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
Karymsky	X			X		X	X	X								XP	X						X	X		X	X	X			

Legend
X = Satellite Observations including hot spots and plumes
Blanks = no observations, or cloud cover prevented observations

Seismicity

Spurr
A total of 125 earthquakes were located in the general vicinity of Spurr during January-February (figs. 3A, 13A and 14A). The largest such event had a magnitude of 2.6.However, this event was located in the Strandline Lake region (northeast corner of the map). There were a total of 105 Strandline Lake events. As usual, the discussion will be restricted to the 20 non-Strandline Lake earthquakes. The largest non-Strandline Lake event had a magnitude of 2.1 and was located about 2 km north of the summit of Spurr. This is a relatively large event for this area. A total of nine events were located within 10 km of the summit. Seven of these events were located within ~2 km of the summit. One of the other proximal events was located about 2 km east-southeast of the Crater Peak or about 5 km southsoutheast of the summit. The ninth proximal event was located slightly less than 10 km east-southeast of the summit. The remaining 11 non-Strandline Lake events were all located relatively far away from both Spurr and Crater Peak, and thus are probably regional tectonic events unrelated to volcanic activity in the Spurr area. The number of events located within 10 km of the summit of Spurr during January-February is virtually the same as that of the previous two-month interval. This value is, however, about half the number of proximal events predicted from the 4-year mean seismicity rate.

During March-April a total of 93 earthquakes, the largest of which had a magnitude of 2.3, were located in the Spurr region (figs. 3B, 13B and 14B). Twenty-nine of the 93 located earthquakes were not located in the Strandline Lake area. The largest of the non-Strandline Lake events had a magnitude of 1.5 and was located about 1 km south-southeast of the summit of Spurr. A total of 24 earthquakes were located within 10 km of the summit. Twenty of these events formed a north-south trending zone of activity about 4 km in length and more or less centered on the summit. Two of the remaining four proximal events were located about 7 km south of the summit, while the other two events were located about 6 km east and 7 km west of the summit. The five more distal non-Strandline Lake events were located relatively far away from both Spurr and Crater Peak, and thus are probably just tectonic events unrelated to volcanic activity in this region. The number of events located within 10 km of the summit of Spurr during March and April greatly exceeds the corresponding value for January-February. The March-April value is also greater than the 17 proximal events predicted from the 4-year mean seismicity rate. The relatively low number of Strandline Lake events located during this two-month time period may, to some extent, be due to the temporary outage of seismic station NCG for nearly all of April.

Karymsky

Karymsky showed increased surface temperatures starting in early January (two observations) but by February hot pixels caused by a lava flow were frequently observed. The increased activity continued through April. Hot spot temperatures ranged from 36 to –15 °C and background temperatures from 5 to -26 °C with the size ranging from 1 to 6 pixels. Plumes were observed on 17 and 18 March with the longest (137 km) on 16 April.

The geothermally-heated Karymsky Lake was observed twice during this period, on 13 January and on 27 March. Temperatures at the time of the January observation were 2.3°C with a background of –25°C. The lake is seen in the winter due to the colder temperatures

Katmai Region

The geothermally-heated Katmai Lake was observed six times in January and throughout February. The lake had temperatures from 0 to –3.3°C with a background temperatures of –12 to –15 °C. The anomaly was not observed in March or April probably due to increasing surface temperatures which decreases the thermal contrast between the lake and the surrounding land.

Okmok

In January, the Okmok lava flow had temperatures that ranged from -10 to 15 degrees C with background temperatures around –10 degrees C. The anomaly was slightly warmer in February ranging from –4.7 degrees C to 23 degrees C with background temperatures around –8 degrees C. The temperatures may be slightly warmer due to the anomaly being observed in daytime images. The Okmok lava flow was not observed in March or April.

Kenai Region

The Kenai anomaly was observed in the beginning of January about 15 degrees C above background. The anomaly was not seen again until February 22 in three images on the same day. On March 2, the anomaly was observed again with temperatures at 27 degrees above background and on 3 March 17 ° C above background. The Kenai anomaly was not observed in the month of April.

Shelly Worley, Jon Dehn, Kevin Engle, Ken Dean, Dave Schneider and Deb Coccia

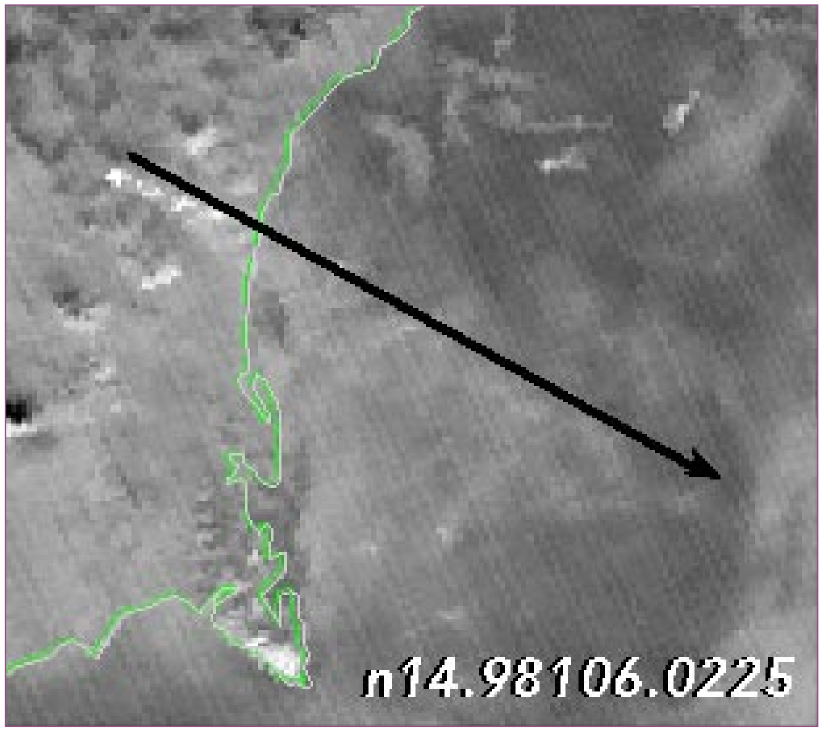
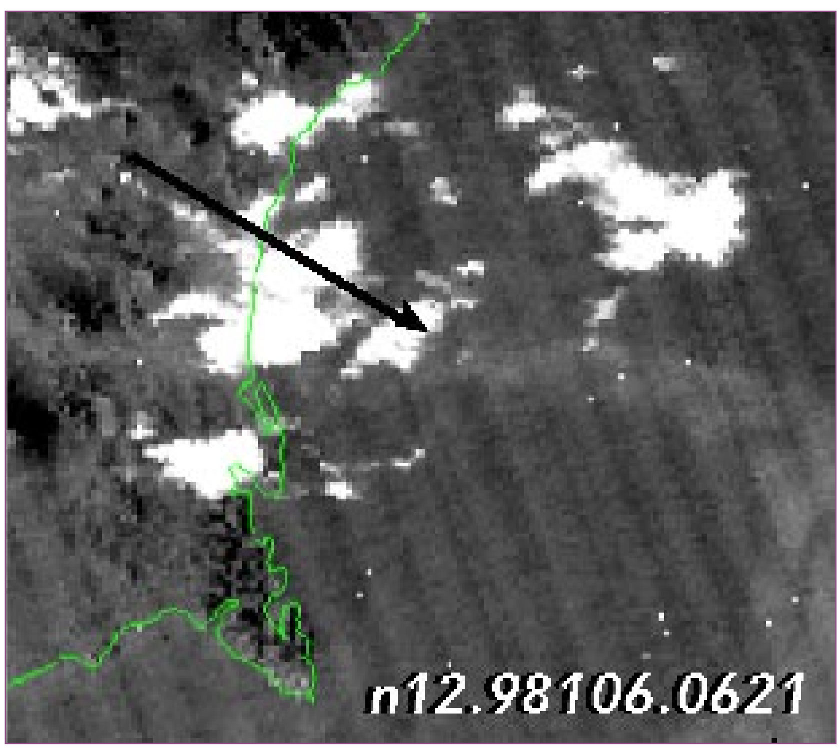


Figure 1: NOAA satellite images recorded on day 106J (16 April) show the plume from Karymsky Volcano blowing SE. The arrows are above the volcano, and start at the volcano and extend to the end of the plume.

Figure 2: The narrow and mostly quasi-transparent plume is about 140 km long (0225 UT), and approximately 70 km long two hours later (0621 UT). The arcurate structure ahead of the plume appears on both images and is not considered as part of the plume.



see next page for table

ers proved to be a higher bar than we could clear this time. The hazard argument fell prey to the objection that more assets are at risk to volcanoes and earthquakes elsewhere. Citation of scientific opportunities was countered with objection to the added expense of operations in this part of the world and the absence of enough background data to know "where to begin", versus better-trod places, (and, I think, by a profound ignorance of what is here, that comes from decades of neglect). The international collaboration aspect was not really evaluated. In general, much of the volcanological and seismological communities would prefer to work in warmer climes and generally closer to home (with occasional exceptions made for missionary work). Inclusion of solid earth activities in the Arctic polar funding pie is not accepted as a topic for polite conversation, though by tradition it is in the Antarctic. It would be easy to whine about this, and I already have, but the challenge is to mount a "Solid Earth Science Rush" in the Far North, one hundred years after the Gold Rush.

What is the case for a comprehensive, multi-disciplinary investigation of the Aleutian Volcanic Arc? The arc is vigorously active yet beautifully simple: the quintessential arc without which such structures would probably not be called "arcs". It is the birthplace of the subduction paradigm. Critical parameters of subduction, such as angle of convergence, sediment load, composition of the overriding plate, change in a regular way along strike, allowing a test of their influence on both magmatic and seismic processes. If there can be a coordinated, collaborative approach to such a study, the logistical challenges will be tractable. Advances in our science will come not just from ever-more sophisticated studies of the known. There remain important tasks in the exploration of the unknown.

John Eichelberger

Non-Eruptions

AVO was kept hopping by many reports of "steaming" from Spurr, probably Crater Peak, on March 26th. The "steam" was actually meteorological in origin. Also, a severe storm with high winds in the vicinity of Akutan volcano produced tremor-like seismic signals during April 10-11. This required 36 hours of response by AVO until the storm blew through and there was verification that no volcanic activity had occurred.

Terry EC Keith

Monitoring

Satellite observations of Alaska and Kamchatka volcanoes

AVO monitors volcanoes in Alaska and Kamchatka using the relatively high spatial resolution and nadir view of polar-orbiting satellites, and the high temporal resolution provided by geostationary satellites. All of these systems include visible and thermal infrared wavelength data.

The polar orbiting system used is the Advanced Very High Resolution Radiometer (AVHRR) on the NOAA-12 and -14 satellites. Images are recorded in five spectral bands at a spatial resolution of 1.1 km at nadir. Alaskan volcanoes are received by the ground station at the Geophysical Institute, University of Alaska Fairbanks, and are analyzed daily to detect volcanic eruption clouds and thermal anomalies at volcanoes in the north Pacific region. Repetitive coverage by these data are eight images per day for Alaska volcanoes and approximately 4 images per day for Kamchatka Volcanoes. The timing of satellite passes are not distributed evenly over the 24-hour time frame.

Geostationary data are received from the GMS and GOES Satellites via computer networks at AVO-Anchorage, and provide off-nadir observations of the western North Pacific (GMS), and the eastern North Pacific (GOES). Hourly GMS data (4km resolution in the visible and TIR) are available for analysis within 75 minutes after receipt by a ground station. GOES data are available at 15-minute and 30-minute intervals at resolutions of 1 km (visible band), and 4 km (TIR bands), within 15-30 minutes after receipt by a ground station.

During this period our attention was primarily focused on eruptions at Bezymianny and Karymsky Volcanoes in Kamchatka, but there were additional observations of volcanic-related thermal features at Katmai Lake, Karymsky Lake, and Okmok Caldera. The Bezymianny and Karymsky eruptions are phases of ongoing activity including dome heating and cooling, lava flows and short-lived phreatic bursts. Katmai and Karymsky lakes are geothermally heated but their detection is probably related to the lowering of surrounding ground temperature and not increased water temperatures related to volcanic activity. The Okmok Caldera temperatures are related to the cooling of the lava flow. A periodically re-occuring hot spot on the Kenai Peninsula was observed and monitored. This hot spot is thought to be related to the clearing of land and burning of trees and brush.

Table 1 shows dates of eruptions or reports of volcanic-related activity at these volcanoes. Note, hot spots mentioned in the report are Band 3 pixels with elevated temperatures, and that the AVHRR Band 3 sensor saturates a approximately 50 °C. A lava flow or hot ground need occupy only a portion of a pixel to increase the temperature.

Satellite Data Base: This is the first bi-monthly report that used the online satellite data base of observations to derive the table and other descriptions. The satellite information was readily available as opposed locating individual journals for each analyst to compile the summary. The availability of the online data base is very timely with satellite monitoring now split between Fairbanks and Anchorage.

Bezymianny

Bezymianny showed increased surface temperatures in January and February ranging from 4 to –18 °C with background –12 to –35 °C. The size of the anomaly ranged from 1 to 4 pixels.

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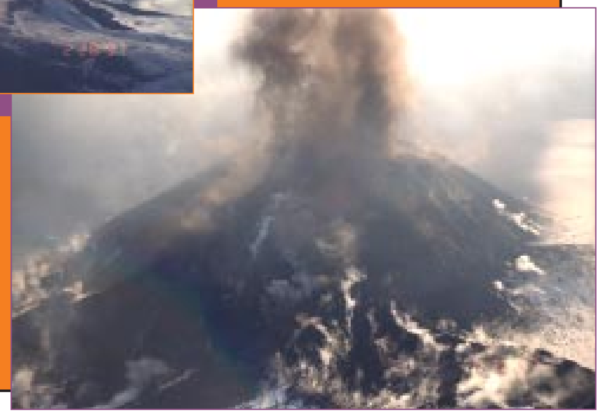
AVO is a cooperative program of the U.S. Geological Survey,[1] University of Alaska Fairbvanks, Geophysical Institute[2], and the Alaska Division of Geological and Geophysical Surveys[3]. Scientist-in-Charge: Terry Keith [1A] (907) 786-7443, email: tkeith@tundra.wr.usgs.gov Coordinating Scientist: John C. Eichelberger[2] (907) 474-5530, email: eich@gi.alaska.edu This report was edited by John C. Eichelberger and designed and prepared by Jean Sobolik, email: jsobolik@gi.alaska.edu Cover photos: Okmok Volcano in eruption, February, 1997, by John Sease, NOAA.

In This Issue



Highlights and Summary

- Meteorological conditions triggered numerous reports of vigorous “steaming” of Mount Spurr Volcano on March 26.
- Persistent tremor-like signals from Akutan seismic stations during April 10-11 were identified, after a period of considerable concern, as caused by a severe storm rather than volcanic activity.
- There were modest swarms of seismicity at Akutan, Makushin, and Augustine Volcanoes.
- A comprehensive geophysical study of the Aleutian Volcanic Arc was proposed to NSF.

Winter is a time when cabin fever leads to strange quests, and this winter was no exception. Amid the darkness, it became apparent to a number of us that basic geoscience in the Aleutian Volcanic Arc was not proceeding apace with the expansion of the volcano monitoring effort. This of course is not to say that AVO’s activities are without a scientific component. We have indeed been fortunate to be able to carry out substantial supporting investigations as we work our way westward with seismic instrumentation. Nevertheless, there is a basic underpinning of understanding of the “big picture” that is present in the rest of the US but is not present in the Aleutians, and which can not be rightfully funded out of a program of volcano hazard mitigation. Can arguments about hazards of volcanoes, earthquakes, and tsunamis; the “world class” scientific character of Earth features and rates of Earth dynamics in the Aleutian Arc; and the promise of peaceful international collaboration on our border where once there was hot and cold war, be married to launch a new voyage (literally, because large ships are required) of discovery?

An opportunity was provided by the competition for new Science and Technology Centers in the National Science Foundation’s Science Infrastructure Division. The intent of this program is to establish multi-disciplinary centers of excellence to address themes of great scientific and societal timeliness, with a decade-long anticipated life and a budget that can accomplish goals beyond the realm of the normal small-grant program. A cross-geoscience study of the fundamental Earth processes that are producing Aleutian Arc volcanism and seismicity seemed like a good candidate for such a center. In addition, the center could be seen as a mechanism to open the door to much broader participation in the science by academic and other institutions, both in the “Lower-49 States” and from other countries, than can currently be achieved within AVO’s monitoring-focused mission and resources. The center was envisioned as a broadly collaborative undertaking with a physical base in Fairbanks that would serve as a nucleus for both scientific exchange and for logistical support. The goals would be to “image” and understand the North Pacific plate boundary, and individual magma systems within it.

Accordingly, organizational meetings for proposal development were held at National GSA in Salt Lake City, Fall AGU in San Francisco, and then in Fairbanks. (The latter was augmented by a visit to the local hot springs to help our Japanese colleagues fend off the January chill.) Results are presented in this report. Unfortunately, however, the marshalling of the various arguments sufficient to convince the review-

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