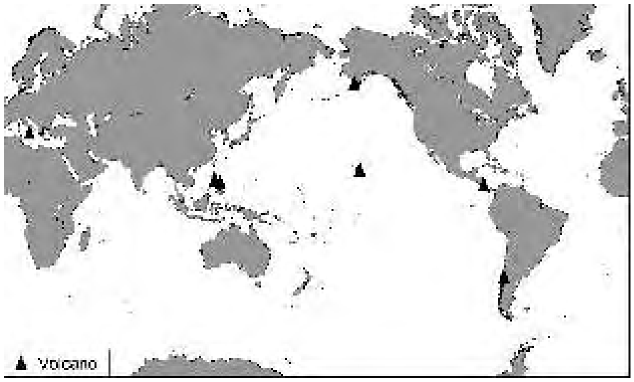
Bulletin of the Global Volcanism Network



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Etna

Italy
37.734°N, 15.004°E; summit elev. 3,350 m
All times are local (= UTC + 1 hour)

Strombolian eruptions, which had resumed in late August 2006, continued into September and took place in conjunction with lava flows escaping towards the ESE and reaching over 1 km in length by mid-September. A large circular depression had grown along the SE side of the cone at Southeast Crater (SEC) during 2004-5. The wall between the depression and the SEC's established central crater became increasingly eroded. On 10 September 2006 that weak zone failed. Lava erupted in the SEC's central crater soon filled the depression and then moved SSE.

The following report was supplied by Sonia Calvari and other members of the Istituto Nazionale di Geofisica e Vulcanologia (INGV). The INGV website featured several reports on this time interval (including Lodato and Consoli, 2006; and Neri and others, 2006).

Figure 1. A view of the E side of Etna's SEC with Bocca Nuova (crater) in the background, 5 September 2006. The frame is drawn around the area that failed on 10 September. The depression, larger in diameter than the central SEC crater, had carved away material backing the eventual zone of failure. Photo taken from the report of Lodato and Consoli (2006).

After the short eruptive phase of 14-24 July 2006 (*BGVN* 31:07) and the renewal of explosive activity at the Northeast Crater at the end of July, Strombolian activity resumed at SEC's summit in the early morning of 31 August. This activity was mild, with fallout of lapilli and bombs mainly within the crater. The ejecta eventually filled the SEC, and between 1900 and 2000 on 5 September an overflow from the summit formed spectacular lava falls along the breached E side. The descending lava accumulated within the prominent circular depression (figure 1) on the SEC's eastern flank.

Figure 2 presents plan views of Etna's SEC and vicinity, indicating the large depression that grew on the cone's SE side. The scene during July 2006 (left panel) provides a size comparison between the SEC's established central crater and the recent depression immediately to its SE. The 12 September 2006 scene (figure 2, right) shows the lava's eventual path. After lava flows escaped the central crater, they ponded in the adjacent depression. They later crossed the rim of the depression, and went on to advance over 1 km E.

The overflow from the SEC's central crater that began on 5 September continued to spread within the depression until about 0645 on 7 September, when it overflowed the SEC's eastern rim and started to spread on the outer E flank and from there towards the Valle del Bove rim. The flow was extremely viscous, slow, thin, and cold, mainly propagating through collapses and breaching of the `a`a flow front. Explosive activity continued at the SEC summit with variable intensity and lava blocks falling as far down as the base of the SEC's cone.

The failure of the SEC's upper wall (figure 1) took place late in the evening of 10 September, due to the pressure of magma accumulating within the summit crater. A new rock fall occurred at the wall dividing the SEC summit crater from the eastern depression, and was suddenly cov-

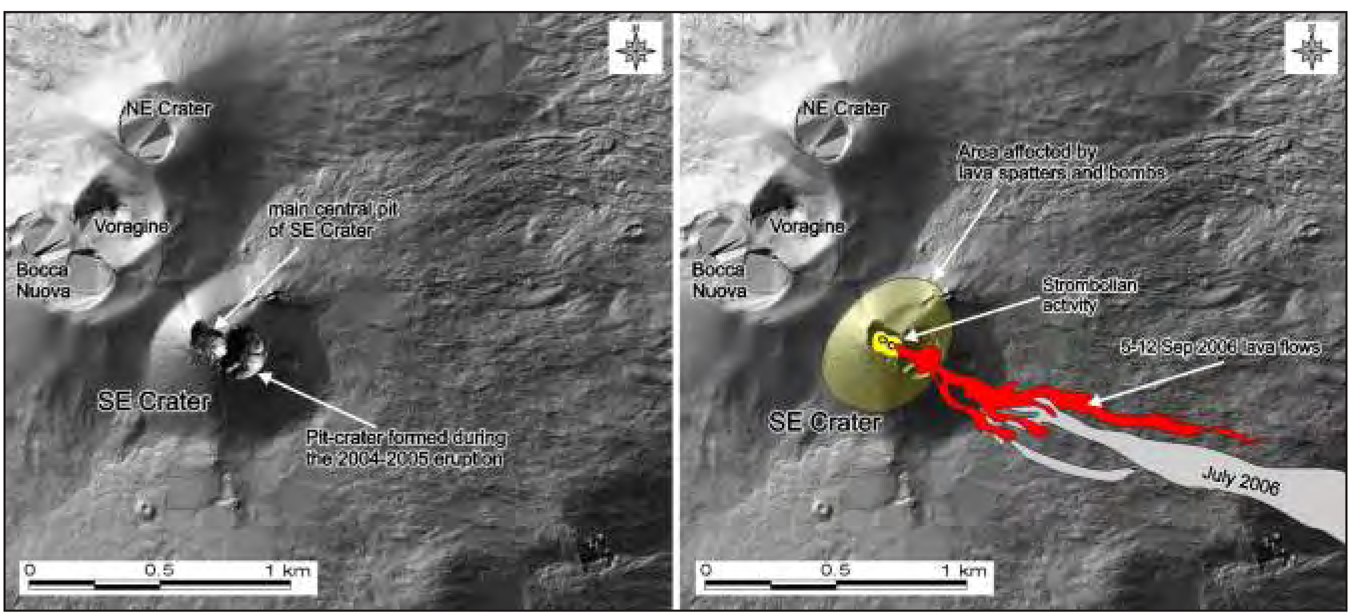

Figure 2. (Left) 2005 digital elevation map at Etna, including two key features: the established SEC crater and the adjacent (larger, circular) depression that grew to its SE during the 2004-05 eruption. This was the scene prior to the collapse of the wall between the two features. (Right) A schematic map discussing eruptive activity during July through 12 September 2006. Base map from M.T. Pareschi (INGV- Sezione di Pisa) and right-hand panel from Neri and others (2006).

Figure 3. Etna's SEC seen during the evening of 11 September 2006. Note the large breach of the SE side of the SEC's wall, permitting a direct view of strombolian eruptions within the summit crater in the SEC and channeling of the lava flow toward the SSE (towards the viewer and in the direction of the observatory). From the report by Neri and others (2006).

ered by the lava flow spilling from the summit crater. An ash plume rose from the failed material and blew W. No significant ash fallout was observed on the ground, but a lava flow spread E, advancing slowly towards the Valle del Bove rim. After the wall had fallen Strombolian emissions continued at the SEC (figure 3).

On 12 September the lava-flow length reached ~ 1.5 km E of the vent at SEC's crater. Both lava effusion and explosive Strombolian activity continued until 27 September, when both stopped following a sudden decrease in volcanic tremor.

References: Neri, M., Behncke, B., and Norini, G., 12 September 2006, Forma e strutture del Cratere Sud-Est (Etna) tra l'eruzione di luglio 2006 e l'attività eruttiva in corso, aggiornata al 12 settembre 2006 ['Forms and structures of the SEC from the eruption of July 2006 and ongoing eruptive activity, updated 12 September 2006']: Prot. int., WKRVGFTR20060913.pdf [UFVG2006/107].

Lodato, L., and Consoli, O., 11 September 2006, Aggiornamento attività Etna ['Etna activity update']: INGV, Catania, U.F. Vulcanologia e Geochimica, 20060911.pdf [UFVG2006/107].

Geologic Summary. Mount Etna, towering above Catania, Sicily's second largest city, has one of the world's longest documented records of historical volcanism, dating back to 1500 BC. Historical lava flows of basaltic composition cover much of the surface of this massive volcano, whose edifice is the highest and most voluminous in Italy. The Mongibello stratovolcano, truncated by several small calderas, was constructed during the late Pleistocene and Holocene over an older shield volcano. The most prominent morphological feature of Etna is the Valle del Bove, a 5 x 10 km horseshoe-shaped caldera open to the east.

Two styles of eruptive activity typically occur at Etna. Persistent explosive eruptions, sometimes with minor lava emissions, take place from one or more of the three prominent summit craters, the Central Crater, NE Crater, and SE Crater (the latter formed in 1978). Flank vents, typically with higher effusion rates, are less frequently active and originate from fissures that open progressively downward from near the summit (usually accompanied by Strombolian eruptions at the upper end). Cinder cones are commonly constructed over the vents of lower-flank lava flows. Lava flows extend to the foot of the volcano on all sides and have reached the sea over a broad area on the SE flank.

Information Contacts: *Sonia Calvari*, *Marco Neri*, *Luigi Lodato*, *Boris Behncke*, *Gianluca Norini*, and *Orazio Consoli*, Istituto Nazionale di Geofisica e Vulcanologia (INGV), Sezione di Catania, Piazza Roma 2, 95123 Catania, Italy.

Poás

Costa Rica
10.20°N, 84.233°W; summit elev. 2,708 m
All times are local (= UTC - 6 hours)

At least two phreatic eruptions took place at the crater lake in the main crater at Poás volcano on 25-26 September 2006. Prior to the eruption, the warm hyper-acid crater lake (figure 4 (A)) was a weak turquoise color. It later turned milky gray.

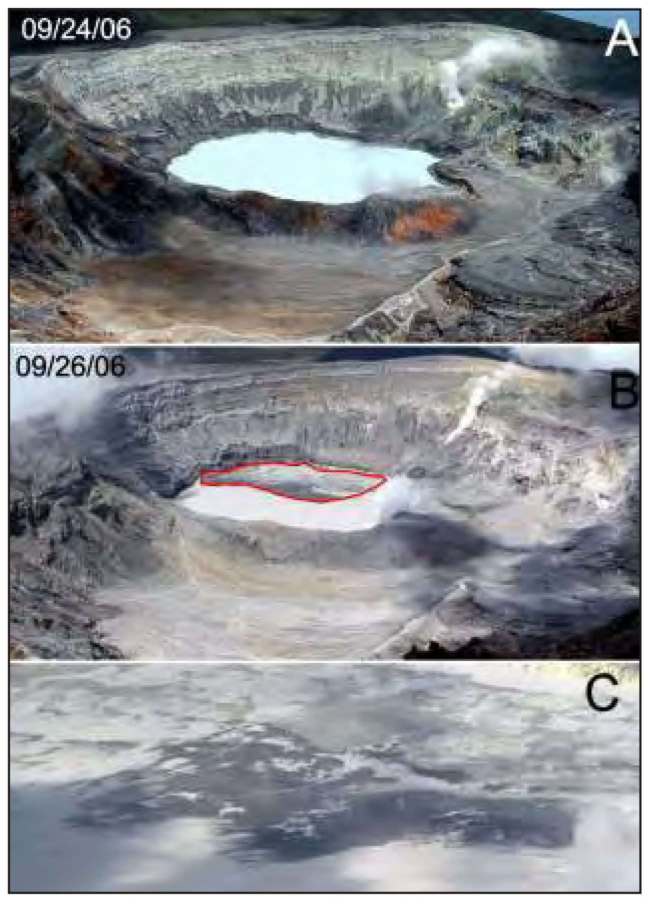

Figure 4. Three photos depicting changes in the active crater at Poás during late September 2006. A) The scene looking into the crater on 24 September. B) The deposit left by the minor, subaqueous events of 26 September, which left a raft of scum floating on the lake's surface. C) A closer look at the material left floating on the lake after the minor eruption on the 26th. Courtesy of Red Sismologica Nacional (RSN: UCR-ICE).

The first eruption, during the night of 25 September, sent material to a height of at least 350 m above the crater lake. It deposited hydrothermally altered rock fragments, mud, and water in the S sector of the inner crater and outside the W part of the crater. Mud was found deposited ~ 500 m from the main crater. Sulfur chunks up to 35 cm in diameter and rock, including old pieces of andesite, failed to travel father than the confines of the crater. Ash erupted the night of 25 September reached ~ 10 km SW (to Trojas de Sarchí).

Observers noted another, smaller, minor eruption at 1038 on 26 September. That eruption had effects limited to the area of the crater lake (figure 4 (B)), where it formed spots of black and green-yellow mud and sulfur spread across a zone up to 75 m long. The process was interpreted to correspond with material coming from subaquatic pools of molten sulfur rising to the lake surface (figure 4 ©)).

A visit into the crater on the 27th determined the lake temperature and pH, 45°C and 0, respectively. The visitors also measured the temperatures of fumaroles (> 95°C) and an orange fumarole, over 200°C. Samples of lake water and erupted mud were obtained.

Geologic Summary. The broad, well-vegetated edifice of Poás, one of the most active volcanoes of Costa Rica, contains three craters along a N-S line. The frequently visited multi-hued summit crater lakes of the basaltic-to-dacitic volcano, which is one of Costa Rica's most prominent natural landmarks, are easily accessible by vehicle from the nearby capital city of San José. A N-S-trending fissure cutting the 2708-m-high complex stratovolcano extends to the lower northern flank, where it has produced the Congo stratovolcano and several lake-filled maars. The southernmost of the two summit crater lakes, Botos, is cold and clear and last erupted about 7500 years ago. The more prominent geothermally heated northern lake, Laguna Caliente, is one of the world's most acidic natural lakes, with a pH of near zero. It has been the site of frequent phreatic and phreatomagmatic eruptions since the first historical eruption was reported in 1828. Poás eruptions often include geyser-like ejections of crater-lake water.

Information Contacts: *Raul Mora* and *Carlos Ramírez*, Red Sismologica Nacional (RSN: UCR-ICE); Universidad de Costa Rica, Escuela Centroamericana de Geología, Instituto Costarricense de Electricidad, Apto 35-2060, Ciudad Universitaria Rodrigo Facio, San José, Costa Rica (Email: raulvolcanes@yahoo.com.mx; carlosjru@yahoo.com).

Villarrica

Central Chile

39.42°S, 71.93°W; summit elev. 2,847 m

During 29 March to 3 April 2005, the lava lake inside Villarrica's crater remained active, with Strombolian explosions occurring. Some gas explosions were observed to hurl volcanic bombs as far as ~ 300 m. According to a news report, the Oficina Nacional de Emergencia reported that unusual seismicity was recorded during early April 2005. Fresh ash deposits were seen outside of the crater. Visitors were banned from climbing the volcano.

Since the beginning of 2005, relatively consistent and continuous MODIS/MODVOLC thermal anomalies were recorded during 1 January through 25 March, 7-21 July, 31 August through 26 September, 17 October through 25 December 2005, and 23 January through 4 September 2006 (figure 5). The gaps between these periods are probably artificial, due to such interference as cloud cover or other phenomena that obscured satellite observations. For example, the activity reported above for late March through early April 2005 did not generate MODIS/MODVOLC thermal anomalies.

Geologic Summary. Glacier-clad Villarrica, one of Chile's most active volcanoes, rises above the lake and town of the same name. It is the westernmost of three large stratovolcanoes that trend perpendicular to the Andean chain. A 6-km wide caldera formed during the late Pleistocene. A 2-km-wide caldera that formed about 3500 years ago is located at the base of the presently active, dominantly basaltic to basaltic-andesitic cone at the NW margin of the Pleistocene caldera. More than 30 scoria cones and fissure vents dot Villarrica's flanks. Plinian eruptions and pyroclastic flows that have extended up to 20 km from the volcano have been produced during the Holocene. Lava flows up to 18 km long have issued from summit and flank vents. Historical eruptions, documented since 1558, have consisted largely of mild-to-moderate explosive activity with occasional lava effusion. Glaciers cover 40 sq km of the volcano, and lahars have damaged towns on its flanks.

Information Contacts: *HIGP MODIS Thermal Alert System*, Hawai'i Institute of Geophysics and Planetology (HIGP), University of Hawaii and Manoa, 168 East-West Road, Post 602, Honolulu, HI 96822, USA (URL: http://modis.higp.hawaii.edu/).

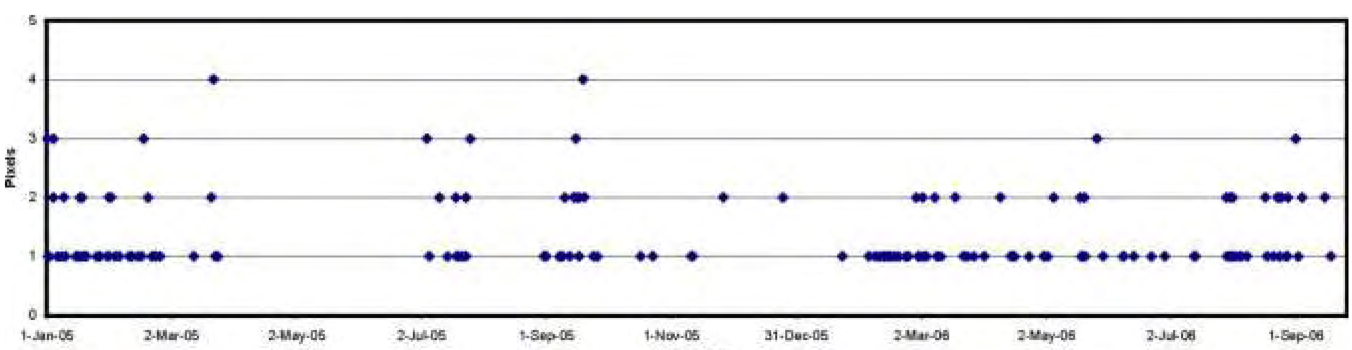

Figure 5. Thermal anomalies at Villarrica from the MODIS/MODVOLC satellite observations, January 2005 to 18 September 2006. Anomalies are from both the Aqua and Terra satellites. Courtesy of the HIGP MODIS Thermal Alert System.

Loihi

Hawaiian Islands, United States
18.92°N, 155.27°W; summit elev. -975 m
All times are local (= UTC -10 hours)

Our previous report (*BGVN* 26:09) discussed an earthquake swarm in September 2001; this report lists larger earthquakes near Loihi during 1998-2006. In addition, it presents graphics depicting Loihi morphology and makes reference to some recent research there.

An M 4.7 earthquake occurred with epicenter 24 km NW of Loihi seamount at a focal depth of 40 km at about 1600 hours on 18 January 2006 (according to the U.S. Geological Survey (USGS) Earthquake Information Center (NEIC)). Such a depth would rule out the signal representing an eruption of the volcano. No damage occurred on land. Head scientist Jim Kauahikaua at the Hawaii Volcano Observatory (HVO) said the earthquake was felt as far as Pepeekeo, 16 km N of Hilo.

Table 1 gives a summary of earthquakes of M 4 or greater reported near Loihi since 1998.

From mid-July through August 1996, instruments had recorded a swarm of thousands of earthquakes (*BGVN* 21:07 and 21:09). For this period, 84 earthquakes of M 4 or greater were recorded; the largest event, M 4.9 MD, occurred at 0930 UTC on 28 July (2330 local time on 27 July). Observers in a submersible during a cruise from 6-10 August 1996 determined that the swarm was associated with the collapse of Loihi's summit and an eruption (figure 6 and 7).

Investigators at the Monterey Bay Aquarium Research Institute (MBARI) have been studying Loihi. When lava comes in contact with seawater, it cools so rapidly that it shatters into glass sand and rubble. When lava enters the sea under confined mixing conditions such as those within a lava tube, rapid expansion of seawater to steam in the tube can produce large basalt glass bubbles that shatter into curved, paper-thin, bubble-wall fragments known as "limu o Pele" (Pele's seaweed, figure 8). Such bubble-wall fragments and thin strands of volcanic glass, known as Pele's hair, have been recovered from Loihi seamount and other deep-sea locations around Hawaii. Layered volcaniclastic deposits up to 11 m thick crop out along faults at the caldera's edge on Loihi's summit. The layers include unconsolidated volcanic gravel, sand, silt, and mud. Fragments in

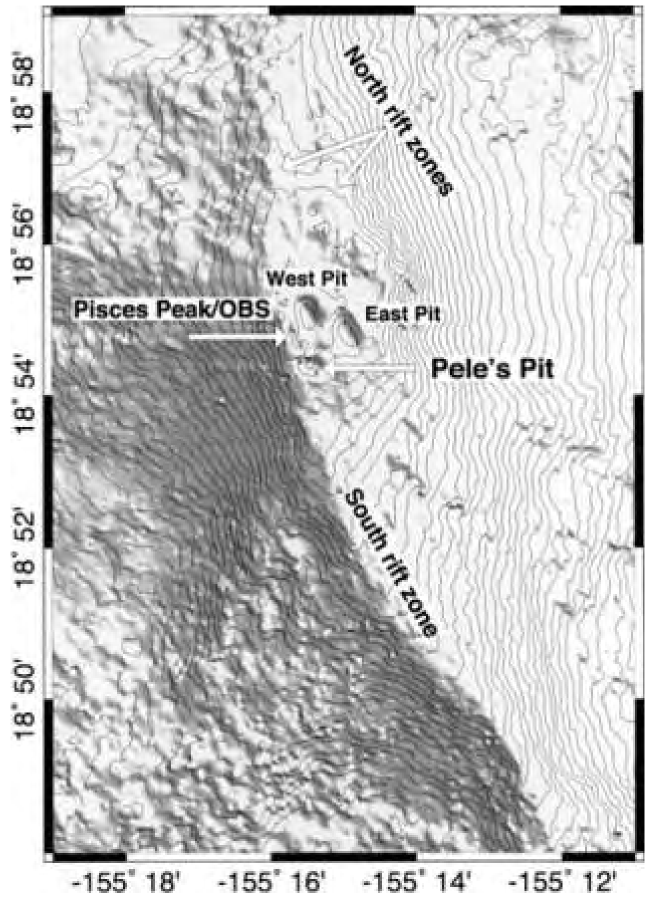

Figure 6. Bathymetry of Loihi seamount indicating the locations of Pele's Pit (the pit crater formed during the 1996 earthquake swarm) and Pisces Peak. To the N and NE of Pele's Pit are two older pit craters, West Pit and East Pit. Contour interval is 100 m; illumination is from the NE. From Caplan-Auerbach and Duennebier (2001).

Date (UTC)	Origin time (UTC)	Latitude	Longitude	Depth (km)	Magnitude	Distance (km)
12/27/98	2140	18.79°N	155.23°W	10	4.70 MD	14
		Note: during 1999-2000, no earthquakes over M 4				
07/21/01	1801	18.91°N	155.25°W	13	4.10 MD	2
09/11/01#	0009	18.85°N	155.24°W	12	4.90 mb	7
09/13/01#	1311	18.86°N	155.24°W	12	5.20 mb	7
09/13/01#	1839	18.87°N	155.18°W	12	4.40 mb	10
		Note: during 2002-2004, no earthquakes over M 4				
03/08/05	1726	19.01°N	155.36°W	18	4.20 mb	13
04/23/05	1301	18.80°N	155.19°W	44	4.30 ML	15
05/13/05	1006	18.87°N	155.20°W	44	5.10 MD	9
07/17/05	1915	18.78°N	155.45°W	32	5.4 MD	24
12/07/05*	0902	18.92°N	155.26°W	13	4.00 mb	0
12/07/05*	1142	18.92°N	155.18°W	28	4.70 MD	9
12/07/05*	1158	18.87°N	155.18°W	12	4.00 MD	10
01/19/06	0204	19.05°N	155.43°W	40	4.70 MD	22

Table 1. Summary of earthquakes of M 4 or greater reported near Loihi (within a radius of 25 km from volcano's summit) during 1998 to September 2006. Magnitudes: mb = body wave, MD = duration (coda-length) magnitude, ML = local magnitude. Distance is from the center point of Loihi (latitude 18.92°N, longitude 155.27°W) to the epicenter. # = swarm—see *BGVN* 26:09. * = largest three earthquakes in the swarm of ~100 earthquakes on 7 December 2005. Courtesy of USGS-NEIC.

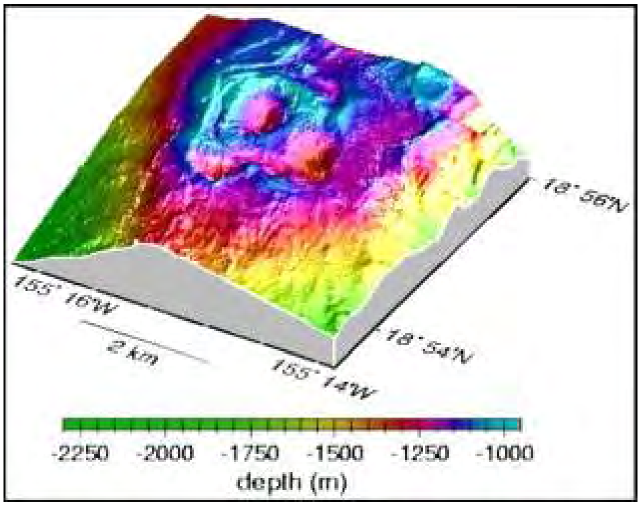

Figure 7. Three-dimensional bathymetric map of the southernmost two-thirds of the Loihi summit platform. Courtesy of HVO web site.

volcaniclastic units include fluidal clasts, limu o Pele, highly vesicular to scoriaceous fragments, and Pele's hair (Clague and others, 2003; Clague and others, 2000).

The high sulfur and carbon-dioxide contents of these basaltic glass shards suggest that they were erupted at great depth. These fragments indicate that submarine eruptions can be more violent than previously thought, and can produce features to depths of at least 4 km similar to those observed in shallow-water environments.

A December 2000 NOAA Research article (Malahoff, 2000) noted that "Three pit craters occupy the summit of Loihi. The southernmost crater, Pele's Pit, formed during a two-week seismic swarm in 1996 that collapsed the hydrothermally active cone Pele's Vents. The new pit has steep walls with the floor located 200 meters below the rim of the crater. The crater floor and north slope are sites of spectacular and extensive hydrothermal venting with water temperatures ranging from 30°C to nearly 200°C. Diverse microbial mats surround the vents and cover the near vertical slopes of Pele's Pit."

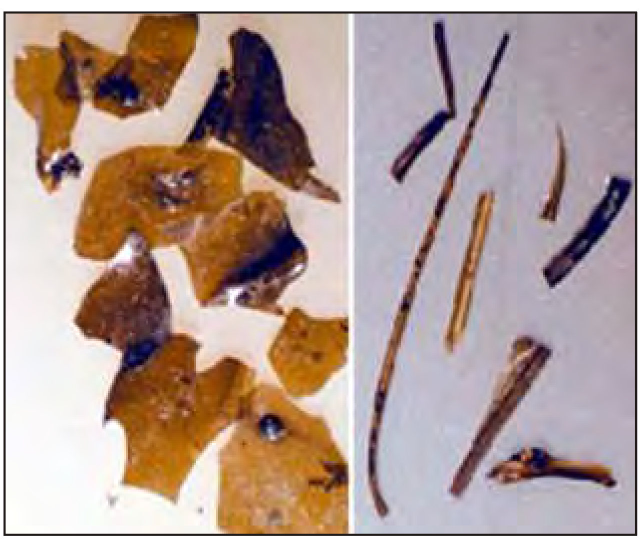

Figure 8. Fragments of limu o Pele (upper photo, largest diameters ~ 0.5 mm) and Pele's hair (lower photo, longest specimen is slightly over 1 cm), formed from lava bubbles during eruption (Clague, Davis, Bischoff, Dixon, and Geyer, 2000). Courtesy of MBARI, 2001.

New organisms identified at Loihi include the bacteria, *L2TR* and *Idiomarina loihiensis* (a halophilic g-Proteobacterium (Donachie and others, 2003) and a shrimp, *Opaepele loihi* (Williams and Dobbs, 1995).

Embodying both the topic of limu o Pele and marine organisms, David Clague and colleagues at MBARI have identified foraminifera that incorporated volcanic bubble walls in their tests (figure 9). These were discussed on the MBARI website. "Benthic foraminifera often glue particles to their tests, perhaps for protection from predators. These particles may be sponge spicules, sand grains, or other detritus, depending on the materials available and the 'specialty' of the foram. In sediment cores from the Gorda Ridge, we found forams that 'specialized' in volcanic glass grains and others that 'specialized' in limu o Pele. They effectively concentrated the glass samples for us!"

References: Caplan-Auerbach, J., and Duennebier, F., 2001, Seismicity and velocity structure of Loihi seamount from the 1996 earthquake swarm: Bulletin of the Seismological Society of America, v. 91, no. 2, p. 178-190.

Clague, D.A., Baiza, R., Head, J.W., III, and Davis, A. S., 2003, Pyroclastic and hydroclastic deposits on Loihi Seamount, Hawaii, *in* Explosive Subaqueous Volcanism, White, J.D.L., Smellie, J.L., and Clague, D.A. (eds.): Geophysical Monograph 140, American Geophysical Union, p. 73-95.

Clague, D.A., Davis, A.S., Bischoff, J.L., Dixon, J.E., and Geyer, R., 2000, Lava bubble-wall fragments formed by submarine hydrovolcanic explosions on Lo'ihi Seamount and Kilauea Volcano: Bulletin of Volcanology, v. 61, no. 7. p. 437-449.

Davis, A.S., Clague, D.A., Zierenberg, R.A., Wheat, C. G., and Cousens, B.L., 2003, Sulfide formation related to changes in the hydrothermal system on Loihi Seamount, Hawai'i, following the seismic event in 1996: The Canadian Mineralogist, v. 41, p. 457-472.

Donachie, S.P., Shaobin, H., Todd, S.G., Malahoff, A., and Alam, M., 2003, Idiomarina loihiensis sp. nov., a halophilic ã-Proteobacterium from the Lo'ihi submarine

Figure 9. Benthic foraminifera with agglutinated limu o Pele (foram ~ 2 mm across). Image © MBARI 2003.

volcano, Hawai‘i: Int J Syst Evol Microbiol, v. 53, p. 1873-1879, DOI 10.1099/ijs.0.02701-0 (International Union of Microbiological Societies).

Malahoff, A., 2000, Loihi submarine volcano: a natural extremeophile laboratory: U.S. Dept of Commerce, National Oceanic and Atmospheric Administration, Office of Oceanic and Atmospheric Research (http://www.oar.noaa.gov/spotlite/archive/spot_loihi.html), 12 October 2006.

Williams, A.B, and Dobbs, F.C, 1995, A new genus and species of caridean shrimp (Crustacea: Decapoda: Bresiliidae) from hydrothermal vents on Loihi Seamount, Hawaii: Proceedings of the Biological Society of Washington, v. 108, p. 228-237.

Geologic Summary: Loihi seamount, the youngest volcano of the Hawaiian chain, lies about 35 km off the SE coast of the island of Hawaii. Loihi (which is the Hawaiian word for “long”) has an elongated morphology dominated by two curving rift zones extending north and south of the summit. The summit region contains a caldera about 3 x 4 km wide and is dotted with numerous lava cones, the highest of which is about 975 m below the sea surface. The summit platform includes two well-defined pit craters, sediment-free glassy lava, and low-temperature hydrothermal venting. An arcuate chain of small cones on the western edge of the summit extends north and south of the pit craters and merges into the crests of Loihi’s prominent rift zones. Deep and shallow seismicity indicate a magmatic plumbing system distinct from that of Kilauea volcano. During 1996, a new pit crater was formed at the summit of the volcano, and lava flows were erupted. Continued volcanism is expected to eventually build a new island at Loihi; time estimates for the summit to reach the sea surface range from roughly 10,000 to 100,000 years.

Information Contacts: *Hawaii Center for Volcanology*, University of Hawaii at Manoa, Honolulu, HI (URL: http://www/soest.hawaii.edu/GG/HCV/loihi.html); *U.S. Geological Survey Earthquake Information Center (NEIC)* (URL: http://neic.usgs.gov/neis); *Scripps Institution of Oceanography*, Marine EM Laboratory (URL: http://marineemlab.ucsd.edu); *Monterey Bay Aquarium Research Institute (MBARI)*, 7700 Sandholdt Road, Moss Landing, CA 95039-9664, USA (URL: http://www.mbari.org/); *Hawaiian Volcano Observatory (HVO)*, U.S. Geological Survey, PO Box 51, Hawaii National Park, HI 96718, USA (URL: http://hvo.wr.usgs.gov/; Email: hvo-info@hvomail.wr.usgs.gov); and *Alexander Malahoff*, Institute of Geological and Nuclear Sciences Ltd. (GNS), Avalon, Lower Hutt, P. O. Box 30 368, New Zealand.

Kilauea

Hawaiian Islands
19.421°N, 155.287°W; summit elev. 1,222 m
All times are local (= UTC - 10 hours)

Much of the activity at Kilauea has remained the same since last reported in *BGVN* 31:04. This report covers the time interval 8 February through most of July 2006. Lava continued to enter the sea at the East Lae`apuki area with volcanic tremor near normal background levels at Kilauea’s summit. Numerous shallow earthquakes continued to occur at the summit and upper E rift zone. Volcanic tremor reached moderate levels at Pu`u `O`o. Slow, steady inflation continued at Kilauea’s summit as it has more or less since mid-January 2006. A 4-hectare (10 acre) bench collapse occurred 30 July 2006 (figure 10).

Beginning on 8 February, surface lava flows were not visible on the Pulama pali scarp due to lava traveling underground through the PKK lava tube.

Figure 10. An aerial view of the E Lae`apuki entry at Kilauea showing the area of the 30 July bench collapse. A four-hectare chunk of the W side of the bench broke off and fell into the water. The black line marks approximate edge of the bench before the collapse. Courtesy of USGS-HVO.

On 1 March, lava emerged from the PKK lava tube at elevations between 45 and 75 m, and proceeded in lava streams extending 200-400 m to the coast. The lava streams continued to flow off of the lava delta and into the ocean throughout this reporting period.

Inflation on 16 May was accompanied by an abrupt drop in volcanic tremor at Kilauea’s summit. Volcanic tremor reached moderate levels at Pu`u `O`o. Small lava flows were visible on 19 May and minor incandescence was observed on 21-22 May at Kilauea’s East Lae`apuki lava delta. Incandescence was visible from East Pond vent, January vent, and Drainhole during 24-30 May, and from the South Wall complex on 24 and 30 May and throughout June.

On 24 June, lava that flowed over a sea cliff was fed from a breakout point about 50 m inland

Figure 11. A view of the East Lae`apuki bench from the W photographed at unstated date and published on 4 August 2006. The dashed line shows the approximate seaward extent of the area lost to the bench collapse on 30 July 2006. Photo courtesy of Greg Santos, Honolulu Advertiser.

from the cliff. The area of East Lae`apuki lava delta was estimated to be approximately 21 hectares (52 acres). The floor of Drainhole vent in Pu`u `O`o's crater collapsed and produced a 30 x 25 m lava pond with dynamically active lava on the SE side of the pit. Lava from the Campout flow and tube, located on the E margin of the PKK shield, advanced 1.2 km towards the Pulama pali during about 19-24 June.

On 30 June, surface lava flows originating from the Campout lava tube were visible on the upper part of the Pulama pali fault scarp, which had not been seen since 8 February. Incandescence was visible from Drainhole vent in Pu`u `O`o's crater and tremor remained at moderate level at Pu`u `O`o. By the end of July, the Campout flow was ~ 1.7 km from the sea at Ka`ili`ili, about 440 m from the observed terminus on 14 July.

A 4-hectare (10-acre) area of the lava delta at Kilauea's East Lae`apuki collapsed into the ocean at 1247 on 30 July. The collapse represented less than 15% of the delta's total area (figures 10 and 11). During the collapse, explosive activity bombarded the older lava delta and sea cliff on the western side of the bench, sending spatter and rock debris up to about 40 m inland—nearly half the distance to the rope barricade.

During 2-8 August, lava from the PKK lava tube flowed into the ocean at two entries on the SE flank, East Lae`apuki and about 3. 5 km E at East Ka`ili`ili. Tilt at the Pu`u `O`o cone displayed a saw-tooth pattern and tremor remained at a moderate level. A leveling survey revealed an inflationary trend at the summit of Kilauea, in areas S of Halema`uma`u crater. Elevations have increased 11 cm in the past 6 months and continued to increase during the reporting period.

Geologic Summary. Kilauea volcano, which overlaps the east flank of the massive Mauna Loa shield volcano, has been Hawaii's most active volcano during historical time. Eruptions of Kilauea are prominent in Polynesian legends; written documentation extending back to only 1820 records frequent summit and flank lava flow eruptions that were interspersed with periods of long-term lava lake activity that lasted until 1924 at Halemaumau crater, within the summit caldera. The 3 x 5 km caldera was formed in several stages about 1500 years ago and during the 18th century; eruptions have also originated from the lengthy East and SW rift zones, which extend to the sea on both sides of the volcano. About 90% of the surface of the basaltic shield volcano is formed of lava flows less than about 1100 years old; 70% of the volcano's surface is younger than 600 years. A long-term eruption from the East rift zone that began in 1983 has produced lava flows covering more than 100 sq km, destroying nearly 200 houses and adding new coastline to the island.

Information Contacts: *USGS-HVO* (see Loihi); *Honolulu Advertiser* (URL: http://the.honoluluadvertiser.com/).

Mayon

Luzon, Philippines
13.257°N, 123.685°E; summit elev. 2,462 m
All times are local (= UTC + 8 hours)

During 6 September to 3 October 2006, the Philippine Institute of Volcanology and Seismology (PHIVOLCS) described lava extrusion and associated rockfalls on Mayon's SE slopes. This continued the previous pattern seen during

Figure 12. Satellite image of the SE area of the Philippine island of Luzon showing Mayon volcano and surrounding volcanoes and towns. Courtesy of Google Earth.

23 August-5 September 2006 (*BGVN* 31:07). Mayon's eruptive vigor generally declined by mid-September into October. Background on Mayon's geography follows (figures 12-14 and table 2).

Seismicity and lava extrusion generally decreased during 6-26 September. SO_2 fluxes broadly declined, generally ranging between 1,200 and 3,000 tons per day, although the 25 August and 2 September readings were outliers, ~ 5,400 and ~ 6,600 tons per day, respectively. Ground-deformation measurements showed an overall deflation. On 11 September, the Alert Level was lowered from 4 to 3 (on a scale of 0-5, with 0 referring to No Alert status).

During late September surface activity was characterized by intermittent spalling of incandescent lava fragments and glow from the summit crater. Steaming at the summit was moderate with white plumes drifting NNE and SE.

Town Name	Bearing	Distance (km)
Alcala	SSE	9.6
Amtic	NW	7.7
Anoling	SSW	6.1
Arimbay	SE	10.9
Bacacay	ENE	12
Baligang	WNW	6.2
Banadero	S	8
Bantayan	NNW	9.5
Baranghawon	NNE	11.4
Basag	W	9.6
Basagan	N	8.8
Bigaa	ESE	10.1
Binanowan	W	10.7
Binitayan	NE	10.5
Binogsacan	SW	12.5
Bonga	SE	8.5
Bongabong	NNE	9.3
Bono?	NNW	7.8
Boring	N	8.2
Buang	NW	7.4
Bubulusan	WSW	10.3
Budiao	S	8.1
Buhian	NNW	8.3
Burabod	SE	9.9
Buyuan	SE	8.1
Cabangan	SSW	8.1
Cagsawa	S	10
Calbayog	NE	6.5
Camalig	S	8.8
Canaway	NNE	7.6
Comon	N	6.8
Daraga	SSE	12.2
Dita	SE	10.3
Dona Tomasa	WSW	8.5
Fidel Surtida	E	9.9
Guinobat	N	11
Guinobatan	SW	11.8
Hindi	NE	10.4
Ilawod	SW	11.5
Kilicao	SSE	10.3
Legaspi City	SSE	13.5
Libod	SSW	10
Lidong	ESE	8.7
Ligao	W	14
Lower Bonga	ENE	8.1
Mabinet	SSE	8.5
Magapo	NW	5.7
Maipon	SW	10
Malilipot	NE	9
Maninila	SW	8.1
Mariroc	N	9.7
Masarawag	SW	8.1
Matagbac	N	11
Matanag	SE	8.4
Matnog	SSE	8.4
Mayon Rest House Observatory	NW	3.6
Miisi	S	6
Muladbucad Grande	W	8.9
Muladbucad Pequeno	W	8.8
Nabonton	W	10.3
Nasisi	W	10.8
Oson	N	7.3
Padang	ESE	9.4
Pingabobong	N	8.3
Quinastillohan	N	10
Quirangay	SSW	7.3
Rawis	SSE	11.7
Sabinitayan	NE	10.5
Salugan	SSW	7.8
Salvacion	S	8.6
San Andres	E	10.4
San Antonio	N	10.2
San Fernando	E	8.2
San Francisco	NE	8.8
San Isidro	NNE	9.3
San Joaquin	SE	11
San Lorenzo	NNE	11.7
San Rafael	SW	10.8
San Roque	E	8.8
San Vincente	N	11.4
Sta. Misericordia	E	8.2
Sta. Misericordia Observatory	E	7.9
Sta. Cruz	NNE	8.7
Sto. Domingo	ESE	10
Sua	SSW	8.1
Sugod	NE	10.6
Tabaco	NNE	12.5
Tabiguian	NW	8.8
Tagas	NNE	11.2
Tambo	WNW	7.9
Tandarora	SW	9.4
Travesia	SW	10.8
Tumpa	SW	8
Upper Bongo	ENE	8.3

Table 2. An alphabetical list including some of the settlements and other place names on and surrounding Mayon volcano, and their bearings and distances from the summit. Taken from the PHIVOLCS map referenced below.

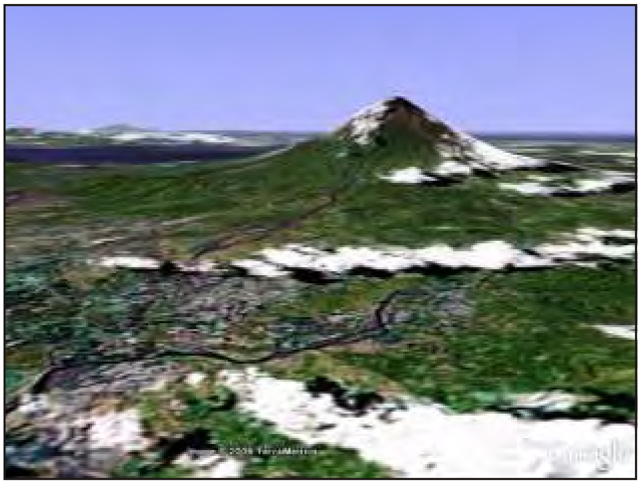

Figure 13. Oblique aerial image of Mayon, looking from the N at an eye altitude of 1.78 km. Courtesy of Google Earth.

Low-frequency tremor continued to indicate elevated unrest. Alert Level 3 remained in effect, meaning that the new Extended Danger Zone (EDZ) of 7 km from the summit crater in the SE sector and the normal 6 km-radius Permanent Danger Zone (PDZ) for other areas continued. Table 3 lists Mayon's reported seismicity from 25 August-27 September 2006, continuing the list developed in *BGVN* 31:07.

Reference: PHIVOLCS, (date unknown), Geologic map of the deposits and features of the 1984 eruption of Mayon Volcano: PHIVOLCS, prepared by H.B. Ruelo, scale 1:50,000.

Geologic Summary. Beautifully symmetrical Mayon volcano, which rises to 2,462 m above the Albay Gulf, is the Philippines' most active volcano. The structurally simple volcano has steep upper slopes averaging 35-40 degrees that are capped by a small summit crater. The historical eruptions of this basaltic-andesitic volcano date back to 1616 and range from strombolian to basaltic plinian, with cyclical activity beginning with basaltic eruptions, followed by longer term andesitic lava flows. Eruptions occur predominately from the central conduit and have also produced lava flows that travel far down the flanks. Pyroclastic flows and mudflows have commonly swept down many of the approximately 40 ravines that radiate from the summit and have often devastated populated lowland areas. Mayon's most violent eruption, in 1814, killed more than 1,200 people and devastated several towns.

Date	Volcanic Earthquakes	Tremor Episodes	Low-frequency Harmonic Tremor	SO_2 Emission Rate (tons per day)	Comments
25 Aug 2006	17	303	—	5401(magma degassing)	mild state of eruption, Alert Level 4
01 Sep 2006	25	277	—	—	lava extrusion, four explosions
02 Sep 2006	31	248	—	6585 (high)	small explosion
03 Sep 2006	9	high	—	2021	
04 Sep 2006	—	305	—	2961	
05 Sep 2006	0	455	—	1447	
06 Sep 2006	13	295	—	2032	
07 Sep 2006	10	315	—	—	
08 Sep 2006	26	333	—	1841	
09 Sep 2006	2	300	—	1701	
11 Sep 2006	6	206	—	1500	
12 Sep 2006	0	253	—	1500	Begin Alert Level 3
13 Sep 2006	8	108	—	1500	
14 Sep 2006	18	111	—	1500	
15 Sep 2006	12	104	continuous	1600	
16 Sep 2006	2	31	continuous	1400	
17 Sep 2006	—	57	—	1800	
18 Sep 2006	2	57	continuous	1500	
19 Sep 2006	—	47	—	1500	
20 Sep 2006	1	33	continuous	1200	
21 Sep 2006	3	20	continuous	2200	
22 Sep 2006	2	80	continuous	1600	lava extrusion
23 Sep 2006	1	14	continuous	1599	decline in lava extrusion
24 Sep 2006	6	21	continuous	—	intense crater glow
25 Sep 2006	14	114	—	1300	crater glow, lava extrusion
26 Sep 2006	12	65	—	1200	
27 Sep 2006	7	18	—	none measured due to rain	crater glow, lava fragments
30 Sep 2006	0	3	—	none measured due to weather	white plumes drifting ENE
01 Oct 2006	0	0	—	none measured due to weather	white plumes drifting ENE
02 Oct 2006	0		—	none measured due to weather	
03 Oct 2006	0	0	—	—	

Table 3. Summary of 25 August-3 October 2006 events observed at Mayon volcano for 24-hour periods ending at 0800 hours on the date indicated. The SO_2 emission rates apply to the gas within the volcanic plume. No data was available for 10, 28, or 29 September. Courtesy of PHIVOLCS.

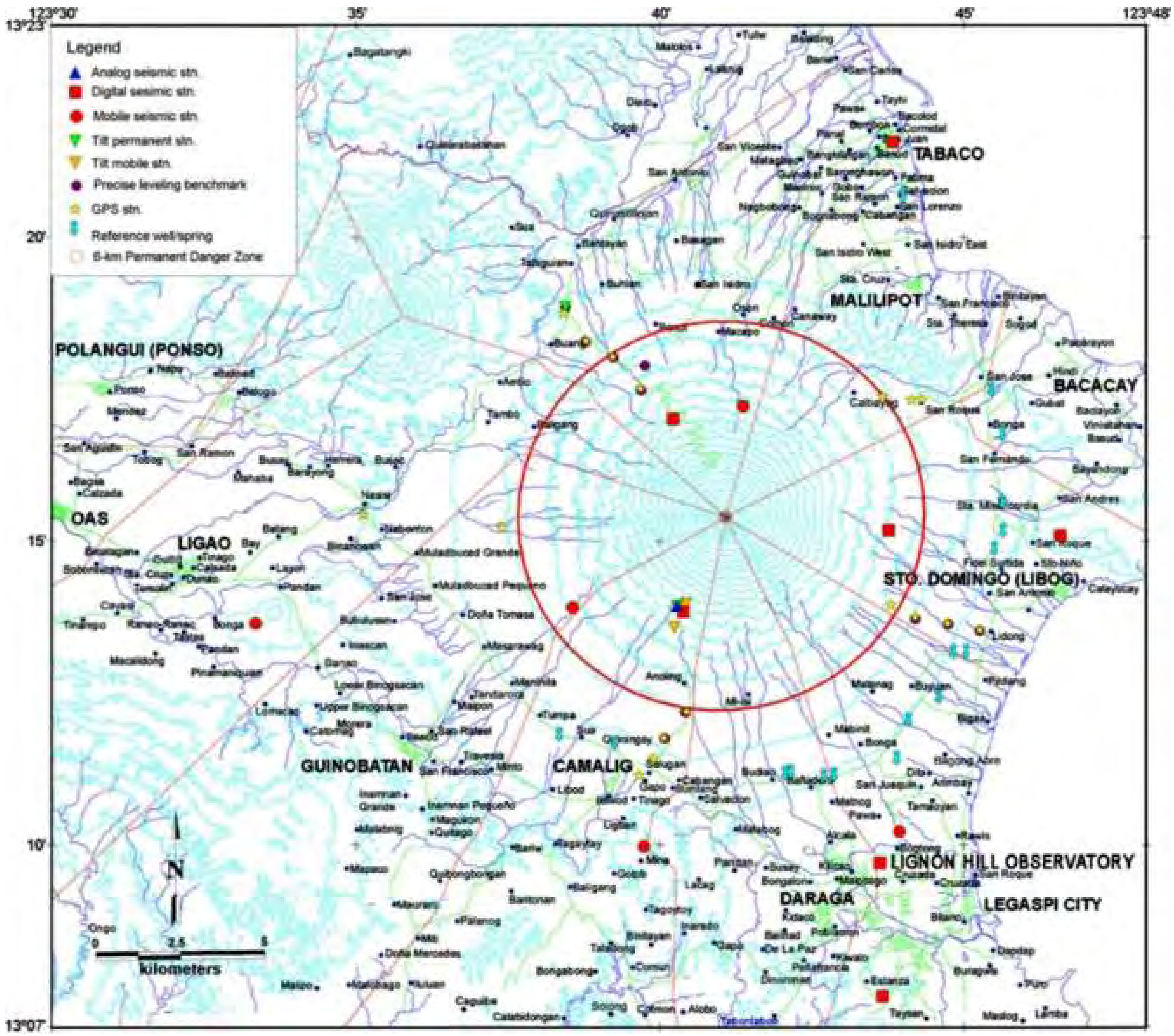

Figure 14. Contour map of Mayon volcano showing surrounding towns (see table 2 for more detailed list of names of nearby settlements). The prominent circle around the volcano delineates the 6-km Permanent Danger Zone. Scale is 1:50,000. Courtesy of PHIVOLCS.

Information Contacts: *Philippine Institute of Volcanology and Seismology (PHIVOLCS)*, University of the Philippines Campus, Diliman, Quezon City, Philippines (URL: http://www.phivolcs.dost.gov.ph/).

Taal

Luzon, Philippines
14.002°N, 120.993°E; summit elev. 400 m
All times are local (= UTC + 8 hours)

The Philippine Institute of Volcanology and Seismology (PHIVOLCS) notified the public on 26 September 2006 of ongoing seismic unrest at Taal. The Main Crater Seismic Station recorded 29 volcanic earthquakes during the 24-hour period from 0600 hours on 25 September. Five of these earthquakes, at 0233, 0234, 0242, 0247, and 0249 hours on 26 September, were felt at Modified Mercalli Intensities II to III by residents on Volcano Island. The earthquakes were accompanied by rumbling sounds. Initial locations showed epicenters generally dispersed in the vicinity of Daang Kastila (NE), Tibag (N), Tablas (NE), Mataas na Gulod (NE), and Panikihan (NW). This seismic activity was notably higher than the usual levels, generally only five or less events detected in 24 hours.

Surface thermal observations, however, did not indicate significant change in the thermal and steam emission manifestations of the Main Crater lake area. The increase in seismicity at Taal reflects a low-level episode of unrest. However, there is still no indication of an impending eruption. Possible precursors, such as increased steam emission, increased temperatures of steam vents at the Main Crater lake waters and adjacent areas are being monitored continuously. The ongoing seismic unrest could intensify in the coming days or weeks so that PHIVOLCS recommends appropriate vigilance by the public when visiting the island.

Geologic Summary. Taal volcano is one of the most active volcanoes in the Philippines and has produced some of its most powerful historical eruptions. In contrast to Mayon volcano, Taal is not topographically prominent, but its prehistorical eruptions have greatly changed the topography of SW Luzon. The 15 x 20 km Taal caldera is largely filled by Lake Taal, whose 267 sq km surface lies 700 m below the south caldera rim and only 3 m above sea level. The maximum depth of the lake is 160 m, and several eruptive centers lie submerged beneath the lake. The 5-km-wide Volcano Island in north-central Lake Taal is the location of all historical eruptions. The island is a complex volcano composed of coalescing small stratovolcanoes, tuff rings, and scoria cones that has grown about 25% in area during historical time. Powerful pyroclastic flows and surges from historical eruptions of Taal have caused many fatalities.

Information Contacts: *Philippine Institute of Volcanology and Seismology (PHIVOLCS)*, University of the Philippines Campus, Diliman, Quezon City, Philippines (URL: http://www.phivolcs.dost.gov.ph/).

Veniaminof

Alaska Peninsula
56.17°N, 159.38°W; summit elev. 2,507 m

Intermittent, very small-volume steam and ash bursts from the intra-caldera cone have been typical of this volcano intermittently over the past few years, and this pattern continued. The previous report mentions several minor bursts of ash, particularly on 13 June 2006 and 7 September, and minor white plumes through mid-September. This report discusses the interval 8 April through 15 September. Seismicity during this interval was nearly always low, although it often rose above background.

Clouds obstructed visibility during 7-14 April. For the duration of April and June, activity remained low with few steam plumes containing minor amounts of ash. On 30 May a weak daytime thermal anomaly was recorded, possibly due to solar heating inside the dark intra-caldera cone. Intermittent clear weather on the week ending 9 June indicated weak steam plumes.

On 13 June an ash emission rose to a height estimated at ~ 600 m above the summit area, as reported by a passing aircraft. Transient plumes were seen on satellite imagery during the week ending 21 July.

During the week ending 28 July, an AVO field party flew over the summit and observed typical steaming from the intra-caldera cone with no signs of recent ash emissions. Satellite and web camera views during occasional clear periods showed no other signs of activity. Occasional satellite views during clear weather failed to disclose new ash emissions during 28 July through 15 September.

AVO noted a slight increase in seismicity starting 2 August but in the subsequent weeks it again returned to low levels. Available satellite and camera views continued to reveal occasional small white plumes through 15 September.

Geologic Summary. Massive Veniaminof volcano, one of the highest and largest volcanoes on the Alaska Peninsula, is truncated by a steep-walled, 8 x 11 km, glacier-filled caldera that formed around 3,700 years ago. The caldera rim is up to 520 m high on the N, is deeply notched on the W by Cone Glacier, and is covered by an ice sheet on the S. Post-caldera vents are located along a NW-SE zone bisecting the caldera that extends 55 km from near the Bering Sea coast, across the caldera, and down the Pacific flank. Historical eruptions probably all originated from the westernmost and most prominent of two intra-caldera cones, which reaches an elevation of 2,156 m and rises about 300 m above the surrounding ice field. The other cone is larger, and has a summit crater or caldera that may reach 2.5 km in diameter, but is more subdued and barely rises above the glacier surface.

Information Contacts: *Alaska Volcano Observatory (AVO)*, a cooperative program of the U.S. Geological Survey, 4200 University Drive, Anchorage, AK 99508-4667, USA; Geophysical Institute, University of Alaska, P.O. Box 757320, Fairbanks, AK 99775-7320, USA; and Alaska Division of Geological & Geophysical Surveys, 794 University Ave., Suite 200, Fairbanks, AK 99709, USA (URL: http://www.avo.alaska.edu/).