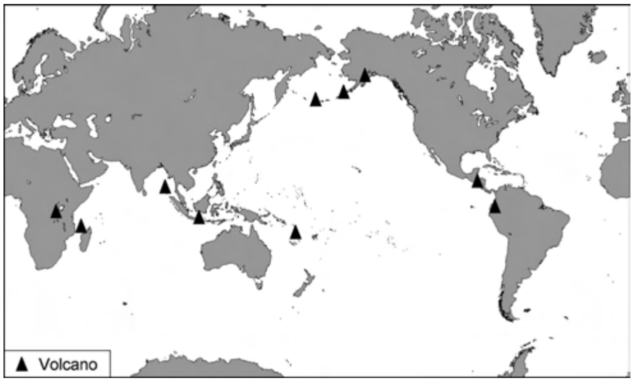
Bulletin of the Global Volcanism Network



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Editors: Rick Wunderman, Catherine Galley, Edward Venzke, and Gari Mayberry

Volunteer Staff: Robert Andrews, Jerome Hudis, Jackie Gluck, William Henoch, Veronica Bemis, and Stephen Bentley

Global Volcanism Program · National Museum of Natural History, Room E-421, PO Box 37012 · Washington, DC 20013-7012 · USA
Telephone: (202) 633-1800 · Fax: (202) 357-2476 · Email: gvn@volcano.si.edu · URL: http://www.volcano.si.edu/

Karthala

Comoros Islands, western Indian Ocean
11.75°S, 43.38°E; summit elev. 2,361 m
All times are local (= UTC + 3 hours)

After the 11 July 1991 phreatic eruption, 14 years of quiescence at Karthala was disrupted in 2005 by two strong explosive events. These events, occurring on 16 April 2005 (*BGVN* 30:04) and 24 November 2005 (*BVGN* 30:11), resulted in deposits of fine ash scattered over a large part of the island. This report presents some further observations and analyses of the November event by scientists from the Comoros and Reunion.

Seismic precursors. The seismicity on figure 1 delineates four periods during 2005: (1) From the beginning of the year until the 16 April explosive event, an interval characterized by significant seismicity. (2) From the 16 April event until just prior to the 25-26 August seismic crisis, an interval with relatively low seismicity (only 102 events recorded in 116 days). (3) An interval from 26 August to 23 November that began during the 25-26 August seismic crisis when 190 events occurred. Moderate seismicity following the seismic crisis ramped up after 27 October until the 24 November eruption. This period was characterized by a total of 1,063 seismic events, an average of 12 earthquakes per day. (4) From the 24 November eruption until the end of the year, an interval of relatively low seismicity similar to the second period. The 24 November earthquake swarm began at 1902, dropped significantly at 1950, and restarted at 2021 with sustained tremor.

The investigators noted that the seismic crisis of 25-26 August 2005 marked the beginning of the new eruptive cycle. It preceded the November 2005 eruption, but was much more subdued than the build up before the eruptions in April 2005 and July 1991 (*BVGN* 16:06 and 16:08). Earthquakes were located by KVO using Sismalp (the French Alps Seismic Network). Uniquely, for the November 2005 seismic crisis, the hypocenters were 500-1,000 m shallower than those of April 2005. This could be attributed to shallower magma storage for the last eruption.

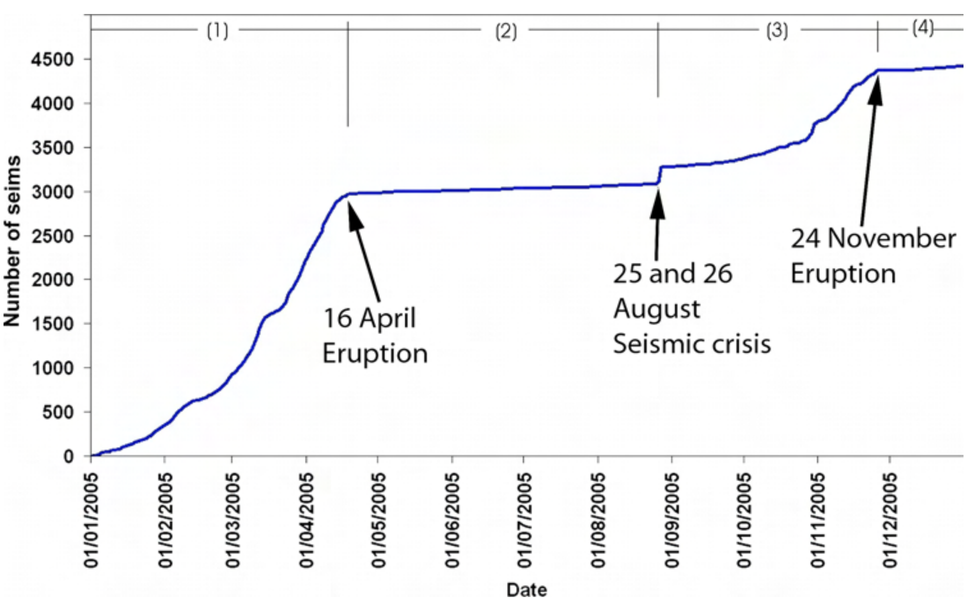

Figure 1. Cumulative distribution of earthquakes registered at Karthala during the year 2005. Courtesy of KVO.

Figure 2. An ash plume from Karthala at 1000 on 25 November 2005 led to ash-draped surfaces and heavily filtered sunlight in the capital, Moroni (population variously estimated at 20,000-63,000 residents, located 13 km NW of the summit). Ashfall was very heavy until 1200, then decreased throughout the rest of the day. Courtesy of Hamid Soulé, KVO.

Activity during 24 November-5 December 2005. The beginning of the 24 November eruption was visible from Moroni (the capital city of the Comoro Islands) with lightning, rumblings, and a large dark plume at the summit. Ash first fell on the E coast of the island around 2300 on 24 November and the tremor intensity significantly dropped. On the W part of the island, ash started to fall on 25 November at 0500 with very strong intensity. Evacuation became very difficult, schools remained closed, and some people used masks to breathe. Ashfall was so intense that the authorities required the inhabitants to remain in their homes. The United Nations Office for the Coordination of Humanitarian Affairs (OCHA) reported that, according to the local authorities, ~ 2,000 people fled from their villages in the region of Bambao in the central part of the island, and sought refuge in less exposed areas, such as Mitsamiouli, Mboudé, and Oichili.

At 0700 on 25 November the sky was darkened by ash (figures 2 and 3). Part of the population fled towards the N of the island. It was only around 0900 that the sky partially cleared; however, ash continued to fall with decreasing intensity during the day. Ash deposits covered three-quarters of the island. The international airport located in the N part of the island remained free of ash deposits. The Toulouse Volcanic Ash Advisory Center issued an advisory to limit risks for air traffic; however, the eruption did not halt airport operations. Satellite imagery on 25 November revealed an ash cloud reaching ~ 11.6 km altitude.

During 25 November, about 30 seismic events were recorded by KVO, causing concern about the possibility of a crack or fissure opening on Karthala's flank, as occurred in April 1977 (*SEAN*

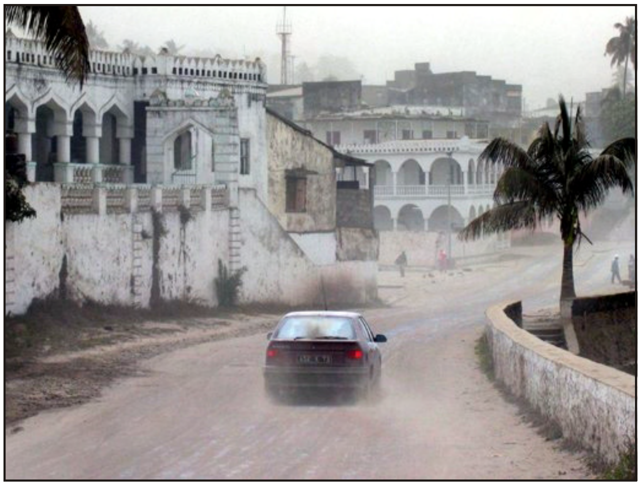

Figure 3.Downtown Moroni as it appeared at 1000 on 25 November 2005 after the eruption of Karthala. Courtesy of Dominique Meyer-Bisch, Embassy of France in Comoros Islands.

Figure 5. On 30 November 2005 a field excursion allowed investigators to observe the ongoing solidification of the lava lake inside Karthala's Chahalé crater. The only incandescence plainly visible appears in the lake's central area. This picture was taken looking from the crater's NW edge. Courtesy of François Sauvestre, KVO.

02:03). During the night, red glow at the summit was clearly visible from the coast.

On 26 November, a field excursion found a lava lake in the Chahalé crater (figure 4). Prior to the eruption that crater's floor had been covered by a water lake some tens of meters deep. In contrast to the crusted-over lava lake of April 2005 (*BGVN* 30:04), in November it was almost entirely liquid, with a very large fountain in its center. By 30 November the lava lake had solidified over ~ 80 % of its surface (figure 5). On 5 December it was almost entirely solid, with only two small spatter cones active (figure 6).

Eruptive products. The landscape at the summit illustrated the style and intensity of the eruption. Measurements of ash deposit thickness were difficult to make. Along the coast ash deposits were between a few millimeters and a few tens of millimeters thick. On the W side of the caldera, ~ 1.5 km from the crater, 70 cm of ash deposits were measured at the same location where 40 cm of ash had fallen in April 2005, an increase of 30 cm in thickness. Closer to the crater, the thicknesses were not measured because they were greater than 1.5 m.

Field work revealed that on the edge of the caldera, ballistic blocks had fallen from the phreatomagmatic phase at the beginning of the eruption. Closer to the central crater the density of volcanic debris increased strongly. In an area covered by several tens of centimeters of ash, blocks impacted the ground leaving an amazing number of craters on the surface (figure 7). Distinctive tephra deposits, presumably related to lava fountains were identifiable everywhere around the central crater (figure 8). These juvenile deposits spread 500 m N from the central crater, whereas they extended only 100 m or less to the S. Products of this magmatic phase were clearly erupted or carried by wind to the N, and they must have ascended higher than 300 m, the depth of the Chahalé pit crater. On 8 December 2005 at about 1000 (15 days after the eruption), both seismic and explosive activity stopped.

Figure 4. On 26 November 2005 investigators ascended Karthala and observed a molten-surfaced lava lake inside Chahalé crater. The lake was about 60-80 m in diameter. Many parts of the lake had a molten surface covered by a chilled skin, although some large blocks of cooler material also lay scattered in the lake. This picture was taken looking down from the crater's N edge. Courtesy of Christophe Roche, French school teacher in Moroni.

Human impact. This eruption was more explosive and longer than the two preceding eruptions in spite of weaker seismicity, and a significant quantity of ash fell in water cisterns. According to OCHA, there were about 118,000 people living in 75 villages that were affected by the cistern contamination. Wind continued to raise large quantities of ash that again fell on the dwellings and

Figure 6. A Karthala excursion on 5 December 2005 allowed scientists to observe an almost entirely solidified lava lake. Two small (5-m high) spatter cones had developed over the area previously hosting the most intense incandescence, and some small zones adjacent to them still remained incandescent. The cones stopped being active on 8 December. This picture was taken looking from the NW edge of the crater. Courtesy of François Martel-Asselin.

into cisterns. In contrast to the April 2005 eruption, no coastal residents reported smelling sulfurous odors. After the end of the eruption, few long period earthquakes were recorded.

Background. The southernmost and largest of the two shield volcanoes forming Grand Comore Island (also known as Ngazidja Island), Karthala contains a 3 x 4 km summit caldera generated by repeated collapse. Elongated rift zones extend to the NNW and SE from the summit of the Hawaiian-style basaltic shield, which has an asymmetrical profile that is steeper to the south. The lower SE rift zone forms the Massif du Badjini, a peninsula at the SE tip of the island. Historical eruptions have modified the morphology of the compound, irregular summit caldera. More than twenty eruptions have been recorded since the 19th century from both summit and flank vents. Many lava flows have reached the sea on both sides of the island, including during many 19th-century eruptions from the summit caldera and vents on the northern and southern flanks. An 1860 lava flow from the summit caldera traveled ~13 km to the NW, reaching the western coast north of the capital city of Moroni.

Information Contacts: *Nicolas Villeneuve*, Centre de Recherches d'Études Géographiques de l'Université de La Réunion (CREGUR), Université de La Réunion, BP 7151, 15 Avenue, René Cassin, 97715 Saint-Denis, Réunion, France (Email: Nicolas.Villeneuve@univ-reunion.fr); *Anthony Finizola* and *Patrick Bachèlery*, Laboratoire des Sciences de la Terre de l'Universite de la Reunion (LSTUR), Université de La Réunion, BP 7151, 15 Avenue, René Cassin, 97715 Saint-Denis, Réunion, France; *François Sauvestre* and *Hamid Soulé*, Centre National de Documentation et de Recherche Scientifique (CNDRS), Place France, BP 169, Moroni, République Fédérale Islamique des Comores (Email: obs_karthala@ifrance.com, cndrs@snpt.km; URL: http://volcano.ipgp.jussieu.fr:8080/karthala/stationkar.html); *Karthala Volcano Observatory (KVO)*, Centre National de Documentation et de la Recherche Scientifique des Comores, BP 169, Moroni, République Fédérale Islamique des Comores.

Figure 7. Bomb impact craters on the N and E sides of Karthala's summit convey a surprising intensity of ballistic bombardment. This picture was taken from the summit (E side of Chahalé crater) looking to the N. Courtesy of Philippe Crozet.

Figure 8. An area around Karthala's summit was covered by tephra deposits. The approximately 2-m high vegetation that remained after the eruption of April 2005 was reduced to about 1-m high in this later, though undated, photo. A 1-m-thick layer of tephra was measured 700 m from the eruptive center. This picture was taken on the W part of the caldera looking NW. Courtesy of François Martel-Asselin.

Nyamuragira

Democratic Republic of Congo
1.408°S, 29.20°E; summit elev. 3,058 m
All times are local (= UTC + 2 hours)

Nyamuragira last erupted during May 2004; weak but steady ash emissions continued until 1 June 2004, when satellite imagery indicated that the eruption had ceased (*BGVN* 29:05). The volcano, whose name is sometimes written as Nyamlagira and Nyamulagira, was the scene of several seismic swarms in middle and late 2005.

On 6 July 2005, the Goma Volcano Observatory (GVO) reported that a significant seismic crisis had occurred at Nyamuragira in late June 2005. The crisis consisted of swarms of mainly long-period earthquakes, which increased in number daily and peaked on 26 and 27 June. Most of the events occurred within a 10 km radius around Nyamuragira's summit caldera and were aligned roughly N-S. The depths of the earthquakes ranged from 0 to 30 km, with two main areas of concentration; one between 15 and 25 km deep, and the other between 0 and 4 km. Based on precursory activity before previous historical eruptions at Nyamuragira, GVO reported that a new eruption might occur in the next 2-4 months. They stressed that an eruption would not threaten the city of Goma or other inhabited areas.

Beginning on 23 October 2005, GVO again recorded heightened seismic activity along the East African Rift and around the Virunga volcanoes when a swarm of long-period earthquakes occurred N of Nyamuragira. More than 140 events were recorded at a station 19 km E of the volcano. On 27 October at 1500, another swarm of long-period earthquakes began beneath the same area. More than 300 events were recorded until at least 28 October. At 2010 on that day, a M 4.5 tectonic earthquake occurred N of Lake Tanganika, followed by several aftershocks. The Alert Level for the nearby city of Goma remained at Yellow.

Background. Africa's most active volcano, Nyamuragira is a massive high-potassium basaltic shield volcano that rises about 25 km N of Lake Kivu across the broad East African Rift Valley NW of Nyiragongo volcano. Nyamuragira, also known as Nyamulagira, has a volume of 500 km^3, and extensive lava flows from the volcano blanket 1,500 km^2 of the East African Rift. The broad low-angle shield volcano contrasts dramatically with its steep-sided neighbor Nyiragongo. The 3,058-m-high summit of Nyamuragira is truncated by a small 2 x 2.3 km caldera that has walls up to about 100 m high. Historical eruptions have occurred within the summit caldera, frequently modifying the morphology of the caldera floor, as well as from the numerous fissures and cinder cones on the volcano's flanks. A lava lake in the summit crater, active since at least 1921, drained in 1938, at the time of a major flank eruption. Historical lava flows extend down the flanks more than 30 km from the summit, reaching as far as Lake Kivu.

Information Contacts: *Baluku Bajop*e and *Kasereka Mahinda*, Observatoire Volcanologique de Goma, Departement de Geophysique, Centre de Recherche en Sciences Naturelles, Lwiro, D.S. Bukavu, DR Congo (Email: ocha.volcan@wfp.org); *Toulouse Volcanic Ash Advisory Center (VAAC)*, Météo-France, 42 Avenue Gaspard Coriolis, F-31057 Toulouse cedex, France (Email: vaac@meteo.fr; URL: http://www.meteo.fr/aeroweb/info/vaac/); *TOMS Volcanic Emissions Group*, NASA Goddard Space Flight Center, Code 613.3, Greenbelt, MD 20771, USA (URL: http://skye.gsfc.nasa.gov/).

Nyiragongo

Democratic Republic of Congo
1.52°S, 29.25°E; summit elev. 3,470 m
All times are local (= UTC + 2 hours)

During May and June 2004, eruptions of Nyiragongo produced ash plumes that rose to a maximum of 6 km altitude (*BGVN* 29:06). According to the Toulouse VAAC, eruptions continued through July, producing plumes to a maximum of 5.5 km altitude. On 7 and 28 September 2004, short-lived plumes that may have contained ash were visible on satellite imagery. The Alert Level for the nearby city of Goma remained at Yellow.

An eruption on 3 November 2004 produced a thin W-drifting plume to 3.6-4.9 km altitude that was visible on satellite imagery. On 22 November a narrow SW-drifting plume was discerned on satellite imagery at 5 km altitude. A narrow plume was seen again on satellite imagery on 23 November at 1130, although no ash was identifiable.

The Goma Volcano Observatory (GVO) reported that during 10-17 November 2004 continuous volcanic tremor was recorded at all seismic stations around Nyiragongo. Visual observation on 12 and 13 November revealed that the lava lake surface had widened considerably, with strong lava fountains. Numerous Pele's hair and scoriae were seen on the cone's S, W, and N sides. A gas plume and incandescence were visible above the volcano. All fractures that opened during the 2002 eruption on the S flank had widened slightly and showed minor temperature increases.

During 18-29 November 2004, continuous banded tremor at high amplitudes occurred beneath the volcano, but the amplitudes seemed to be lower than during 9-18 November. Visual observations on 25-26 November revealed a slight decrease in the level of the lava lake, although strong lava fountains and a high flux of lava and gases continued. Pele's hair, scoriae, a gas plume, and incandescence were still present. Measurements of the fractures on the slopes showed that they remained stable.

The Toulouse VAAC reported faint SO_2 plumes from Nyiragongo visible on satellite imagery on 8 and 10 December. During 29 November to 12 December, volcanic activity remained at relatively high levels. Nearly continuous high-amplitude tremor was recorded at all seismic stations on the volcano. Observations of the crater area on 9 and 10 December revealed that the level of the lava lake remained stable compared to previous visits and that strong lava fountaining was present. Pele's hair and scoriae fell in the area around the volcano, gas plumes rose above the volcano, and strong incandescence was visible at night.

In May 2005 a visiting group from Société de Volcanologie Genève (SVG) estimated that the lava lake was approximately 200 x 150 m across. They observed lava fountaining in the lake to tens of meters high (figure 9).

On 7 September 2005, high-resolution satellite imagery showed a thin plume emitted from Nyiragongo. The plume was not confirmed by other data. Another thin plume visible on satellite imagery on 10 October; it was not confirmed by SO_2 data.

As of 28 October 2005 Nyiragongo remained very active, but stable, with a large active lava lake in the crater. A gas plume was emitted and incandescence was visible at night from several tens of kilometers away. On 7 and 13 November thin plumes from Nyiragongo that may have contained some ash were observed on satellite imagery.

In Janury 2006 a group from Stromboli Online undertook an expedition to Nyiragongo and photographed the lava lake (figure 10).

Background. One of Africa's most notable volcanoes, Nyiragongo contained a lava lake in its deep summit crater that was active for half a century before draining catastrophically through its outer flanks in 1977. In contrast to the low profile of its neighboring shield volcano, Nyamuragira, 3470-m-high Nyiragongo displays the steep slopes of a stratovolcano. Benches in the steep-walled, 1. 2-km-wide summit crater mark levels of former lava lakes, which have been observed since the late-19th century. Two older stratovolcanoes, Baruta and Shaheru, are partially overlapped by Nyiragongo on the north and south. About 100 parasitic cones are located primarily along radial fissures south of Shaheru, east of the summit, and along a NE-SW zone extending as far as Lake Kivu. Many cones are buried by voluminous lava flows that extend long distances down the flanks of the volcano, which is characterized by the eruption of foiditic rocks. The extremely fluid 1977 lava flows caused many fatalities, as did lava flows that inundated portions of the major city of Goma in January 2002.

Figure 10.This photo of Nyiragongo's lava lake was taken from the Belvedere (Bastion) on the crater's W rim. The lake is ~ 300 m wide and its surface sat ~585 m below the rim. The second platform cuts across the bottom foreground. The exact date when the photo was taken in January 2006 is unknown. Photo courtesy of Marco Fulle.

Information Contacts: *Goma Volcano Observatory* (see Nyamuragira); *Jürg Alean, Roberto Carniel*, and *Marco Fulle*, Stromboli Online, Rheinstrasse 6, CH-8193 Eglisau, Switzerland (URL: http://stromboli.net/; Email: jalean@stromboli.net); *Pierre Vetsch* and *Marc Caillet*, Société de Volcanologie Genève (SVG), PO Box 6423, CH-1211 Geneva 6, Switzerland (URL: http://www.volcan.ch/); *Toulouse Volcanic Ash Advisory Center* (see Nyamuragira).

Figure 9. This photo presents Nyiragongo's lava lake in a view from a point on the second platform, which lies ~250 m below the summit. The inner pit with the new lava lake formed after the 2002 lateral eruption. The exact date when the photo was taken in January 2006 is unknown. Photo copyright Marc Caillet and provided courtesy of Pierre Vetsch, SVG.

Barren Island

Andaman Islands, India
12.278°N, 93.858°E
summit elev. 354 m

Activity continued at Barren Island since the volcano's latest eruption that began 28 May 2005 (*BGVN* 30:05, 30:07, and 30:09). The MODVOLC Alerts Team web site has shown that the MODIS (moderate resolution imaging spectroradiometer) satellite recorded nearly daily thermal anomalies from 26 May 2005 (two days earlier than observed by other means). The thermal anomalies continued through 21 January 2006. In contrast, no thermal anomalies were recorded by satellites in the year prior to 26 May 2005.

D. Chandrasekharam of the Indian Institute of Technology and members of the Indian Coast Guard observed that since 4 November the volcano emitted large volumes of gas and ash emissions, and lava flows had reached the sea. Chandrasekharam stated that the early 2006 activity was more intense than when the eruption began in May 2005. The recent activity was preceded by about ten moderate earthquakes in the region, including M 4.8 and 4.5 events on 3 November.

During 12-15 November 2005, ash plumes emitted from Barren Island were visible on satellite imagery drifting predominantly SSW, but they were no longer visible on 16 November. Ash plumes were visible on satellite imagery on 19 and 20 December at a maximum height of ~ 3.7 km, and during 21-23 December at a maximum height of 4.6 km. Satellite imagery showed a thin ash plume from Barren Island extending WNW during 5-7 January 2006.

Two earthquakes occurred in January 2006. On the 6th, an M 5.4 event struck 137 km E of Barren Island, and on the 21st, an M 5.6 event struck 104 km NNW of the island.

To monitor the ongoing volcanism, a team from the Geological Survey of India, including M.M. Mukherjee, P. C. Bandopadhyay, Tapan Pal, and Sri Prasun Ghosh, approached aboard the Indian Coast Guard Ship *C.S. GANGA DEVI* during 12-13 January 2006. The party sailed to within 0.8 km of Barren Island and studied the nature of the eruption from shipboard. The eruption resembled fireworks projecting different colors over the crater and on the slope of the cone. Dense clusters of incandescent pyroclasts of various sizes ejected forcefully from the crater mouth "with ballistic trajectories." Apart from eruption from the main crater, a "glow of fire" from the N flank of the cone and thin layers of red hot materials on W slope were observed. The Darwin VAAC reported that ash plumes from Barren Island during 26-27 January rose to ~ 3 km.

Background. Barren Island, a possession of India in the Andaman Sea about 135 km NE of Port Blair in the Andaman Islands, is the only historically active volcano along the N-S-trending volcanic arc extending between Sumatra and Burma (Myanmar). The 354-m-high island is the emergent summit of a volcano that rises from a depth of ~ 2,250 m. The small, uninhabited 3-km-wide island contains a roughly 2-km-wide caldera with walls 250-350 m high. The caldera, which is open to the sea on the west, was created during a major explosive eruption in the late Pleistocene that produced pyroclastic-flow and -surge deposits. The morphology of a fresh pyroclastic cone that was constructed in the center of the caldera has varied during the course of historical eruptions. Lava flows fill much of the caldera floor and have reached the sea along the western coast during historical eruptions.

Information Contacts: *D. Candrasekharam*, Indian Institute of Technology, Department of Earth Sciences, Bombay 400076, India (Email: dchandra@iitb.ac.in; URL: hhtp://www.geos.iitb.ac.in/dchandra); *Dhanapati Haldar*, Presidency College, Kolkata, 4/3K/2 Ho-Chi-Min Sarani, Shakuntala Park, Biren Roy Road (West), Kolkata-700 061, India (Email: haldar2115@yahoo.co.uk); *Geological Survey of India*, 27 Jawaharlal Nehru road, Kolkata 700 016, India (URL: http://www.gsi.gov.in/barren.htm); *Indian Coast Guard*, National Stadium Complex, New Delhi 110 001, India (URL: http://indiancoastguard.nic.in/indiancoastguard/); *Darwin Volcanic Ash Advisory Center* (URL: http://www.bom.gov.au/info/vaac/); *MODVOLC Alerts Team*, Hawaii Institute of Geophysics and Planetology (HIGP), University of Hawaii at Manoa, 1680 East-West Road, Post 602, Honolulu, HI 96822, USA (URL: http://modis.higp.hawaii.edu/).

Lamongan

Java, Indonesia
8.00°S, 113.342°E; summit elev. 1,651 m

Elevated seismicity occurred at Lamongan on 5-6 January 2005. From 1200 to 0700 on 5 January, 22 events occurred with Modified Mercali Intensity (MMI) of 1. At each of three times (0331, 0447, and 0524) observers noted an event of MMI 3. During this period, instruments detected continuous tremor with an amplitude of 3 to 15 mm. On 5 January there were 282 local tectonic earthquakes and 53 volcanic A-type earthquakes. The volcano alert level was raised to 2.

On 6 January 2005, 107 volcanic A-type earthquakes were recorded. Local tectonic earthquakes over the two day period occurred 159 times, of which 10 of them were events had Modified Mercali Intensity (MMI) of 1-3.

Background: Lamongan, a small (1,631-m high) stratovolcano located between the massive Tengger and Iyang-Argapura volcanic complexes, is surrounded by numerous maars and cinder cones. The currently active cone has been constructed 650 m to the SW of Gunung Tarub, the volcano's high point. As many as 27 maars with diameters from 150 to 700 m, some containing crater lakes, surround the volcano, along with about 60 cinder cones and spatter cones. Lake-filled maars, including Ranu Pakis, Ranu Klakah, and Ranu Bedali, are located on the eastern and western flanks; dry maars are predominately located on the northern flanks. None of the Lamongan maars has erupted during historical time, although several of the youthful maars cut drainage channels from Gunung Tarub. Lamongan was very active from the time of its first historical eruption in 1799 through the end of the 19th century, producing frequent explosive eruptions and lava flows from vents on the western side of the volcano ranging from the summit to about 450 m elevation.

Information Contact: *Darwin Volcanic Ash Advisory Centre (VAAC)*, Bureau of Meteorology, Northern Territory Regional Office, PO Box 40050, Casuarina, NT 0811, Australia (URL: http://www.bom.gov.au/info/vaac/).

Lopevi

Vanuatu, SW Pacific
16.507°S, 168.346°E; summit elev. 1,413 m

An error occurred in the March 2005 issue of *BGVN* (30:03) in a table included in the article on Lopevi. The table had listed MODVOLC thermal anomalies, but it mistakenly included those for both Lopevi and Ambrym. The corrected table for Lopevi thermal anomalies only is provided here (table 1).

Background. The small 7-km-wide conical island of Lopevi is one of Vanuatu's most active volcanoes. A small summit crater containing a cinder cone is breached to the NW and tops an older cone that is rimmed by the remnant of a larger crater. The basaltic-to-andesitic volcano has been active during historical time at both summit and flank vents, primarily along a NW-SE-trending fissure that cuts across the island, producing moderate explosive eruptions and lava flows that reached the coast. Historical eruptions

Date	Time (UTC)	Sensor	Spectral radiance
28 Sep 2004	1410	Aqua MODIS	0.937
28 Sep 2004	1410	Aqua MODIS	1.052
30 Jan 2005	1130	Terra-MODIS	0.710
05 Feb 2005	1355	Aqua MODIS	0.983
05 Feb 2005	1355	Aqua MODIS	1.426
No thermal anomalies were measured from June 2003 to March 2005.			

Table 1. MODVOLC thermal anomalies as observed from the MODIS satellite for Lopevi volcano for the period July 2003 to March 2005. The fourth column shows radiance in watts per square meter, per steradian, per micron ($W\ m^{-2}\ sr^{-1}\ \mu m^{-1}$) in MODIS band 21 (central wavelength of 3.959 µm). Courtesy of the Hawai'i Institute of Geophysics and Planetology.

at the 1,413-m-high volcano date back to the mid-19th century. The island was evacuated following eruptions in 1939 and 1960. The latter eruption, from a NW-flank fissure vent, produced a pyroclastic flow that swept to the sea and a lava flow that formed a new peninsula on the western coast.

Information Contacts: *MODVOLC Alerts Team*, 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/).

Aoba

Vanuatu, SW Pacific
15.40°S, 167.83°E; summit elev. 1,496 m
All times are local (= UTC +11 hours)

As previously reported, a new eruption at Aoba began 27 November 2005 in one of the crater lakes (Lake Voui). The eruption formed a cinder cone in the lake (figures 11 and 12) that contained a crater with a small hot lake (*BGVN* 30:11 and 30:12).

On 31 January a high, dark ash plume caused ashfall in the S part of the island. Small eruptions continued in February.

Alain Bernard recently processed a 26 January 2006 nighttime ASTER (Advanced Spaceborne Thermal Emission and Reflection Radiometer) image. Figure 13 shows the ASTER product called AST_04 (TIR–thermal infrared radiometer, 8.12-11.65 µm wavelengths–band 10) unprocessed image of Aoba with Lakes Voui and Lakua. The TIR bands, with a spatial resolution of 90 m, give the ability to detect small thermal anomalies (a few degrees C), perform thermal mapping, and monitor temporal variations in the lake surface temperature. As shown in figure 14, Lake Voui's temperature in early January 2006 dropped by ~ 10°C to a mean of 25.4°C (down from 35.7°C one month earlier). Temperature differences between Voui and Lakua dropped to 4.3°C, reaching almost to the background levels observed in July 2005 (see plot "Temperature data from Lake Voui at Aoba, October 1998-December 2005 . . ."; *BGVN* 30:11). There is still a strong thermal anomaly of 46.1°C inside the new island (figure 13).

As of 11 February 2006 at 1011 hours (10 February 2006 at 2311 UTC), Alain Bernard reported that Lakes Voui and Lakua temperatures were, respectively, 27.2°C and 23.2°C (delta T = 4°C). The maximum temperature for the mud pool was ~ 57°C.

Background. Aoba is a massive 2,500 km^3 basaltic shield volcano that is the most voluminous volcano of the New Hebrides archipelago. A pronounced NE-SW-trending rift zone dotted with scoria cones gives the 16 x 38 km island an elongated form. A broad pyroclastic cone containing three crater lakes is located at the summit of the Hawaiian-style shield volcano within the youngest of at least two nested calderas, the largest of which is 6 km in diameter. Post-caldera explosive eruptions formed the summit craters of Lake Voui (also spelled Vui) and Lake Manaro Ngoru about 360 years ago. A tuff cone was constructed within Lake Voui about 60 years later. The latest known flank eruption, about 300 years ago, destroyed the population of the Nduindui area near the western coast.

Information Contacts: *Alain Bernard*, IAVCEI Commission on Volcanic Lakes, Université Libre de Bruxelles (ULB), CP160/02, avenue F.D. Roosevelt 50, Brussels, Belgium (Email: abernard@ulb.ac.be; URL: http://www.ulb.ac.be/sciences/cvl/aoba/Ambae1.html; http://www.ulb.ac.be/sciences/cvl/multispectral/multispectral2.htm); *Esline Garaebiti*, Department of Geology, Mines, and Water Resources (DGMWR), Port-Vila, Vanuatu (Email:esline@vanuatu.com.vu).

Figure 11. A view of Aoba's Lake Voui on 18 January 2006, showing the new island and its steaming internal lake. Courtesy Alain Bernard.

Figure 12. Steam rising from the lake on the island in the middle of Aoba's Lake Voui, 18 January 2006. Courtesy Alain Bernard.

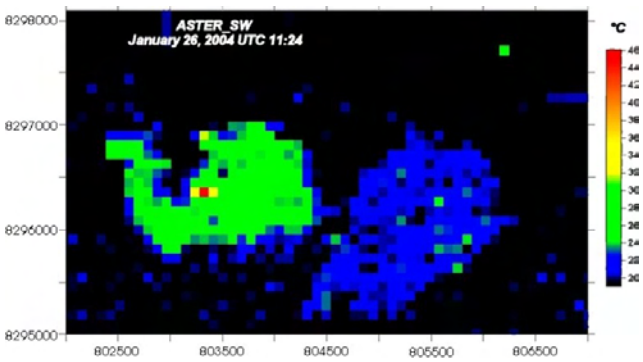

Figure 13. A thermal image of Aoba's lakes Voui and Manaro Lakua (to the W and E, respectively) for 26 January 2006 at 1124 UTC (2224 local). The image results from the ASTER On-Demand L2 Brightness Temperature at the Sensor. This AST_04 product is the brightness temperature data as recorded by the satellite, not the temperature of the target at the ground level. To retrieve the actual surface temperature, one needs to correct for atmospheric effects (absorption of water vapor, etc.) that significantly alter the spectral radiance during the travel from the ground to the satellite. A new method for this correction, developed by Alain Bernard and called AST_SW (SW stands for "split window"), is explained on his ("multispectral") website. Courtesy of Alain Bernard.

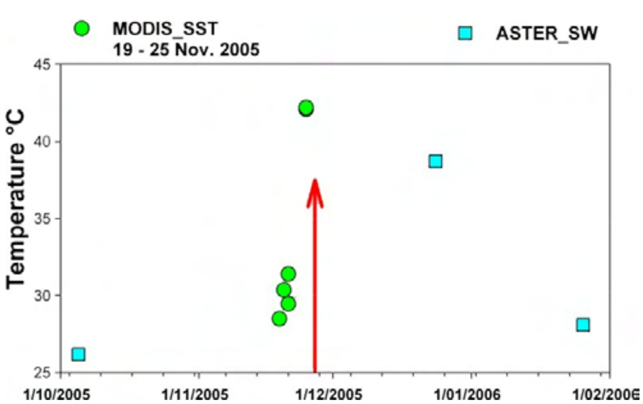

Figure 14. A plot of computed temperatures from 1 October 2005 to 1 February 2006 for Aoba's Lake Voui. The two different symbols distinguish processed MODIS and ASTER thermal data. A similar plot for an earlier period appeared in *BGVN* 30:11. Courtesy of Alain Bernard.

Galeras

Colombia
1.22°N, 77.37°W; summit elev. 4,276 m
All times are local (= UTC - 5 hours)

Galeras was last reported on in *BGVN* 30:09, covering the period from July 2004 to mid-October 2005. During July through October 2004, eruptions generated ash and gas plumes that caused ashfall in surrounding areas. On 21 November 2004 Galeras erupted explosively. During January - September 2005, low-level relatively shallow seismicity and small gas-and-ash emissions continued. Occasional steam plumes were visible from Pasto in October 2005. Seismicity fluctuated and some instrumentally measured deformation continued.

During the first week of November 2005, low-level seismicity included several tornillo earthquakes (long-period seismic events related to pressurized fluid flow at shallow depth). Small amounts of deformation were recorded at the volcano. During 9-14 November, a large number of tornillo earthquakes were reported by Instituto Colombiano de Geología y Minería (INGEOMINAS). The earthquakes were similar to those that occurred before eruptions in 1992-93. Activity during October suggested that the volume of magma beneath the volcano was greater than that inferred to have been present during the 1992-93 eruptions. Due to increased activity, the Alert Level was raised to 2 (probable eruption in days or weeks) on 14 November.

According to news reports, on 14 November local authorities recommended an evacuation of as many as 9,000 people living in towns near the volcano, including Pasto (to the E), La Florida (to the N), and Nariño (to the N). Heightened seismicity continued during 16-22 November. According to news articles, only ~ 1,000 residents had actually left as of 18 November.

On 24 November at 0246 seismic signals indicated the beginning of an eruption. Ash fell in the towns of Fontibon, San Cayetano, Postobon, and in north Pasto. Around this time, INGEOMINAS raised the Alert Level to 1 (eruption imminent or occurring). The Washington VAAC observed a small puff of ash NE of the volcano at ~ 4.6 km altitude. Activity decreased by the next day, so the Alert Level was reduced to 2. Thousands of people had been evacuated during the week prior to the eruption.

Due to a decrease in activity, on 28 November INGEOMINAS reduced the Alert Level to 3. Low levels of seismicity and deformation were continuing. Although poor weather conditions obscured the volcano most of the time, steam and gas emissions were photographed on 2 December coming from several locations on the active cone, including the main crater. The plume rose 1 km above the summit on 3 December.

Through 12 December, seismicity indicated fluids moving within the volcano, small changes in deformation occurred, and gas rose to a height of ~ 500 m. Based on information from the US Geological Survey, the Washington VAAC reported that a pilot observed an ash plume from Galeras on 23 December at an altitude of ~ 7.3 km and drifting W.

During 23 December to 2 January 2006 there were emissions of gas and small amounts of ash. On 23 December four ash plumes rose to ~ 3 km altitude and drifted to

Consacá. A cluster of 33 volcano-tectonic earthquakes, reaching a maximum M 1.2, occurred beneath the volcano's crater during 29-30 December. The SO_2 flux varied between 300 and 1,500 metric tons per day (t/d).

Gas emissions with small amounts of ash, and heightened seismicity, continued through 9 January. The SO_2 flux at the volcano varied between 490 and 1,500 t/d. A lava dome was visible in the main crater during an overflight on 13 January. Around this time, there was an increase in the amount of seismicity and deformation. The Washington VAAC reported that a pilot observed an ash plume on 23 December at an altitude of ~ 7.3 km and drifting W.

During 23 January to 6 February, the lava dome in the main crater continued to grow; seismicity associated with the movement of fluids continued, with an average of 200 small earthquakes per day, and slight deformation was recorded. SO_2 flux of about 300 t/d was measured. Strong degassing occurred in several sectors of the active cone and around the lava dome. Steam rose to 900 m above the volcano. During a field visit on 8 February, scientists found pyroclastic-flow deposits high on the SE flank.

The rate of seismicity the week of 13-20 February averaged 190 small earthquakes per day, while the SO_2 flux was about 200 metric tons per day. Steam rose to ~ 1.1 km above the volcano on 19 February and incandescence was visible at parts of the lava dome. The volume of the dome in the main crater was approximately 1.5 times larger than when it was first observed on 13 January. Seismicity increased to an average of 280 small earthquakes per day during 20-27 February. SO_2 flux also rose, to about 600 t/d. On 26 February a cluster of earthquakes included an M 4.8 volcano-tectonic earthquake followed by 35 smaller earthquakes. Slight deformation was recorded at the volcano. Steam and gas rose to ~ 700 m above the volcano. Galeras remained at Alert Level 3 through February 2006.

Background. Galeras, a stratovolcano with a large breached caldera located immediately west of the city of Pasto, is one of Colombia's most frequently active volcanoes. The dominantly andesitic Galeras volcanic complex has been active for more than 1 million years, and two major caldera collapse eruptions took place during the late Pleistocene. Long-term extensive hydrothermal alteration has affected the volcano. This has contributed to large-scale edifice collapse that has occurred on at least three occasions, producing debris avalanches that swept to the west and left a large horseshoe-shaped caldera inside which the modern cone has been constructed. Major explosive eruptions since the mid Holocene have produced widespread tephra deposits and pyroclastic flows that swept all but the southern flanks. A central cone slightly lower than the caldera rim has been the site of numerous small-to-moderate historical eruptions since the time of the Spanish conquistadors.

Information Contacts: *Diego Gomez Martinez*, Observatorio Vulcanológico y Sismológico de Pasto (OVSP), INGEOMINAS, Carrera 31, 1807 Parque Infantil, PO Box 1795, Pasto, Colombia (Email: dgomez@ingeomin.gov.co; URL: http://www.ingeomin.gov.co/pasto/; Email: ovp@ingeomin.gov.co); *Washington Volcanic Ash Advisory Center (VAAC)*, Satellite Analysis Branch (SAB), NOAA/NESDIS E/SP23, NOAA Science Center Room 401, 5200 Auth Rd., Camp Springs, MD 20746, USA (URL: http://www.ssd.noaa.gov/); *El Pais* (URL:http://elpais-cali.terra.com.co/paisonline/).

Santa Ana

El Salvador
13.853°N, 89.630°W; summit elev. 2,381 m
All times are local (= UTC - 6 hours)

Previous comments regarding terminal phases of the 1 October 2005 eruption (*BGVN* 30:09) included: . "Following the eruption of 1 October, small explosions, degassing, and low-to-moderate seismicity occurred at Santa Ana during 5-11 October . . .. During an aerial inspection of the volcano on 11 October, no changes were observed at the crater."

Carlos Pullinger (Servicio Nacional de Estudios Territoriales, SNET) later noted that "The 1 October eruption only lasted about 1 hour. After that we had some small activity, probably associated [with] degassing on Sunday evening [2 October] and at about the same time the continuous rains produced the first of a series of lahars that affected the communities close to the shore of Coatepeque lake. During the rest of the week it was very difficult to know what was going on because of continuous rains and cloudy conditions."

Pullinger further noted that some eye witnesses said that they had observed a column on 2 October. SNET registered strong and continuous tremor during approximately 1900-2400 (local time) on 2 October. Much of this activity coincided with rain-induced lahars. Over 300 mm of rain fell on the volcano that day. Using both witness reports and seismicity, SNET inferred that on 2 October the volcano possibly generated strong degassing or even geyser-type activity. However, there was no confirmation of ashfall deposits from these or other post-1 October events.

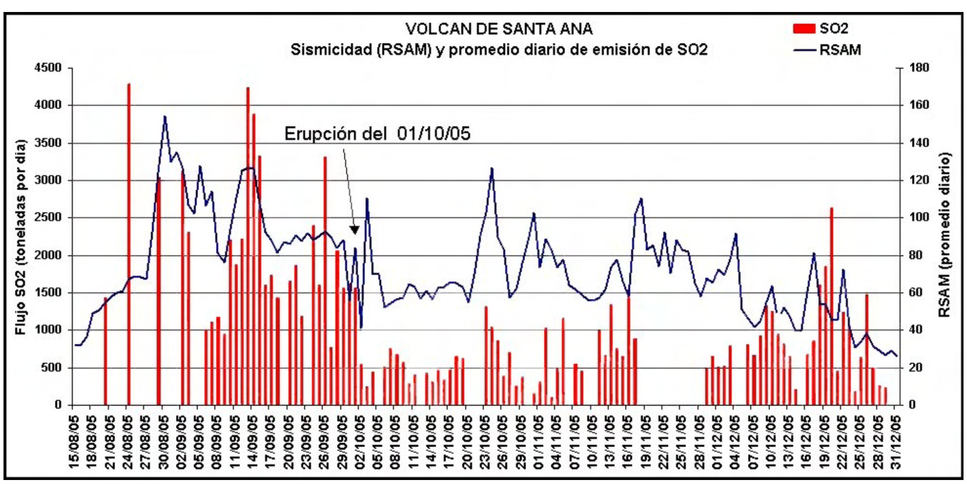

Figure 15. A graph showing Santa Ana's SO_2 flux (vertical bars) and average daily seismic amplitude (RSAM, solid line) during 15 August-31 December 2005. The eruption of 1 October 2005 is indicated with an arrow. Courtesy of SNET.

The same type of seismicity continued intermittently until 5 October, but with much less intensity than on 2 October. SNET could not tell if there was any volcanic activity related to these events, or if it was mainly lahars. After the 5th continuous tremor was not recorded.

Post-eruption behavior. SNET reported that, in general, following Santa Ana's 1 October 2005 eruption, seismicity was relatively stable and there were generally low-level gas emissions (figure 15).

Storms on 12 October 2005 caused lahars that traveled E towards Lake Coatepeque (see ASTER image of the region in *BGVN* 30:09). On 22 October, a lahar was reactivated in the Potrero Arriba area, NE of the volcano. During 22-25 October, the volcano was subjected to increased tremor and a slight increase in seismicity associated with gas emissions. On 28 October volcanic activity appeared to increase slightly and sulfur-dioxide emission rates during 28 and 29 October averaged 257 metric tons per day. The Alert Level within a 5-km radius around the volcano's central crater was at Red, the highest level.

Figure 16. A photo taken from the crater rim at Santa Ana showing steam and gas emissions from both the lagoon and fumaroles located within the crater. Courtesy of SNET.

During the month of November 2005 seismicity, volcanic activity, and gas emissions all remained for the most part at relatively low levels. There were slight increases on 13, 17, and 26 November; but the 17 November increase was attributed to noise from strong winds. On 26 November only slight changes were noted in the color of the lagoon in the crater's interior, but gas emissions rose to ~ 300 m above the volcano. Small earthquakes occurred during November 2005, inferred to be associated with the fracturing of rocks and gas pulses. Sulfur-dioxide emissions were low during the first part of November, with 100 to 200 metric tons recorded daily, and during the latter part of November, with between 100 and ~ 1,500 metric tons recorded daily.

During December 2005, seismicity was above background levels. Observations of Santa Ana's crater on 28 December revealed that there were continuous emissions of steam and gas from the lagoon and fumaroles located within the crater (figure 16). Gas rose 200-500 m above the crater and drifted SW (figure 17). Small earthquakes occurred, but gas emissions rose to over ~ 2,500 tons per day (figure 15). The Alert Level remained at Red, the highest level, within a 5-km radius around the volcano's summit crater.

From 30 December 2005 to early January 2006, seismic and steam emissions were moderate at Santa Ana. Seismicity was slightly above normal levels with small earthquakes occurring, which were interpreted as being associated with gas pulses. Low-level emissions of steam and gas from the lagoon and fumaroles within the crater remained the same as in December 2005. Gas rose 200-500 m above the crater and drifted SW. The sulfur-dioxide flux ranged between 180 and 1,476 metric tons per day. The Alert Level remained at Red, the highest level, within a 5-km radius around the volcano's summit crater.

Background. Santa Ana, El Salvador's highest volcano, is a massive, 2,381-m-high andesitic-to-basaltic stratovolcano that rises immediately W of Coatepeque caldera. Collapse of the volcano during the late Pleistocene produced a voluminous debris avalanche that swept into the Pacific Ocean, forming the Acajutla Peninsula. Reconstruction of the volcano subsequently filled most of the collapse scarp. The broad summit of the volcano is cut by several crescentic craters, and a series of parasitic vents and cones have formed along a 20-km-long fissure system that extends from near the town of Chalchuapa NNW of the volcano to the San Marcelino and Cerro la Olla cin-

Figure 17. A photo of Santa Ana showing the 28 December 2005 gas emission that rose 200-500 m above the crater rim. Courtesy of SNET.

der cones on the SE flank. Historical activity, largely consisting of small-to-moderate explosive eruptions from both summit and flank vents, has been documented since the 16th century. The San Marcelino cinder cone on the SE flank produced a lava flow in 1722 that traveled 13 km to the E.

Information Contacts: *Servicio Nacional de Estudios Territoriales* (SNET), Alameda Roosevelt y 55 Avenida Norte, Edificio Torre El Salvador, Quinta Planta, San Salvador, El Salvador (URL: http://www.snet.gob.sv/)

Augustine

southwestern Alaska, United States
59.363°N, 153.43°W; summit elev. 1,252 m
All times are local (= UTC - 9 hours)

Following a period of increased seismicity at Augustine that began in May 2005, discrete seismic events on 9 and 11 December may have perturbed the hydrothermal system, initiating small steam explosions. On 12 December, a plume extended 75 km SE of the volcano, and its S and E flanks were dusted with ash (likely non-juvenile). Additional steam explosions took place later in the month, and the smell of sulfur was reported by residents in villages on the E side of Cook Inlet. The first major eruptions at Augustine occurred on 11 January 2006, when two discrete explosions produced an ash cloud that reached 9 km altitude (*BGVN* 30:12) and the Concern Color Code was raised to Red. Further eruptions occurred on 13, 14, and 17 January. After the eruption at 0758 on 17 January, seismicity diminished significantly and AVO lowered the color code from Red to Orange late on 18 January.

By the morning of 19 January seismicity remained fixed at lower levels; it decreased further on 20 January but was still above background. Periods of quiescence and low seismicity in the intervals between eruptive events are not unusual at Augustine, having occurred during the 1976 and 1986 eruptive episodes. During 23-26 January, satellite observations indicated the persistence of faint thermal anomalies and steaming continued at the summit.

Occasional intervals of increased seismicity were observed for the next few days. On 27 January 2006 an explosive eruption began at about 2000 and lasted for 9 minutes. AVO raised the color code from Orange to Red. According to the National Weather Service (NWS), an ash cloud reached a maximum altitude of around 9 km and drifted SE. Augustine erupted again at 2337 on 27 January 2006. This event lasted 1 minute and no ash was detected above 3 km. A third eruption occurred at 0204 on 28 January 2006 and lasted 2 minutes. Ash drifted SE at an altitude of about 8 km according to NWS. A fourth eruption occurred at 0742 on 28 January and lasted 3 minutes; the ash cloud drifted SE at a maximum altitude of 7.5 km.

Another explosive event began at 1430 on 28 January. Seismic activity continued and continuous ash emission was observed in AVO web camera images. NWS reported ash to 9 km altitude travelling SSW. Following this explosion, Augustine was in a state of continuous eruption accompanied by persistent ash emission until around 3 February.

Figure 18. A satellite image showing the Augustine eruption on 2 February 2006. On that day the Alaska Volcano Observatory reported a continuous ash plume accompanied by low-level explosions and pyroclastic flows of hot ash and rock fragments. This image was taken by the Moderate Resolution Imaging Spectroradiometer (MODIS) onboard the Terra satellite. Augustine is partially outlined in this image, indicating a ground surface much hotter than its surroundings; the volcano's ash plume is pale gray-beige, barely darker than the nearby weather clouds. However, the weather clouds can be discerned from the ash by their distinct dot-like pattern. NASA image courtesy Jeff Schmaltz, MODIS Rapid Response Team at NASA GSFC.

Overflight observations on 29 January suggested that pyroclastic flows were being produced. NWS radar indicated that ash clouds from events at 1117 on 29 January, and 0325 and 0621 on 30 January, rose to 7.5 km altitude. Other than during these three events an ash-rich plume rose to about 4 km altitude. On 30 January, Alaska Airlines canceled all flights into and out of Anchorage because of the potential danger of ash. Flights resumed on 31 January.

On 1 February AVO lowered the Concern Color Code from Red to Orange. Although seismic data indicated sustained eruptive activity, ash clouds to altitudes greater than 4.5 km altitude had not been observed on NWS radar since 0621 on 30 January. Low-level explosions, pyroclastic flows, and production of ash continued (figure 18).

By 3 February seismic data indicated that low-level explosions, block-and-ash-flows, and sustained production of ash were continuing intermittently and had changed little in character or intensity since 1 February. Seismicity dropped significantly on the evening of 3 February. Observers on an overflight on 3 February saw a steam-rich, ash-poor plume emerge from the cloud tops and reach no higher than 2 km altitude. NWS reported no ash in satellite or radar data.

Observations by AVO scientists during visits on 8 February, as well as satellite and seismic data and other remote observations, indicated that a lava dome was present at the summit. Streams of gas, ash, and incandescent blocks were observed descending the upper NE flank on the evening of 7 February and early on the 8th, indicating that small-volume collapses of the lava dome were occurring and that the dome was actively growing. Seismicity remained at low levels, though still above background. Low-level ash plumes and occasional pyroclastic flows on the flanks continued. A persistent thermal signal was observed in satellite data. Incandescence was visible from Homer.

On 11 February, seismic data indicated that the new lava dome at Augustine's summit continued to grow. Seismic stations on the flanks of the volcano recorded rockfalls and pyroclastic flows associated with small-volume collapses of the lava dome. A plume composed of gas, steam, and small amounts of ash continued to be emitted from the summit, and low-level, dilute ash clouds were likely present in the vicinity of the volcano.

Just before midnight on 12-13 February a low-light camera operated by the University of Alaska Fairbanks captured a small hot avalanche down the north flank of the volcano. The event was also recorded on AVO's pressure sensor on Augustine Island. A light dusting of new ash on the E flank of the volcano may have been related to this avalanche event. Satellite data on 13 February showed a persistent thermal anomaly at the volcano's summit. Together, these data suggested that the lava dome continued to grow and underwent occasional, minor collapse events.

On 16 February, clear satellite views showed a strong thermal anomaly in the summit crater area. Seismometers continued to record rockfalls and small pyroclastic-flow signals indicative of occasional, minor collapses of the lava dome. Over 10-16 February, the number of these events declined steadily, suggesting that the rate of lava effusion was slowing. An observation flight on 16 February obtained good views of the summit: a new, steaming, blocky lava dome occupied the summit crater. The dome filled much of the crater and extended as a rubbly tongue 500-800 m down the upper N flank. Dark aprons of collapse debris, including large steaming blocks, extend downslope to the N. The rim of the summit crater was largely snow-free and mantled by thick, coarse, pyroclastic deposits, likely from the explosive events in January. The dome resulted from the largely non-explosive extrusion of degassed lava following the cessation of explosive activity on January 30.

By the end of this report period (22 February) unrest was continuing. Seismicity remained above background levels. Rockfalls and avalanches from the lava dome continued but appeared to be declining in frequency. Satellite images continued to show a persistent thermal anomaly. A plume composed of variable amounts of gas, steam, and small amounts of ash likely continued intermittently from Augustine's summit. Dome building eruptive activity may continue intermittently over the next several months.

Aviation hazard. Tina Neal (USGS-AVO) provided some thought-provoking insights into Augustine's aviation-ash issues. The following quote with minor modification is information she sent in a 14 February email message to the Volcanicclouds listserve, some follow up messages, and a review.

"Volcanologists often rely upon pilot observations to provide the all-important visual confirmation and description of distant volcanic events. What we need to remember, however, is that it is quite difficult to get more than snippets of information in a PIREP [aviation pilot report]: Pilots and controllers are often extremely busy and controllers cannot ask more than very basic follow up questions. Air traffic communication protocols put a premium on succinct transmissions. I was lucky enough recently to hear this play out in real time during an Augustine eruption when I happened to be visiting the Anchorage Air Traffic Control facility and was allowed to plug in to monitor the sector around Augustine. While we should continue to encourage full and detailed PIREPs following the VAR [Volcanic Activity Report] format, we should not be terribly surprised when the return is not very complete. Similarly, follow up communications directly with the pilot, possible in some cases, are difficult and not the highest priority of Observatory staff.

"Thus far for the Augustine eruption, we do have documentation of impacts from the ash clouds and the distal fine ash and SO_2 cloud from explosive events, largely taken from PIREPS passed to AVO by the FAA and the National Weather Service. In addition to these instances below, flight routes were moved in anticipation of possible ash cloud motion following several explosions, and flight cancellations did occur.

"[1.] On 14 January a jet aircraft about [80 km E] of Yakutat at FL310 [9.4 km altitude, at 59 deg. 30.65 min. N, 139 deg. 8.89 min. W; ~800 km from Augustine] skimmed through the top of the 'brown' cloud for about 10 minutes and reported smelling a 'dirty, musty odor.' The pilot climbed to FL330 and deviated to the NE around the cloud. [The plane was out of service for two days.] Borescope inspection upon landing showed no damage and no ash accumulation.[Later anaysis suggested the ash cloud encountered may have been a combination of 5 separate drifting ash clouds from 5 separate discrete events during 13-14 January.]

"[2.] On the same day, another jet near the same location saw a brown haze layer about 2000 feet [610 m] thick and made a climbing turn to avoid it.

"[3. On] 31 January [there were reports of a] light sulfur smell from several aircraft over Anchorage.

"[4.] AVO received the followings email account about a possible encounter between a Cessna Cherokee and a distant ash cloud from Augustine on 30 January (we have yet to follow up for any further information and verification).

"I am traveling in the Bristol Bay Area and was in Togiak last night. Last night I started coughing and sneezing and on the flight to Dillingham this morning the pilot and I noticed volcanic ash in the air from ground level and according to the pilot up to 7,000 feet [2.1 km altitude]. The ash is very fine but is sticking to the wind screen of the aircraft. Along with the ash my eyes were stinging and I noticed a little burning in my nose. As we approached the Dillingham area and got out of the mountains the air quickly cleared. At this time it seems to only be in the mountains and according to the pilots in different places all the way to King Salmon. I do not know if you have received these reports yet."

In addition, Volcaniclouds discussions included this message from Ken Dean (Geophysical Institute-AVO). It provided some further discussion and references on past eruption-cloud behavior from Mt. Cleveland (1,250 km SW of Augustine).

". . . there was an incident on 22 February 2001 attributed to a volcanic cloud from the eruption of Cleveland Volcano on 19 Feb. 2001. A PIREP from a B747 near San Francisco [California] reported a strong (sulfur) smell and particles in the cabin. At first we thought this was an erroneous report since it was so far from the eruption and satellite date did not show anything in the region of the aircraft. However, when we ran the Puff dispersion model using re-analysis data, the simulated volcanic cloud encountered the aircraft at the time of the PIREP. This was a match in space, time and altitude. Note: Puff runs using predicted data were somewhat ambiguous regarding this encounter but the re-analysis data were much more definitive."

References: Dean, K.G., Dehn, J., Papp, K.R., Smith, S., Izbekov, P., Peterson, R., Kearney, C., and Steffke, A., 2004, Integrated satellite observations of the 2001 eruption of Mt. Cleveland: Alaska, J. Vol. Geophys. Res., v. 135, p. 63, doi10.1016/j.jvolgeores.2003.12.013.

Simpson, J.J., Hufford, G.L., Pieri, D., Servranckx, R., Berg, J.S., and Bauer, C., 2002, The February 2001 Eruption of Mount Cleveland, Alaska: Case Study of an Aviation Hazard: Weather and Forecasting, v. 17, p. 691-704.

Background. Augustine volcano, rising above Kamishak Bay in the southern Cook Inlet about 290 km SW of Anchorage, is the most active volcano of the eastern Aleutian arc. It consists of a complex of overlapping summit lava domes surrounded by an apron of volcaniclastic debris that descends to the sea on all sides. Few lava flows are exposed; the flanks consist mainly of debris-avalanche and pyroclastic-flow deposits formed by repeated collapse and regrowth of the volcano's summit. The latest episode of edifice collapse occurred during Augustine's largest historical eruption in 1883; subsequent dome growth has restored the volcano to a height comparable to that prior to 1883. The oldest dated volcanic rocks on Augustine are more than 40,000 years old. At least 11 large debris avalanches have reached the sea during the past 1,800-2,000 years, and five major pumiceous tephras have been erupted during this interval. Historical eruptions have typically consisted of explosive activity with emplacement of pumiceous pyroclastic-flow deposits followed by lava dome extrusion with associated block-and-ash flows.

Information Contacts: *Anchorage VAAC*, Alaska Aviation Weather Unit, National Weather Service, 6930 Sand Lake Road, Anchorage, AK 99502, USA (URL: http://aawu.arh.noaa.gov/vaac.php); *Alaska Volcano Observatory (AVO)*, a cooperative program of the *U.S. Geological Survey*, 4200 University Drive, Anchorage, AK 99508-4667, USA (URL: http://www.avo.alaska.edu/), *Geophysical Institute*, University of Alaska, PO Box 757320, Fairbanks, AK 99775-7320, USA, and *Alaska Division of Geological & Geophysical Surveys*, 794 University Ave., Suite 200, Fairbanks, AK 99709, USA; *Jesse Allen*, NASA Earth Observatory; *Tina Neal*, U.S. Geological Survey-Alaska Volcano Observatory; *Ken Dean* and *Pavel E. Izbekov,* Geophysical Institute, University of Alaska.

Cleveland

Aleutian Islands, United States
52.825°N, 169.944°W; summit elev. 1,730 m
All times are local (= UTC - 9 hours)

According to the Alaska Volcano Observatory (AVO), Mount Cleveland, a volcano on an uninhabited island in the central Aleutian chain, erupted at 0757 on 6 February 2006, sending a cloud of ash to 6.7 km (22,000 ft) altitude. Officials at AVO issued a Code Red warning for the volcano because the ash cloud was near a level where it could interfere with jet traffic, said Chris Waythomas, a U.S. Geological Survey geologist. There were no reports of falling ash. The nearest community is Nikolski, a tiny Aleut village of 31 people 73 km E of the volcano.

Cleveland's last major eruptive period was in March 2001 when three explosions occurred and the volcano produced significant ash plumes (*BGVN* 26:04). Discussion of that episode was renewed briefly at the end of the Augustine report in this issue (*BGVN* 31:01). That discussion (and cited references) noted that the ash cloud from a Cleveland eruption on 19 February 2001 had a modeled path that carried the cloud S, passing over Northern California. Two days after the eruption, aviators flying near San Francisco, California, smelled sulfurous gases, presumably from the Cleveland eruption. There were also minor ash emissions from July to October 2005 (*BGVN* 30:09).

AVO downgraded the level of concern color code for Cleveland from Red to Orange on 7 February 2006 at 1655 hours. No new ash emissions or thermal anomalies have been detected in clear to partly cloudy satellite views from the morning of 8 February. AVO noted that Cleveland does not have a real-time seismic network and therefore it is unable to monitor seismic changes.

Background. Beautifully symmetrical Mount Cleveland stratovolcano is situated at the western end of the uninhabited, dumbbell-shaped Chuginadak Island. It lies SE across Carlisle Pass strait from Carlisle volcano and NE across Chuginadak Pass strait from Herbert volcano. Cleveland is joined to the rest of Chuginadak Island by a low isthmus. The 1730-m-high Mount Cleveland is the highest of the Islands of the Four Mountains group and is one of the most active of the Aleutian Islands. The native name for Mount Cleveland, Chuginadak, refers to the Aleut goddess of fire, who was thought to reside on the volcano. Numerous large lava flows descend the steep-sided flanks of the volcano. It is possible that some 18th to 19th century eruptions attributed to Carlisle should be ascribed to Cleveland (Miller et al., 1998). In 1944 Cleveland produced the only known fatality from an Aleutian eruption. Recent eruptions from Mount Cleveland have been characterized by short-lived explosive ash emissions, at times accompanied by lava fountaining and lava flows down the flanks.

Information Contacts: *Alaska Volcano Observatory* (see Augustine), *Washington Volcanic Ash Advisory Center (VAAC)*, Satellite Analysis Branch (SAB), NOAA/NESDIS E/SP23, NOAA Science Center Room 401, 5200 Auth Rd., Camp Springs, MD 20746, USA (URL: http://www.ssd.noaa.gov/).

Tanaga

Aleutian Islands, United States
51.885°N, 178.146°W; summit elev. 1,806 m

The Alaska Volcano Observatory (AVO) detected an increase in seismic activity beneath Tanaga beginning on 1 October 2005, with 15-68 earthquakes occurring daily. Previously, less than one earthquake had occurred per month since the seismic network was installed in 2003. The earthquakes were centered roughly 2 km NE of the summit at depths of 10-20 km below sea level. The largest event was M 1.7, with most earthquakes at M 0.5-1.5. Tanaga was at Concern Color Code Green on 5 October.

During 5-7 October, there was a marked increase in the rate of seismicity. The located earthquakes ranged in magnitude from 0.5 to 1.9 and ranged in depth from 6 to 12 km beneath the summit. In response, AVO raised the Concern Color Code to Yellow on 7 October. AVO reported that while the seismic activity represented a significant increase in rate, the size, depth, and character of the events were not indicative of imminent eruptive activity.

Elevated seismic activity below the young vents continued through 28 October 2005, although the rate of small earthquakes decreased slightly from the previous week. The activity that began on 1 October was at the highest level recorded since the seismic network was installed in 2003, so the Concern Color Code remained at Yellow. An unusual seismic signal on 17 October that persisted for several minutes may have been a landslide or small phreatic explosion, but satellite images detected no airborne ash. Beginning on 24 October, AVO observed weak, nearly continuous volcanic tremor in the vicinity of Takawangha volcano of the Tanaga volcano cluster. This was the first recorded tremor of this type. The daily number of small earthquakes continued to diminish from its peak in early October, but stayed above background levels.

AVO reported on 25 November 2005 that for several weeks seismicity beneath young volcanic vents on Tanaga Island decreased significantly from levels recorded in early October. Satellite images showed no anomalous temperatures or evidence of ash emissions. AVO reported that, based on the decrease in earthquake counts and frequency of tremor episodes, the likelihood of an eruption had diminished. Therefore, AVO downgraded the Concern Color Code to Green. According to AVO, the most recent eruptive activity at Tanaga was a lava flow observed in 1914.

Background. Tanaga volcano, the second largest volcanic center of the central Aleutians, is the central and highest of three youthful stratovolcanoes oriented along a roughly E-W line at the NW tip of Tanaga Island. Arcuate ridges to the east and south may represent the rim of an older caldera that cuts an older shield-like volcano. Most Holocene eruptions originated from Tanaga volcano itself, which consists of two large cones, the western of which is the highest, constructed within a caldera whose 400-m-high rim is prominent to the SE. At the westernmost end of the Tanaga complex is conical Sakaja, a 1,304-m-high double cone that may be the youngest of the three volcanoes (Marsh, in Wood and Kienle, 1990). A thick blanket of fine ash that may have accumulated over the past several thousand years covers much of Tanaga Island.

Information Contacts: *Alaska Volcano Observatory* (see Augustine).