Alaska Volcano Observatory

September/ December 1997

Vol. 9 Nos. 5 & 6

BiMonthly Report

Double Issue

USGS ADGGS UAFGI

Highlights and Summary

- A significant eruption occurred at Bezymianny Volcano, Kamchatka, lofting ash to flight levels.
- Although the Bezymianny eruption occurred without detected precursory seismicity, AVHRR satellite data revealed a thermal anomaly two days before the main outburst.
- Unusually robust steam plumes issued from Mageik and Martin Volcanoes on the Alaska Peninsula.
- Chiginagak Volcano on the Alaska Peninsula began a period of increased fumarolic activity.
- The Aleutian Volcanic Arc remains rather quiet, both seismically and volcanically, during this report period

With this report, AVO reaches the point of monitoring 16 volcanoes seismically in real time. It might be worth mentioning, though it might also be an example of hubris, that this is quite a few volcanoes for a single volcano observatory to watch. It might also be pertinent to observe that, among scientists, the rush to apply new technology to research at Aleutian Arc volcanoes has not exactly been a stampede. A further related observation is that as we reach farther and farther out into the Aleutian Arc, the geological and geophysical basic research underpinnings of our efforts become thinner and thinner. We are doing monitoring, we do as much science as we can in the process, but what of the "big picture" scientifically? The one federally big picture effort here took place more than half a century ago, and for military rather than scientific reasons. I have now been here long enough to find this odd, and it is perhaps appropriate to reflect on it, as AVO has now been here even longer, 10 years.

er

Is it that there is not sufficient scientific interest here? The largest eruption on this planet during the past century and 3 of the top ten earthquakes occurred here. Indeed, the Aleutians were the birthplace of the subduction paradigm. And would magmatic arcs be called arcs if the geometrically beautifully Aleutians did not exist? Are not 14 Holocene caldera-forming eruptions within the Holocene remarkable? Is it lack of local population at risk? But is a village of 100 or 5,000 people not worth worrying about, or the nation's largest seafood port, or 15,000 international airline passengers per day, or much of the air and sea cargo between North American and eastern Asia? Are the local scientists not of sufficient stature? But surely senior scientists from long-established and prestigious international institutions are most welcome, as has been amply demonstrated by, for example, space physicists who come to study the aurora. Is it the expense of logistics? But we join together to overcome such impediments at more remote and expensive and less American places, like Antarctica. Are the Aleutians less a part of the United States than Chesapeake Bay or the Golden Gate? Is a 5000-km-long plate boundary, far longer and more seismically and volcanically active than the San Andreas fault and Cascades Range combined, of only "regional interest"? And what of national interest? If an exceptional planetary feature lies within a single state, however large, does this become of only local as opposed to national concern?

In This Issue

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: Pavlof Volcano in eruption September 1996: photo taken by S. Shulmeister, USFWS and video footage taken by Steve McNutt, UAFGI.

I suspect that the neglect of the Aleutians is not a rational one but an accident of habit, history, and scientific comfort. For more than half a century, the Aleutians were close to hot and cold wars—not a friendly place for science. Until now, power and telemetry of data were big issues, but we have conquered this in far more distant and hostile environments. The technology of getting places has similarly advanced, though in difficult places we must work in team-mode rather than solitary-hero mode. The only obstacle that remains is comfort. We must be willing to plan ahead, to join forces, to forego the one-week-hero in the pickup role within easy range of Hollywood and National Geographic cameras, and to get cold, wet and wind-blown. If we are going to continue to push the frontiers we must go to them. We must do field work in places not because it's fun or visible or cheap or easy but because we need to do it for reasons of both science and society.

John Eichelberger

Eruptions

Anomalous steam plumes at Martin and Mageik volcanoes reported from Karluk Village on Kodiak Island

On the morning of December 11, 1997, Ronnie Lind, a long-time resident of Karluk Village on Kodiak Island who works at the school, reported anomalous steam plumes from both Martin and Mageik volcanoes. He had been watching the peaks with a spotting scope from the school for the past 3 weeks when suddenly, white, towering steam clouds billowed up from Martin, quit, billowed up again up to 600-700 ft above the vent, mushroomed out at the top and then dissipated. He reports that the top of Martin is black. Then a second white, towering, billowing steam plume appeared at Mageik. Any substantial plume from Mageik is unusual. The two steam plumes were definitely white, with no gray or dark color to them. By 2:20pm AST, Ronnie reported the steaming of Mageik had stopped and steam plume at Martin was less vigorous. The large puffing plume from Martin and the large plume from Mageik are very unusual according to Ronnie's experience.

Although there had been a small seismic swarm last week between Mageik and Martin, there was no unusual seismicity during this period and there was none at the time of the anomalous steam plumes. NWS Aviation Weather for King Salmon-Kodiak reported cold invection with NW flow in the area; good conditions for enhanced cloud formation along the mountain chain.

We conclude that these were meteorologically enhanced steam plumes from Martin and Mageik volcanoes. The phenomenon of a large steam plume from both volcanoes at the same time and the puffing of the Martin plume is unusual but not unexpected. Mount Martin's summit area is usually dark from active fumarolic heat melting off the snow. Martin steams almost all the time because of numerous active fumaroles in the crater; Mageik is usually pretty quiet, though small wispy plumes are usual and large steam plumes have been reported from King Salmon NWS and overflying pilots at least every few years.

TEC Keith

Bezymianny

AVHRR imagery showed a growing thermal anomaly at Bezymianny volcano (fig.1) 29 hours before an explosive eruption emitted a plume on day 338 (4 December). The plume was monitored on AVHRR and GMS imagery (fig. 1 & 2). On December 2, a two-pixel thermal anomaly was observed at Bezymianny (image n14.97336.1600). Both pixels were at 3.4°C with background temperatures of -25°C. The next day a three-pixel anomaly on the southern flank of Bezymianny was observed with temperatures around -6 °C on a background of -30 °C (image n14.97337.1550). On December 4, image n14.97338.1538 showed a 12 pixel anomaly with maximum temperatures at 27°C with background temperatures of ca. -25°C. In GMS imagery, an eruption cloud was observed at 1930 Z. The plume continued to grow and spread to the east. Image n14.97339.0132 showed a diffuse cloud 250 km long extending to the east. A circular "mushroom" cloud, 50 km in diameter, was visible over the vent. In band 4, the temperature of the cloud was -52°C. Image n14.97339.0622 showed two regions of ash in band 4 minus 5. The main region of ash was detached from the vent and reached 130 km to the northeast. A very diffuse cloud, possibly from the first event at 1930 Z, was observed extending 300 km east of the vent. These clouds were only observed in band 4 minus 5 which suggests that there was a considerable amount of ash present in the cloud. In the same image, a 20-pixel anomaly was present at the vent, its maximum temperature was 25°C with background temperatures around -35°C.

On the morning of December 5, in image n12.97339.1527, an ash cloud was observed streaming to the northeast. In band 4 minus 5, the cloud was had a temperature of -4°C. A faint steam cloud was observed southeast from the vent. This cloud was not observed in band 4 minus 5, indicating the cloud was ash-poor. Later that evening, in image n14.97340.0120, a similar ash-poor cloud was observed attached to the vent and extending 280 km to the southeast. The cloud was 100-km wide where it crossed over the coastline. A twelve-pixel thermal anomaly was observed at the volcano: six pixels at 49°C and six pixels at 40°C, expanding to a fourteen pixel anomaly in image n12.97340.0600.

On December 6, a six-pixel thermal anomaly was observed. Three pixels were close to saturation at 49°C, other pixels at 40°C, 18°C, and 13°C with background temperatures as low as -25°C. In band 4 minus 5, the plume is visible reaching 40 km in length extending eastward from the anomaly. This was the last significant plume seen. Over the next week, the thermal anomaly faded to 2-3 pixels with all at less than saturation with a few reversals, this trend continued until only one warm pixel was visible on December 31, the last day of this report period.

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

Monitoring

Satellite observations of Alaska and Kamchatka volcanoes

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

The polar orbiting system 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. Data from North Pacific volcanoes are received by the ground station at the Geophysical Institute, University of Alaska Fairbanks and analyzed daily to detect volcanic eruption clouds and thermal anomalies. Repetitive coverage by these data are 8 images per 24 hours for Alaskan Volcanoes and approximately 4 images per 24 hours for Kamchatkan 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 1.25 hours after reception 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), respectively within 15-30 minutes after reception by a ground station.

During this period, our attention was primarily focused on the eruption of Bezymianny Volcano, but there were additional observations of volcanic-related activity from Okmok, Cleveland, Chiginagak and Karymsky volcanoes, and Katmai and Karymsky lakes. Table 1 shows dates of eruptions or reports of volcanic-related activity at these volcanoes. Hot spots mentioned in the report are Band 3 pixels with elevated temperatures. The AVHRR Band 3 sensor saturates at approximately 50°C. A lava flow or hot ground need occupy only a portion of a pixel to increase the apparent temperature indiated by the pixel.

Okmok

On September 1, a 4 pixel thermal anomaly was observed at Okmok in image n14.97244.1424. The anomaly was well over background temperatures with a maximum pixel temperature of 10°C. The Okmok anomaly peristed in the September 2 image n14.97245.1413. This eight pixel anomaly had a maximum temperature of 20°C with background temperatures around -1 °C. In image n14.97254.1415, a single pixel anomaly was observed with a temperature of 10°C. Background temperatures were at 3°C. On October 7, a two pixel anomaly was observed in image n14.97280.1413. The maximum temperature of this anomaly was 8°C with background temperatures of -2°C.

Katmai Caldera Lake

The Katmai Caldera Lake thermal anomaly was observed October through December averaging one to four pixels in size. The values averaged 15 to 20°C above background

continued

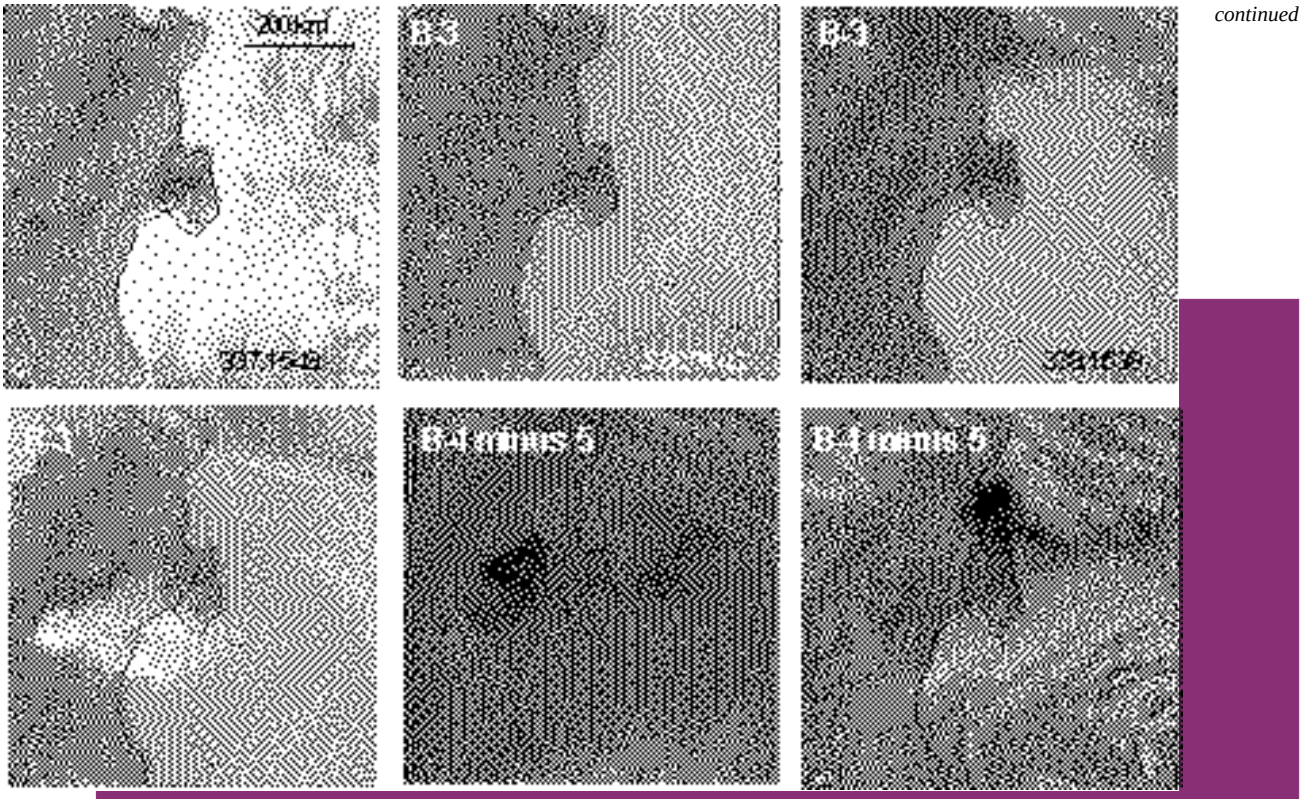

Figure 1: Time series of AVHRR images showing the eruption of Bezymianny Volcano. Increased surface temperatures, indicated by small white area on the top three images, appeared 29 hours prior to the explosive eruption that resulted in an ash cloud. The ash cloud drifted east as shown on the bottom three images.

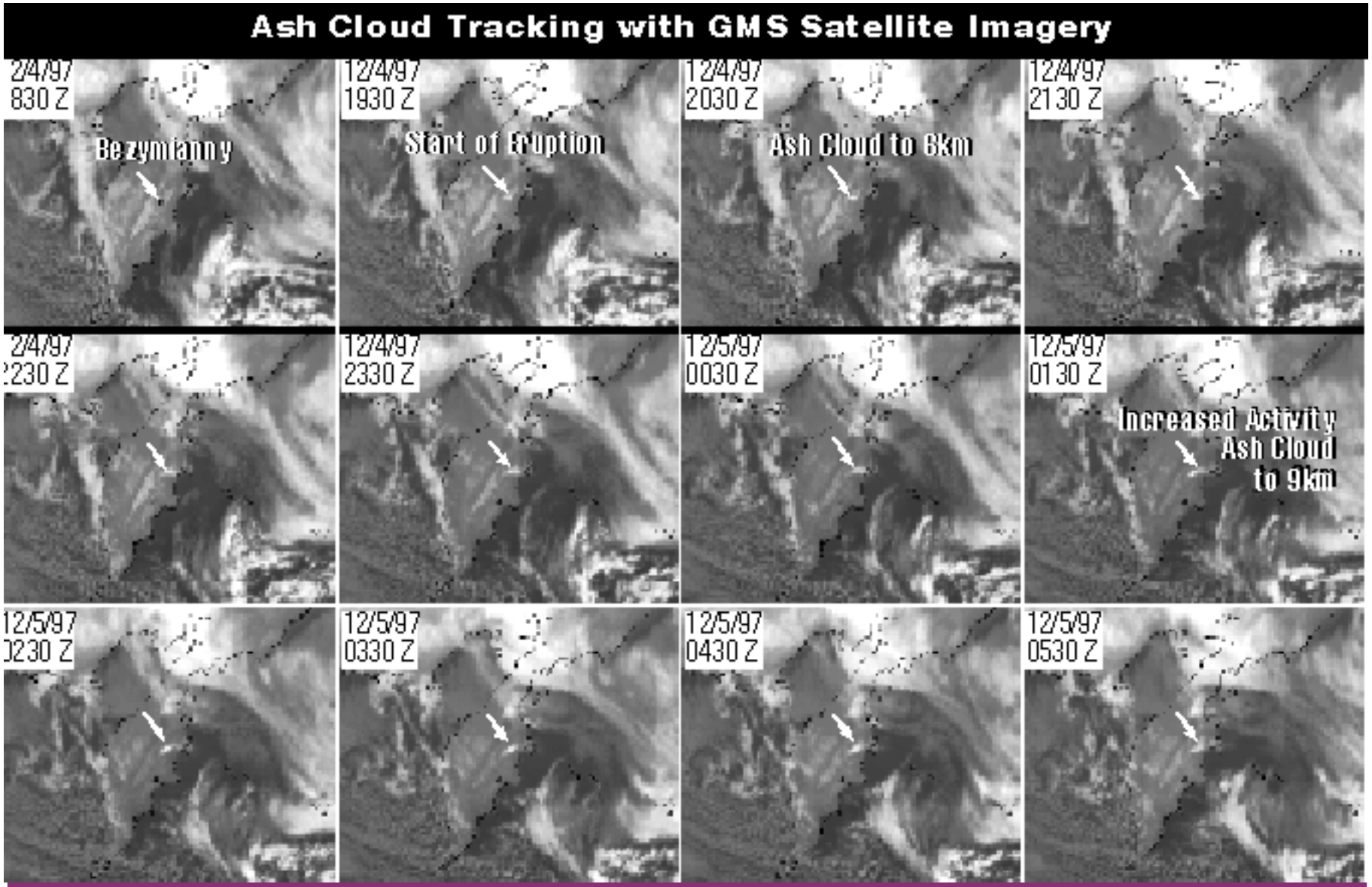

Figure 2: Time series of GMS images shows that the ash cloud producing eruption started between 1830 and 1930 on day 338. These images show the growth and movement of the ash cloud at hourly intervals. The arrow points to the location of the volcano.

Table 1. Satellite Observations of Alaska and Kamchatka Volcanoes for the Months of September-December, 1997

September	**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**
Cleveland																															X
Katmai Lake																															
Karymsky	X																														
Karymsky L.																															
Okmok	X	X	X	X																											
October	**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**
Chiginagak	X	X	X																												X
Cleveland																															X
Katmai Lake	X	X	X	X	X	X	X	X	X	X																					X
Karymsky	X																														X
Karymsky L.																															
Okmok																															X
November	**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
Karymsky	X																														X
Karymsky L.	X	X	X																												X
Katmai Lake																															X
Okmok																															X
December	**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	X	X	X	X	X	X	X	X	X	X	X	X										X
Chiginagak	X	X	X																												X
Karymsky																															X
Karymsky L.																															X
Katmai Lake																															X

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

temperatures in up to four images a day depending on the weather. These temperatures are apparently due to geothermal heating of the lake.

Cleveland

The surface temperature at Cleveland Volcano increased 12°C above background in two images. The anomaly may be due to solar heating although nearby Okmok, a higher peak, did not have elevated temperatures. The cause of this anomaly is unresolved.

Chiginagak

For three to four days between the middle of October and mid December, a thermal anomaly at Chiginagak was averaging 13 to 15 °C above background temperatures. The difference of the anomaly and background temperature did not increase with time. The anomaly was not observed after December 13.

Karymsky Volcano and Karymsky Lake

Surface temperatures at Karymsky Volcano increased to 15°C above background during September through December. Karymsky Lake has been observed reaching 8°C above background temperatures. The Karymsky Lake temperatures is presumed to be due to geothermal heating, based on local reports of previous activity.

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

Seismicity

As has been the case with previous double bimonthly issues, discussion of the seismicity associated with the various volcanoes will be broken up into the two-month intervals. Therefore, there will be two sets of the seismicity plots and histograms corresponding to the September/ October and November/December intervals. Note that seismicity maps will appear below only in those cases in which earthquake epicenters lie within the respective map areas. Monitored volcanoes lacking maps are not presented for earthquakes during this report period.

continued