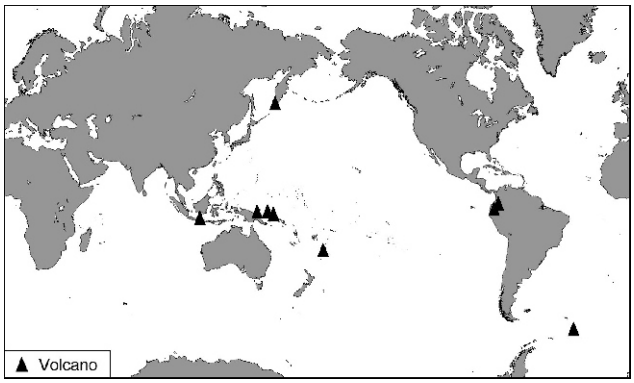
Bulletin of the Global Volcanism Network



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Editors: Rick Wunderman, Edward Venzke, and Sally Kuhn Sennert

Volunteer Staff: Robert Andrews, Hugh Replogle, Michael Young, Paul Berger, Phumtham Limwattananon, Jacquelyn Gluck, Margo Morell, Stephen Bentley, Antonia Bookbinder, and Jeremy Bookbinder, Veronica Bemis, and Ludmila Eichelberger

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@si.edu · URL: http://www.volcano.si.edu/

The text of the *Bulletin* is also distributed through the Volcano Listserv (volcano@asu.edu).

Kelut

Java, Indonesia
7.93°S, 112.308°E; summit elev. 1,731 m
All times are local (= UTC + 7 hours)

The extrusion of a substantial dome into the center of the active crater lake at Kelut (also spelled Kelud) started in early November 2007. The volcano and lake are among the most historically active and dangerous in Indonesia (Thouret and others, 1998). They were studied by members of the Volcanological Survey of Indonesia (VSI), Alain Bernard, and colleagues. During about 15 years prior to the eruption, the crater lake showed considerable hydrothermal influence, with temperatures several degrees above the ambient air temperature of 19°C, but with near-neutral pH. Prior to this eruption, the lake was ~ 34 m deep, ~ 350 m in diameter, and it held ~ 2.1 x 10^6 m^3 of water (Bernard and Mazot, 2004).

Lava was clearly seen emerging from the center of the lake on 4 November 2007. The activity was passive, even at the contact between the dome and lake. Neither water nor substantial ash were thrown forcefully out of the lake and onto the flanks. The dome rose rapidly above the lake, building a steep construct surrounded by a placid but dwindling lake. A well-defined depression crossed the dome's center, dividing its top surface in two. A few undated photos showed a mildly explosive phase. During 29-30 November the still-erupting dome was stable. As of early May 2008, tentative reports suggested that dome extrusion had ceased or paused. A lake still existed at that point.

Setting, historical lahars, and morphology. The volcano resides in a densely populated part of Java (1,800 people/km^2) and could threaten over 3 million residents (Bernard, 2000). Bernard (2000) also noted that Kelut's approximately 30 historical eruptions have caused over 15,000 deaths since 1500 AD. Kelut's last eruption occurred in 1990 (*BGVN* 15:01). One of the most detailed VSI reports on Kelud's pre-eruptive behavior was issued 30 October 2007 (Surono, 2007).

Although lahars were absent during the 2007 eruption, lahars were associated with eruptions in 1919 and 1966; post-1996 lahars came in response to rainfall. To control lahars and related problems, decades before engineers had driven a complex series of drainage tunnels through the edifice's walls, draining much of the lake.

Lake chemistry. Active crater lakes such as Kelut's trap some fraction of the heat and fluids escaping the magmatic and hydrothermal system (Delmelle and Bernard, 1999), and their study has led to breakthroughs in eruption prediction. One example of this kind of study (figure 2) presents various heat and mass-balance factors in a model of Kelut's lake (Bernard and Mazot, 2004). Heat is derived from the enthalpy (E) of hydrothermal fluids (Ebrine + steam) and from solar and atmospheric radiation (Erad). Heat is lost by evaporation (Eevap), conduction (Econd), radiation (Erad), and by the overflow (Eover) of hot waters through the drainage tunnel.

Monitoring instrumentation is in place on and around the lake (figure 3). Fieldwork is also performed to measure the flux of CO_2 emitted at the lake surface (figure 4). Numerous CO_2-bearing gas bubbles rising to the surface were seen in July 2006. Bubbles were also widespread on bathymetric soundings (eg. detected at 50 and 200 kHz) in July 2007, and in some cases observers witnessed frequent discontinuous gas releases (puffing) from bottom fumaroles.

The CO_2 flux from the lake's surface was measured by IR spectrophotometry using a Dräger Polytron instrument. Bernard's team modified a technique initially developed for monitoring the flux of gases in soil (Chiodini and others, 1996), applying this method by means of the floating accumulation chamber at multiple sites.

According to the VSI report, carbon dioxide (CO_2) concentrations measured during 30 July to 2 August 2007 ranged from below 500 g/m^2/d to hotspots of 12,000 g/m^2/d, especially in the E portion of the lake. The overall flux of CO_2 from the lake reached more than 500 tons/day on 11

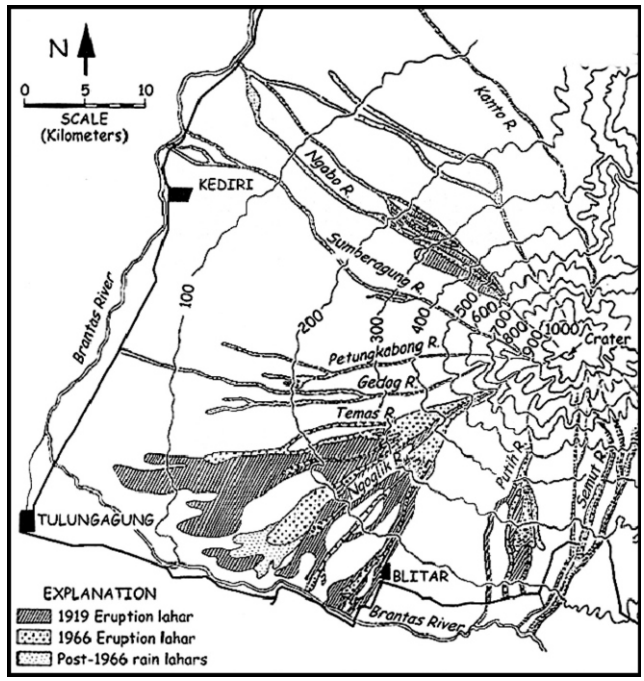

Figure 1. Map of Kelut showing prominent drainages on the W side and key settlements such as Kediri, Tulungagung, and Blitar (respective populations, 252,000, 970,000 and 1,200,000), and three sets of lahars. Heavy (often straight) lines indicate some local political boundaries. The 2007 eruption did not trigger lahars. After Rodolfo (1999).

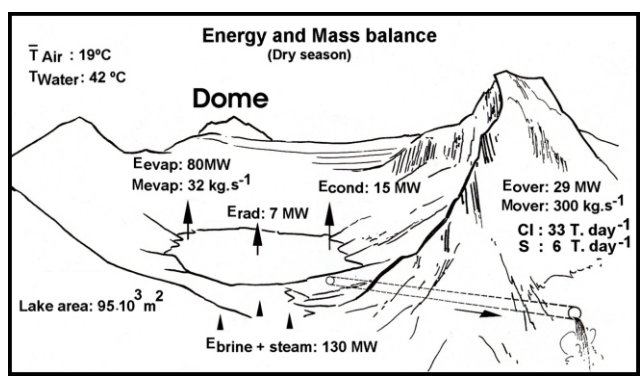

Figure 2. A sketch of Kelut's summit crater made prior to the 2007 eruption, looking E. The 2007 eruption built a dome in the lake's center. The irregular high area on the far wall of the crater (labeled "dome") is called Gunung Kelut, and is but one of many domes at the complex (see Geologic Summary, below). The arrows are explained in the text. The dashed 'drainage tunnel' through the edifice walls is schematic, the actual tunnels consist of a network built in successive stages. Diagram after Bernard and Mazot (2004).

September 2007, about ten times greater than measurements made in 2005 and 2006 (figure 5).

Data on lake chemistry (table 1) was compiled by Surono (2007) and Bernard (2000). The water chemistry of the active crater lake showed both stable and variable parameters. Comparatively stable ones included pH and during various time periods (including 2007), some chemical species. Among the largest perturbations were a sudden, almost two-fold rise in SO_2 during September-October 2007; and a rapid increase in lake water temperature during November 2007. Soluble Cl stood over 1,000 ppm during 1993 and dropped sharply reaching a low of 67 ppm on 20 August 2007. It climbed after that, reaching 354 ppm in the last (11 November) measurement, a value taken about a week after the dome broke the lake surface.

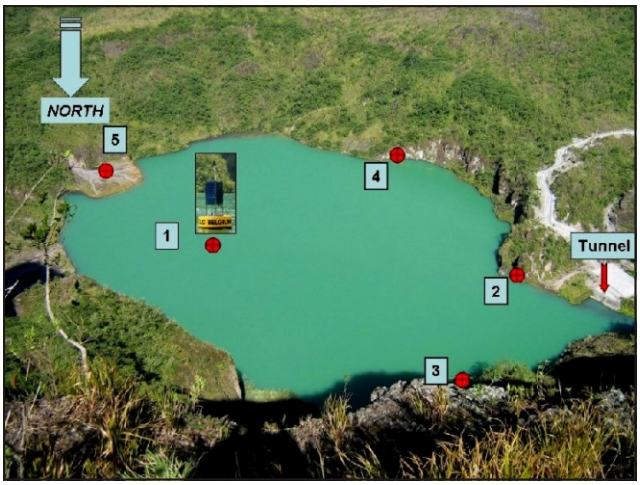

Figure 3. A pre-eruption photo showing Kelut's lake from a high point on the rim. Numbered sites are monitoring stations, as follows: 1) temperature and conductivity at 15 m depth and meteorological conditions (air temperature, relative humidity, and wind velocity), 2-4) lake level sensors, where the pressure difference between stations 3 and 4 functions as a N-S tilt meter), and 5) a radon sensor. Instrumentation also monitors the runoff volume in the drainage tunnel. A buoy (at 1) was one of three ultimately installed in the lake. A service road down the crater wall leads to the lake end of a drainage tunnel. Courtesy of A. Bernard.

Monitoring, hazards status, and dome extrusion. Visual monitoring was carried out by means of a closed-circuit video monitor installed on Mount Lirang, as well as from photographs taken in or near the crater. During 15-28 September, gas emissions from the crater lake increased and spread over a zone within a radius of ~ 5 m.

According to Surono (2007), pre-eruption CO_2 fluxes from the lake were typically 50 metric tons/day. During August 2007 they rose to 333 tons/day; during late August to early September they reached 500 tons/day.

During 2006, the Darwin Volcanic Ash Advisory Center (VAAC) reported a pilot observation. An ash plume on 18 May 2006 allegedly reached an altitude of 5.5 km.

On 17 October 2007 Kelut was the subject of further VAAC reports, first noting the elevation of the hazard status to 4 (the highest level, indicating an eruption imminent). On 23 October there was a brief noting evidence from a satellite of a eruption (to ~ 6 km altitude) but ground observers suggested that it was a meteorological cloud. A VAAC report on 4 November noted "ash not identifiable on satellite imagery." On 8 November an advisory noted the continued absence of identifiable ash.

Seismicity rose suddenly on 10 September 2007 (figure 6). It peaked on 16 October at all four seismic stations on or adjacent the volcano, at 510 events. The next day, the number of earthquakes still stood quite high, 151.

Cross sections showing hypocenters for 10-11 and 26-29 September 2007 depicted them broadly centered below the edifice but distributed around 2.5 km depth; they were initially absent in a zone about 2-3 km below the summit . During mid-October the hypocenters became more closely packed along a narrow vertical band beneath the edifice. They then filled a zone 0.7-1.2 km beneath the summit, with a few other hypocenters centered ~ 2 km below the summit. During 24-29 October, many hypocenters clustered ~ 6 km below the summit, but others strung out on or about a vertical line intersecting near the summit. The shallowest events plotted were then ~ 1 km below the summit. Reports also noted tremor was common during 24 October through 4 November.

VSI issued a series of increases in Kelut's hazard status (a scale of 1-4, figure 6). On 11 September 2007, VSI raised the status from 1 to 2. This corresponded to the CO2 flux

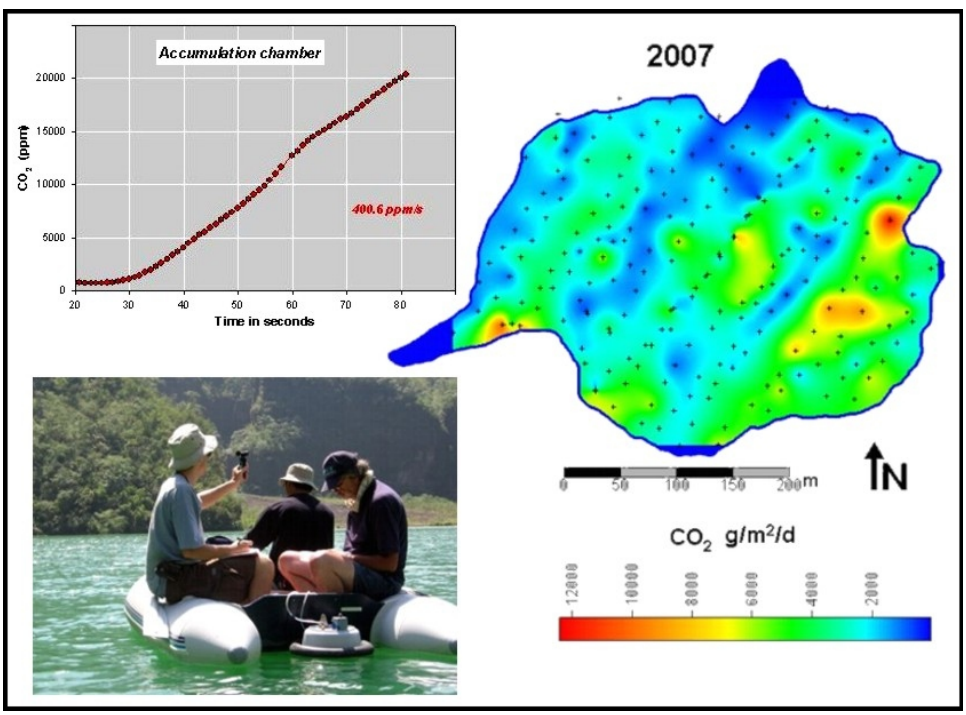

Figure 4. (bottom left) A July 2006 photo at Kelut of the team taking a CO_2 flux measurement at a sample site. The team consisted of (left to right) Loic Peiffer, Khirul Huda from VSI, and Alain Bernard. The team used a floating accumulation chamber connected by tubing to a dedicated spectrometer residing in the boat. (top left) A graph of 2007 spectrometer data from a sampling cycle with the accumulation chamber. After a lag time of ~ 30 seconds, the accumulation rate was stable at a slope of ~ 400 ppm/s. (right) Resulting map of lake surface showing CO_2 flux per unit area (in the units of grams per square meter per day, $g/(m^2 \cdot d)$). The map resulted from 230 spot measurements taken between 30 July and 2 August 2007. Courtesy of Alain Bernard.

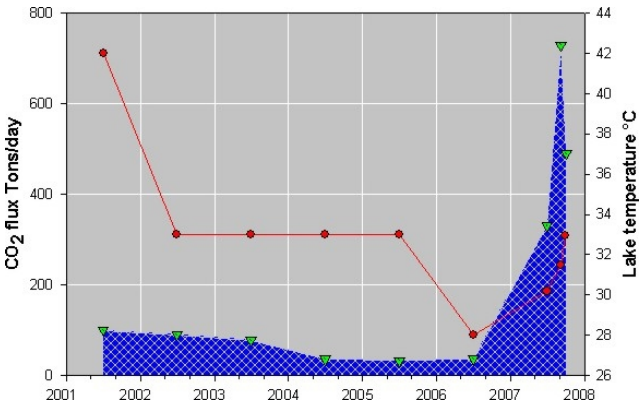

Figure 5. A plot for Kelut from 2001 through 2 August 2007 showing water temperature and total CO_2 flux from the lake. The total CO_2 flux was estimated by normalizing the data to the relevant lake area at Kelut, 103,600 m^2). The latest CO_2 field measurements were made during 30 July to 2 August 2007. The line shows lake temperature readings (taken at uncertain depth and location, but presumably more consistently measured than temperature data shown on table 1. Unfortunately, these plotted temperature data do not extend into late 2007 when table 1 suggests lake temperatures rose more than 50°C higher, to ~ 78°C).

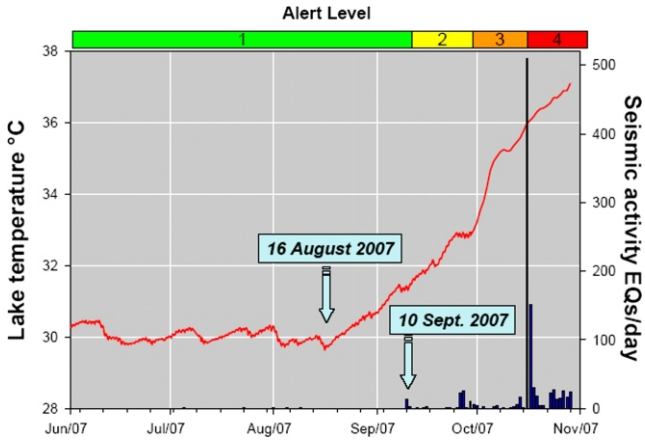

Figure 6. Kelut seismicity, lake-water temperature, and Alert Levels registered during June to early November October 2007. After plots by Surono (2007) and Bernard.

mentioned above, a sudden jump in seismicity on 10 September (figure 6), and changes in both lake temperature and color, which shifted from its usual green, becoming yellow in some areas and blue-white in others. On 29 September, the status went from 2 to 3 based on visual observations, increased seismicity, deformation measurements, and further changes of crater lake water chemistry and temperature.

VSI brought the status to 4 on 16 October (figure 6). Factors included the sudden rise in seismicity, and the summit's inflation during 13-16 October. Before the crisis of 16 October the lake water was whitish green; after the crisis, dominantly green. VSI to recommend that villagers within a 10-km radius evacuate. According to a United Nations report, local authorities evacuated ~ 117,000 people within this radius. The UN report cited Indonesian media as stating that an eruption could affect as many as ~ 290,000 people (figure 7).

According to a news article, thousands returned to their homes on 17 October to tend to crops and animals, and to retrieve food. On 8 November the status fell to 3 and residents were allowed to return home. On 29 November the status fell from 3 to 2 following both decreased seismicity and a lack of deformation. At this stage, people were advised to remain at least 1.5 km from the lake.

During 24-31 October, a series of regional earthquakes occurred, dominated by shallow events and tremor. Seismicity intensified during 2-3 November, but then decreased on 4 November.

Dome emerges during 3-4 November 2007. On 3 November, VSI and news media mentioned plumes, and possibly some evidence of erupted solids entering the lake. Also, their buoy ceased functioning. On 4 November, white plumes rose to an altitude of 2.2 km and drifted N.

Plumes on the 4th came from a fresh black lava dome, protruding from the then turbid green lake. Monitoring cameras showed copious steam obscuring the dome. The exposed mass grew quickly. Although steaming continued, relative calm usually prevailed at both the dome and the

Date	Temp (°C)	pH	Concentration (ppm)							
			Na	K	Ca	Mg	HCO_3	Cl	SO_4	B
18 Dec 1993	42.8	5.9	700	92	105	55	238	1,297	631	11
01 Aug 1994	42.1	6.3	1,024	102	130	67	207	1,289	692	14
24 Sep 2002	33.2	6.5	342	39	135	80	435	289	670	4
04 Sep 2003	30.7	6.5	271	30	147	78	472	202	679	2.5
27 Apr 2005	32.2	6.6	198	23	121	71	330	139	571	2
20 Aug 2007	31.5	6.9	104	14	166	48	221	66.5	538	0.8
16 Sep 2007	33.2	6.4	106	16	184	52	294	120	1,083	1.1
25 Sep 2007	33.4	5.9	109	17	178	51	279	133	1,121	1.3
29 Sep 2007	36.1	5.9	109	17	179	45	279	137	1,121	1.5
23 Oct 2007	38.4	5.8	257	22	186	56	297	210 (173)	1,119	1.3
28 Oct 2007	39.2	5.6	117	20	190	48	303	179	1,151	1.4
02 Nov 2007	~50	—	—	—	—	—	—	—	—	—
3-4 Nov 2007	Eruptions began on 3 Nov; the dome emerged above lake surface on 4 Nov.									
06 Nov 2007	77.5	6.7	124	21	200	48	170	294	542	1.7
11 Nov 2007	77.8	6.2	130	21	223	45	26.3	354	615	2.1

Table 1. A compilation for Kelut's lake water showing temperature, pH, and chemical concentration data from VSI for 2007 (Surono, 2007) and Alain Bernard (2000) during 1993 to 2005. Some of the data presented here were rounded and the number of significant figures reduced. The 23 October 2007 Cl value was variously reported. Some of the original data were presumably collected at different locations and depths; and some of the original data included additional parameters such as total dissolved solids (see cited publications).

lake. Although the dome steadily displaced the lake, the water did not undergo violent broad-scale boiling.

According to VSI, the temperature at the surface of the crater lake on 6 November had climbed to over 75°C. The newly exposed dome surface was 150-210°C. Plumes generally inhibited clear views.

On 8 November, VSI reported a decrease in seismicity, and deformation-monitoring suggested greater stability. An infrared camera (FLIR) captured images of the dome on 9 November as it emerged from the lake. The images revealed considerable radiant heat in the FLIR-sensitive wavelengths (figure 8).

According to a news article by Agence France Presse on 12 November, a volcanologist reported that the lava dome had reached 250 m in diameter and was 120 m above the lake surface.

November photos and videos. On 11 November, a plume rose to an altitude of 3.7 km and ashfall was reported in several areas. News accounts indicated that tremors continued and that Kelut was spewing ash and lava. More photos of the dome, particularly during 10-29 November, would be useful for understanding activity in this period.

An undated video provides views of a short-lived avalanche down from the new dome's upper walls. Based on the size of the dome then, the scene was probably captured in mid- to late November (it was posted on 7 December; Masdjawa, 2007). The avalanche initially contained on the order of 5-20 m^3 of loose material, much of it incandescent in daylight. A large portion of this material bounced downslope into the steaming lake. When sufficient fragmental material entered the lake an intense phreatic eruption took place. The clouds rose vertically; they were initially jet black, but within tens of seconds became dominantly white steam, hiding the dome for ~ 1-2 minutes.

Daniel Brazilier visited during 25-26 November and saw mildly to moderately explosive activity; his photos appeared in Societe de Volcanologie Geneve reports (SVG, 2007). Many of his photos were taken during daylight from ~ 1.5 km away; they showed several explosions with billowing white-to-tan clouds. The foreground, the W crater wall, contained small amounts of tephra and some bombs. The billowing clouds appeared to contain minor ash; they vented from the dome upper area or side, and accompanied numerous steaming bombs, which from their arcing trails, seemed destined to land within the crater. Night photos disclosed large areas of incandescence on the W side.

Tom Pfeiffer took a series of remarkable photos on 29-30 November 2007, documenting a surprisingly large and clearly fast-growing dome. He posted over 60 photos on the Volcano Discovery website and elsewhere, and several of them appear here (figures 9, 10, and 11).

Note that Pfeiffer's photos are night-time shots with long exposures and thus the impression of large glowing areas implies more activity than really occurred at any one time. The dome had clearly crowded out the then green or brownish lake, which in the field of view had been reduced to an arcuate sliver. The extent of the lake on the dome's W and SW sides was unclear from his perspective.

Figure 7. A map of a portion of E Java that indicates the location of Kelut (sometimes written as "Kelud," as is the case here) and the major city Surabaya (~ 85 km NE; population, ~ 4 million). The map was issued after the alert status was raised to the highest level ("4"; at 1800 on 16 October) and indicates the number of people in two adjacent jurisdictions that could be affected by its eruption. Courtesy of Relief Web (United Nations); boundaries and names shown and the designations used on this map do not imply official endorsement or acceptance by the United Nations.

Figure 8. On 9 November 2007, scientists looking at Kelut's new dome took these two photos, and at right, coinciding infrared (FLIR) images. The scale bars on the FLIR images indicate that the highest temperatures were on the order of 135°C. The hottest zones occurred both over a large area at the dome's top and along a band following the dome near the lake surface. Courtesy of VSI and taken from Bernard (2007).

Figure 9. Kelut's dome seen in low-light conditions on 29 or 30 November 2007 in a view looking towards the E. Myriad incandescent fragments detached from the dome, leaving incandescent scars in the middle to upper dome area. The dome's summit area and much of its lower skirt are chiefly dark, except in the latter case for the trails of material bouncing and falling past. The much reduced lake was calm and wrapping around the dome's left (N) side. The segment of the crater rim towering above the new dome's right side is the older dome mentioned in figure 2. Copyrighted photo by Tom Pfeiffer (Volcano Discovery).

Figure 10. A NE view under dark conditions of Kelut's growing dome at a time on 29 or 30 November when dome incandescence was particularly high. In the foreground is the pathway leading to the lake. Comparatively few bombs littered the curbing along the pathway, but pelting from bombs had apparently damaged the steel hand-rail in a few places. Copyrighted photo by Tom Pfeiffer (Volcano Discovery).

Particularly on figures 9 and 10, the dome was rife with abundant glowing zones and numerous red traces due to incandescent dome rocks bouncing downslope. Abundant were glowing avalanche trails, and large rockfall scars. The photos also suggest possible lava seeps and narrow lava flows, although Tom Pfeiffer attributed most of the incandescence to mobile and solidified material, rather than narrow zones occupied by fluid moving lava.

A few of the glowing traces in the photos terminate upon entering the crater lake (figure 11). After their first contact with the water, some of those descending traces also seemingly shattered and bounced, producing one or more secondary arcs (akin to a skipping stone).

Pfeiffer described the scene as "filled with the noises of cracking lava, falling debris, and chilled lava blocks that splashed into the lake." He went on to note the lack of "explosions, or major ash emissions attached to the activity. The lava dome was simply growing quietly and not doing anything else than what is visible on the photos." He was struck by the observation "that the lake was simply there and NOT boiling. A sign how well rock insulates. Also, the upper 10 meters of the dome, its very top, were rather inactive, like the top of a mushroom being lifted up. The most active zones were just underneath that upper crust . . .."

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Geologic Summary. The relatively inconspicuous, 1,731-m-high Kelut stratovolcano contains a summit crater lake that has been the source of some of Indonesia's most deadly eruptions. A cluster of summit lava domes cut by numerous craters has given the summit a very irregular pro-

Figure 11. Kelut's new lava dome had reduced the crater lake to a narrow band by 29-30 Novemver 2007. This low-light photo looking NE captured the shrinking lake and its contact with the new dome. At right is a prominent avalanche chute choked with the incandescent trails of bouncing blocks. Upon entry into the lake some of the trails made a second bounce. Copyrighted photo by Tom Pfeiffer (Volcano Discovery).

file. Satellitic cones and lava domes are also located low on the E, W, and SSW flanks. Eruptive activity has in general migrated in a clockwise direction around the summit vent complex. More than 30 eruptions have been recorded from Gunung Kelut since 1000 AD. The ejection of water from the crater lake during Kelut's typically short, but violent eruptions has created pyroclastic flows and lahars that have caused widespread fatalities and destruction. After more than 5,000 persons were killed during an eruption in 1919, an ambitious engineering project sought to drain the crater lake. This initial effort lowered the lake by more than 50 m, but the 1951 eruption deepened the crater by 70 m, leaving 50 x 10^6 m^3 of water after repair of the damaged drainage tunnels. After more than 200 deaths in the 1966 eruption, a new deeper tunnel was constructed, and the lake's volume before the 1990 eruption was only about 1 million cubic meters.

Information Contacts: *Volcanological Survey of Indonesia*, Center of Volcanology and Geological Hazard Mitigation, Saut Simatupang, 57, Bandung 40122, Indonesia (URL: http://portal.vsi.esdm.go.id/joomla/); *Alain Bernard*, Free University of Brussels, CP 160/02, 50, avenue F, Roosevelt, 1050 Brussels, Belgium (URL: http://www.ulb.ac.be/sciences/dste/volcano/garde/page%20de%20garde.html); *Relief Web*, United Nations Office for the Coordination of Humanitarian Affairs, Resident Coordinator's Office, Jakarta, Indonesia (URL: http://www.reliefweb.int; http://ochaonline.un.org/).; *Darwin Volcanic Ash Advisory Center*, Bureau of Meteorology, Northern Territory Regional Office, PO Box 40050, Casuarina, Northern Territory 0811, Australia (Email: darwin.vaac@bom.gov.au; URL: http://www.bom.gov.au/info/ vaac/); *Tom Pfeiffer*, Volcano Discovery (Email: tpfeiffer@decadevolcano.net; URL: http://www.decadevolcano.net/; http://www . VolcanoDiscovery.com/); *Daniel Brazilier*, 71, rue du Vieux Rû, F-77210 Avon, France.

Karkar

Northeast of New Guinea, Papua New Guinea
4.649°S, 145.964°E; summit elev. 1,839 m
All times are local (= UTC + 10 hours)

During late 2007 and continuing into 2008, it became clear the Karkar's vegetation had suffered and seismicity was significant (tens of earthquakes per day). Herman Patia of the Rabaul Volcano Observatory (RVO) reported that the Bagiai cone situated in the inner caldera of Karkar volcano continued to release thin to moderate white vapor while a RVO team was at the volcano from 27-31 December 2007. The white vapor plume was also visible from the mainland. Prior to the visit, communities on the W and SW had heard occasional roaring noises associated with the gas emission from the Bagiai cone. The last *Bulletin* (*BGVN* 25:11) discussed light ashfall ultimately attributed to Ulawun. In early November 2007, RVO had reported vegetation die-back and increased fumarolic activity at Bagiai cone on the floor of the inner caldera (figure 12). Latest images sent to RVO by Sir Peter Barter on 11 December 2007 indicated that vegetation on the SE flank had withered completely. According to RVO, the last eruption of Karkar was in 1979.

During the team's December visit, they deployed three portable seismic recorders on the NW, SW, and E sides of the island (figure 13, open triangles). Preliminary results indicated a total of 30 high-frequency (HF) earthquakes recorded during the 3 days of deployment. These events were interpreted as indicative of rock-breaking due to magma movement under the volcano. The overall seismicity was low.

Figure 12. Vegetation die-back and increased fumarolic activity on Bagiai cone at Karkar; (top) photo taken early in 2007, (bottom) photo taken during the last week of October 2007. Courtesy of RVO; photos by Paul Goodyear.

Bagiai cone continued to release variable volumes of white vapor towards the end of January 2008. A second phase of seismic monitoring at Karkar was carried on from 24 January to 3 February 2008. (figure 13, filled triangles). The closest seismometer to the cone was placed ~ 3 km away Seismic activity was low, dominated by high-frequency earthquakes, but low-frequency earthquakes also occurred. About 15–20 earthquakes were recorded daily during the first 3 days of recording (24-28 January), the earthquakes occurring near Bagiai cone in the center of the inner caldera.

The two phases of seismic monitoring detected both

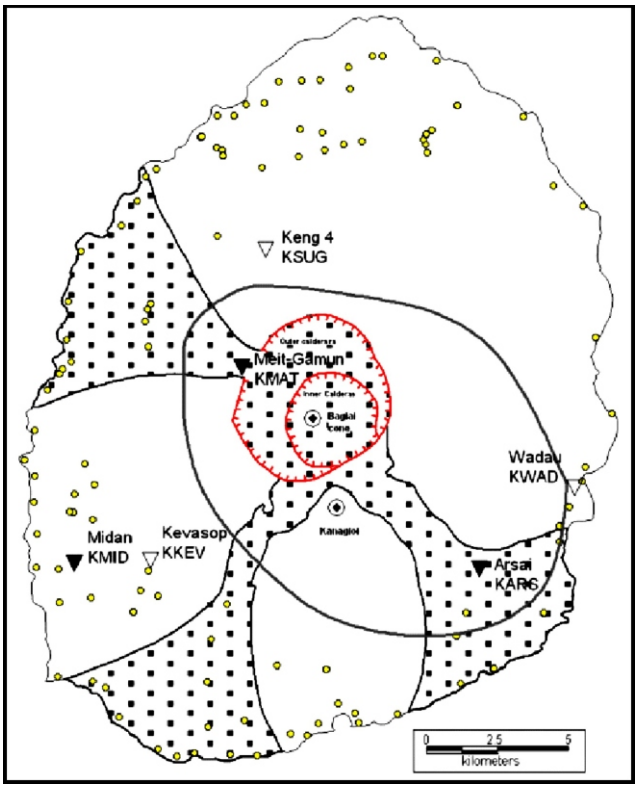

Figure 13. A map of the island of Karkar showing morphology. Open triangles indicate seismograph stations during 28-31 December 2007 (KSUG, KWAD, and KKEV). The filled triangles indicate seismograph stations during 24 January-3 February 2008 (KMAT, KARS, and KMID). The outlined oval-shaped region endorses the approximate area where the high-frequency earthquakes had epicenters. The regions decorated with square dots indicate channels, which provide possible pathways for mudflows and pyroclastic flows. Small dots villages, some of which lie within these channels. Courtesy of RVO.

high-frequency volcano-tectonic (VT) earthquakes and low-frequency earthquakes. VT earthquakes were taken to indicate magma intrusion underneath or near Karkar volcano and were detected during the December 2007 deployment by two of the three stations (KWAD and KKEV) on the E and SE side. Station KSUG did not record the HF earthquakes.

The seismic monitor installed about 3 km from Bagiai cone (KMAT), at a spot adjacent to the thermal activity, recorded LF earthquakes as well. LF earthquakes were presumed to be associated with movement of steam and gas and the hydrothermal activity at Bagiai cone.

To provide continuous seismic monitoring at Karkar, on 3 February 2008 a portable seismic recorder was installed 9 km N of the cone. RVO intends to download and analyze the data every 2 months.

For several weeks during late February into early March 2008, RVO scientists visited Karkar to monitor the increased seismic activity first monitored during December 2007. Once again, the group reported that thermal activity from within the cone had caused the vegetation to die and turn brown. On this visit, withered and dry vegetation could be observed on Bagiai's flanks. Seismicity was continuing, but at low levels. On this visit, three portable seismic recorders were deployed close to the summit area on the outer caldera, 3.5 km from Bagiai. They recorded 15-20 volcanic earthquakes per day.

There have been no thermal anomalies measured over Karkar by MODIS instruments since at least the beginning of 2007 through mid-April 2008.

Geologic Summary. Karkar is a 19 x 25 km wide, forest-covered island that is truncated by two nested summit calderas. The 5.5-km-wide outer caldera was formed during one or more eruptions, the last of which occurred 9,000 years ago. The eccentric 3.2-km-wide inner caldera was formed sometime between 1,500 and 800 years ago. Parasitic cones are present on the northern and southern flanks of basaltic-to-andesitic Karkar volcano; a linear array of small cones extends from the northern rim of the outer caldera nearly to the coast. Most historical eruptions, which date back to 1643, have originated from Bagiai cone, a pyroclastic cone constructed within the steep-walled, 300-m-deep inner caldera. The floor of the caldera is covered by young, mostly unvegetated andesitic lava flows.

Information Contacts: *Herman Patia*, Rabaul Volcanological Observatory (RVO), P.O. Box 3386, Kokopo, Papua New Guinea (Email: hguria@global.net.pg); *MODVOLC Hawai'i Institute of Geophysics and Planetology (HIGP) Thermal Alerts System*, School of Ocean and Earth Science and Technology (SOEST), Univ. of Hawai'i, 2525 Correa Road, Honolulu, HI 96822, USA (URL: http://hotspot.higp.hawaii.edu/).

Ulawun

New Britain, Papua New Guinea
5.05°S, 151.33°E; summit elev. 2,334 m
All times are local (= UTC + 10 hours)

This report updates activity through March 2008. Our last overview of Ulawun (*BGVN* 32:02) reported little activity of note other than frequent ash plumes from March 2006 to January 2007. Typical activity at Ulawun has consisted of gentle emission of thin-to-thick white vapor from the summit Based on satellite imagery and information from the Rabaul Volcano Observatory (RVO), the Darwin VAAC reported that diffuse plumes from Ulawun drifted N on 28 April 2007. On 1 May, an ash plume rose to an altitude of 4 km and drifted W.

On 29 May 2007, RVO reported forceful ash emissions. However, there were no audible noises or night glow. The two N valley vents remained quiet. Seismicity was at a low to moderate level dominated by low-frequency earthquakes. Through May, between 500 and 1,265 low frequency events were recorded daily with the most recorded on 28 and 29 May.

Similar conditions continued through the end of 2007 with only minor incidental variation. On 6 June, the elevated characteristics of the forceful emissions of 28-29 May were repeated. The daily total number of low-frequency earthquakes fluctuated between 400 and 1,042 events with the highest numbers recorded on 24 June (1,032) and 8 August (1,042). A high-frequency earthquake was recorded on 1 August. On 3 September forceful emissions were recorded sending the vapor plume ~ 1 km above the summit before being blown SE.

On 25 December, based on satellite imagery observations, the Darwin VAAC reported that an ash-and-steam plume from Ulawun drifted W.

Low levels of activity continued from January through March 2008. Emissions consisted of thin to thick white vapor and with no audible noises and no glow visible at night. Seismicity continued at moderate level dominated by low frequency volcanic earthquakes. Variable amounts of white fume were emitted, sometimes forcefully. The two N valley vents continued to remain quiet.

Geologic Summary. The symmetrical basaltic-to-andesitic Ulawun stratovolcano is the highest volcano of the Bismarck arc, and one of Papua New Guinea's most frequently active. Ulawun volcano, also known as the North Son, rises above the northern coast of the island of New Britain across a low saddle NE of Bamus volcano, the South Son. The upper 1,000 m of the 2,334-m-high Ulawun volcano is unvegetated. A prominent E-W-trending escarpment on the S may be the result of large-scale slumping. Satellitic cones occupy the NW and E flanks. A steep-walled valley cuts the NW side of Ulawun volcano, and a flank lava-flow complex lies to the south of this valley. Historical eruptions date back to the beginning of the 18th century. Twentieth-century eruptions were mildly explosive until 1967, but after 1970 several larger eruptions produced lava flows and basaltic pyroclastic flows, greatly modifying the summit crater.

Information Contacts: *Herman Patia*, Rabaul Volcano Observatory (RVO), P. O. Box 386, Rabaul, Papua New Guinea (Email: hguria@global.net.pg); *Darwin Volcanic Ash Advisory Centre (VAAC)*, Commonwealth Bureau of Meteorology, Northern Territory Regional Office, PO Box 40050, Casuarina, NT 0811, Australia (URL: http://www.bom.gov.au/info/vaac/; Email: darwin.vaac@bom.gov.au); *US Air Force Weather Agency (AFWA)*, Satellite Applications Branch, Offutt AFB, NE 68113-4039, USA (Email:charles.holliday@afwa.af.mil); *Hawai'i Institute of Geophysics and Planetology (HIGP) Thermal Alerts System*, School of Ocean and Earth Science and Technology (SOEST), Univ. of Hawai'i, 2525 Correa Road, Honolulu, HI 96822, USA (URL: http://hotspot.higp.hawaii.edu/); *James Mori*, Disaster Prevention Research Institute, Kyoto University, Uji, Kyoto 611-0011, Japan (http://eqh.dpri.kyoto-u.ac.jp/~ mori/).

Rabaul

New Britain, Papua New Guinea
4.271°S, 152.203°E; summit elev. 688 m
All times are local (= UTC + 10 hours)

This report describes ash plumes and explosions located at Tavurvur, a cone located on the NE flank of Rabaul caldera. Tavurvur's summit sits at ~ 240 m elevation. The largest nearby settlement is Rabaul Town. Throughout the course of this report, audible sounds such as roaring, glowing of the cone, incandescent events, and hydrogen-sulfide (H_2S) odor were frequently reported. RVO interpreted high-frequency earthquakes as rocks breaking or explosion events, and low-frequency earthquakes driven by fluids, steam or gas (rarely liquid magma), their motions imparting a slower shaking or rocking to the ground.

Low eruptive activity such as reported in this issue have been periodically occurring since the powerful explosion in 1994. Our last report (*BGVN* 32:06) reported the six explosions that occurred in June and July (2007) at Tavurvur cone that produced shockwaves that rattled windows of houses in Rabaul Town and surrounding areas. The explosions also showered the flanks with lava fragments and conveyed ashfall and sulfurous odors to the NW.

RVO stated that there was no indication of any build up that might lead to significant eruptive activity like in October 2006. Ground deformation remains to be in a deflated but stable state. Seismic activity remains at a moderate to high level dominated by low-frequency earthquakes.

Throughout the entire period covered by these observations and reports, authorities have been regularly advising the public not to venture close to the volcano due to the possibility of rocks being expelled during the occasional eruptions.

Late July 2007. Rabaul Volcanic Observatory (RVO) described this time as marked by minor eruptions. The activity consisted of emission of thin to thick, white, and bluish vapor, which rose to an altitude of ~ 0.9 km and drifted NNW. Roaring noises were occasionally heard and incandescence was intermittently visible at the crater rim.

Red glow was visible at night, associated with a small lava dome centrally located within Tavurvur's wide vent. A weak smell of sulphur was evident on the downwind side of the vapor plume on 25 July. Occasional low roaring noise continued to be heard and a weak to bright red glow was visible above the crater rim on 28 and 29 July. On 30 July, a white plume with little ash content rose to an altitude of 2.7 km and drifted SW.

Seismicity was low but it and deformation were consistent with a dynamic and restless caldera. The real-time GPS at the caldera's center of the showed that centimeter-scale movements often occurred over a few hours. Small inflation events sometimes preceded activity by 6-12 hours. Only 17 low-frequency earthquakes were recorded between 22 and 27 July. One high-frequency earthquake was recorded on 26 July which originated NE of the caldera. Ground deformation continued to show a slow inflation trend with movement N.

August 2007. August activity was characterized by Tarvurvur emitting almost continuous ash and vapor plumes. During 1-7 August 2007, ashfall was reported at Rabaul Town (~ 6.5 km NW of the vent) and surrounding areas. Seismicity was generally moderate during the earlier part of August but increased to higher levels between 22-29 August. Activity was usually low frequency earthquakes, with occasional high-frequence earthquakes between 25-29 August. Five weak explosions were recorded on 27 August.

Ground deformation was stable until the middle of August when minor uplifts were noted. On 22 August, a marked uplift began and then subsided with the resumption of ash emissions. The subsidence continued until 28 August when a minor uplift began but subsided on 30 August.

A total of 1,087 low frequency earthquakes were recorded during 28-31 August. Three weak explosions were recorded on 30 August, but no high-frequency earthquakes were recorded. Ash emission persisted before declining significantly on the night of 30 August. A total of 150 low-frequency earthquakes were recorded on 31 August. After a momentary eruptive interlude took place at the end of August, blending into early September

September 2007. On 2 September, fine ashfall continued on Rabaul Town. Seismicity continued at a moderate

level, dominated by bands of irregular tremor and discrete low-frequency earthquakes. A total of 886 low-frequency earthquakes were recorded during 1-5 September; no high-frequency events were recorded. During 6-10 September there was little or no ash emitted. Emissions consisted of billowing white fume when atmospheric conditions were humid or cool. During hot dry periods, observers saw clear air above the cone, with a white plume appearing several hundred meters higher. On 8 September, odors of H_2S became noticeable downwind; this coincided with a blue tinge to the plume. Ground deformation measurements indicated an uplift. Emissions began again on 20 September, with ashfall in Rabaul Town and areas downwind, including Namanula Hill (3 km W). On 27 September, a large explosion was noted. During 30 September-2 October, incandescent fragments were ejected from the summit and rolled down the flanks.

October 2007. On 3 October ashfall was reported from areas downwind, including Rabaul Town. On 4 October ash plumes resulted in ashfall in Matupit Island (3.3 km SE), Malaguna. Incandescent fragments were ejected from the summit. On 5 October, vapor plumes with minor ash content were noted. During 8-23 October, occasional explosions produced ash plumes. Ashfall was reported at Namanula Hill and surrounding areas. Continuous weak glow was visible at night and incandescence at the summit was observed. The glow was bright on the night of 17 October. On 29-30 October ashfall was reported in Rabaul Town. Seismicity continued at moderate to moderately high level between the 17th and 20th. One high-frequency event was recorded on 21 October from NE of Rabaul.

November 2007. In late November, after five weeks of low-level activity, Tavurvur began to emit ash from a new vent on the NE crater rim. The new vent was formed as a result of the lava dome blocking the vent on the crater floor. The activity progressed and on 8-9 December emissions were thick white gray ash. The new dome has been the source of the continuous red glow visible at night.

December 2007. There was a slight increase in seismicity during December, but it was still low. The average daily number of low-frequency earthquakes was 20 during 1-3 December, before increasing to 55 during 4- 6 December, and 85 during 7- 8 December. The activity was accompanied by low-level sub-continuous signals. Two high-frequency earthquakes were recorded on 3 December which originated NE of the caldera. Ashfall continued downwind, including Rabaul Town. During 13-18 December, white plumes were observed and a strong smell of H_2S gas was reported.

January 2008. January 2008 continued the December activity. White ash and vapor plumes continued from the Tavurvur cone. The eruptive activity came from vents based on the inner eastern wall. One vigorous coneless fumarole on the upper outer eastern flank occasionally erupted ash. Unfortunately, NW winds carried ash towards the Provincial Airport (5.3 km NW) on a few occasions, causing closures.

During 11-12 January slight ashfall was reported about 20 km SE of Tokua. On 17 January ashfall at Tokua, prompted Air Niugini to cancel some flights. During 18-20 January, the ash plumes were released at 10-20 minute intervals. Slight ashfall was reported in areas on the E coast. Incandescence from the center of the crater was visible at night throughout most of January.

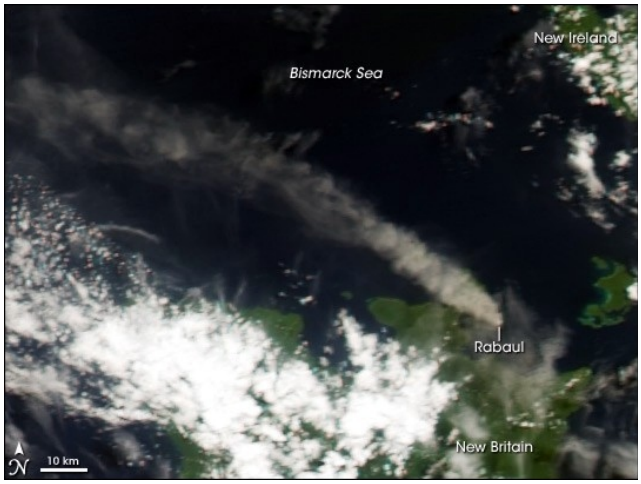

Figure 14. MODIS satellite image of a Rabaul ash plume on 18 March 2008.The plume can be seen over 150 km. Courtesy of NASA Earth Observatory.

Deformation-monitoring instruments indicated that uplift started on 23 January and peaked during 25-26 January with 2 cm of inflation. On 26 January, ashfall was quite heavy but died down on the morning of 27 January. Seismicity remained moderately high, with small sub-continuous low-frequency signals dominating. In the preceeding 24 hrs there were 400 low-frequency events and 3 explosion type signals, most of them were not associated with the seen emissions. There were no high-frequency or hybrid events. There were small explosion type signals, even when ash was not emitted. Deformation monitoring showed a slight uplift superimposed on the gradual 6 month long subsidence. On 29 January two small, instrumentally recorded, high-frequency events occured within the caldera, one between Tavurvur and Rabalanakia and the other just off the E coast of Vulcan (*the first here since the '94 eruption*). Deformation monitoring showed that the center of the caldera underwent a rapid centimetre scale uplift and matching deflation on 31 January.

February 2008. There was little variance in the activity at Tarvurur which was essentially a continuation of the January activity. Because of light winds, the plumes reached 1 km above Tavurvur. Drift was predominantly E. During 1-3 February ashfall was reported in Kokopo (20 km SE). On 4 February, a strong smell of H_2S gas was reported from Rabaul Town (3-5 km NW). Incandescence from the center of the crater was visible almost every night.

Low-frequency seismicity was moderately high and increased slightly, with occasional low-frequency signals dominating. Some hybrid events were also recorded. Seismic activity did not always appear to be related to the observed events. Deformation monitoring showed that the center of the caldera remaining reasonable stable during the early part of the month, although the trend was towards inflation. On 5 February, deformation monitoring showed some small, but significant movements with horizontal strain greater than vertical. A slight deflation was noted.

Toward the middle of February, ashfall was reported everyday in areas downwind, including Matupit, Kokopo, and Rabaul Town, and surrounding areas. Incandescence at the summit was noted and incandescent material was propelled from a vent on the inner E wall of the crater. Seismic activity remained at moderate levels; but again, the activity

did not always appear to be related to observed events. Deflation appeared to continue but only slightly. Occasional periods of high level seismic activity were dominated by low-frequency volcanic earthquakes. A total of over 1,570 events were recorded during 7-8 February. Ground deformation showed no significant movement although the trend after 9 February was towards inflation.

From 13-19 February, ashfall was reported in Barovon, Lalakua, Raluana, Kokopo, and surrounding villages. During 19-20 February, incandescence at the summit was accompanied by projections of lava fragments. Ground deformation as indicated by both the GPS and water-tube tiltmeter continued to indicate a trend towards inflation. On 25 February an explosion showered the flanks with lava fragments. On 26 February a large explosion occurred. The flanks were again showered with lava fragments. Ashfall was reported in Kokopo and surrounding areas.

March 2008. Tavurvur's activity during March was a continuation of the preceeding months. During 27 February-4 March ashfall was reported in areas downwind, including Matupit. A smell of H_2S gas was again reported in Rabaul Town. During 3-7 March, incandescence at the summit. A slight smell of H_2S was reported in areas to the S on 5 March. During 8-11 March, ash fall was reported in ar-

Date	Plume height (km)	Direction	Notes	Other Comments
1-7 Aug 2007	0.9-1.7	N, NW, W	thick, dark gray,	Occasional emission of white vapors. Ashfall
14-20 Aug 2007	—	—	white vapors	Accompanied by blue vapor plumes
22-28 Aug 2007	3	—	—	—
3 Sep 2007	—	NW	gray ash	Fine ashfall
4 Sep 2007	2	WNW	white vapor	—
20-24 Sep 2007	1.2	W, NW	white vapor	Ashfall
25 Sep 2007	1.7	W	—	—
2 Oct 2007	2.4	—	—	—
3 Oct 2007	1.7-2.7	NW	—	Ashfall
4 Oct 2007	—	W	—	Ashfall
8-23 Oct 2007	1.7-2.7	NNE, S	thick white, gray ash clouds	Occasional explosions, ashfall on large area
29-30 Oct 2007	2.7-3.7	—	—	Ashfall
10 Dec 2007	2	SSE, E, NW, W	thick dark ash clouds	Ashfall
11 Jan 200	81.2-1.5	SE	ash plume	—
11-15 Jan 2008	0.9-1.2	SE, E, NE, N, W	ash vapor plume	Ashfall
18-20 Jan 2008	1.7	NE	—	—
28 Jan 2008	1.7	W	—	—
29-30 Jan 2008	1.7	SW, W, E	ash and gas plumes	—
1-3 Feb 2008	1.2	SSE	weak ash emissions	—
Mid Feb 2008	1.2-1.7	NW, W, SW, S, SE, E	thick gray ash clouds	Long duration of ashfall
26 Feb 2008	3.7	SE, E	thick billowing ash plumes	Explosion caused ashfall
27 Feb-4 Mar 2008	0.9-2.2	W	ash and steam plumes	Ashfall
8-10 Mar 2008	1.2-1.7	NW, W, SW, S, SE	ash plumes	Ashfall
13 Mar 2008	2.5	NE	—	Ashfall
16 Mar 2008	2	S, W	gray ash	Ashfall
17 Mar 2008	2.5	WNW	—	High ashfall, rapid gas escape
18 Mar 2008	2	WNW	—	—
19 Mar 20082		NW, N	—	—
20 Mar 2008	2	NW, SSE	—	Ashfall
21 Mar 2008	—	S	—	Fine ashfall
22 Mar 20081		SW, W, NW	—	Ashfall
23 Mar 2008	2.5	N, SE	—	Ashfall
26 Mar 2008	1.5	SE	—	Ashfall, disruption of aviation
27 Mar 2008	2	S	thick gray	—
28 Mar 2008	0.5-1.0	W, SW	gray	—
30 Mar 2008	1-2	N, NW	thick white vapor gray ash clouds	—
1 Apr 2008	0.5	—	fluctuating between water vapor and dense gray ash	Occasional explosions
3 Apr 2008	1	SE	discrete puffs gray ash	Rarer explosions
7-9 Apr 2008	1	E	gray ash clouds	Ashfall
13 Apr 2008	1-1.5	W, NW	—	Ashfall
28 Apr 2008	1-1.5	N	gray	—

Table 2. Summary of events at Rabaul's Tavurvur cone during August 2007 to April 2008. Not all events are reported here. Further details of some of the events can be found in the text. Some data such as plume height or direction of plume were not measured. Areas effected by ashfall can generally be found in the text. Courtesy of the Darwin VAAC.

eas downwind, including Kokopo town (SE), and Rabaul Town (NW) on 11 and 13 March. Seismic activity often remained at a high level during March, but, the instrument's batteries died during 10-11 March. A total of over 980 events were recorded on 9 March. No high-frequency earthquakes were recorded. Deformation continued to indicate an inflationary trend after 8 March. On 13 March fine ash fell upon Rabaul Town. Ground deformation began towards an inflation trend after previous indications towards deflation. Unlike most plume eruptions, on 13 March sounds were not recorded. On 17 March moderate to heavy ash fall rained on Matupit island and surrounding areas.

At 1105 on 20 March a large explosion occurred showering the flanks with lava fragments. The shockwave rattled windows in Rabaul Town. At 1730 on 22 March 2008 an explosion occurred showering the flanks with lava fragments. During 22-23 March areas downwind had ashfall.

On 25 March 2008 ash clouds formed a broad fan from S at Barovon/Ialakua to Kokopo. The cloud drifted SE towards Tokua later that morning. During the morning on 26 March 2008 ash plumes caused Air Niugini flights into Tokua to be affected.

During 27 March into July 2007 overall deflation was 5 cm of subsidence, step-wise with small superimposed up lifts. RVO suggested that low-pressure intrusions were periodically rising in an open conduit causing the uplift before intersecting with the surface. The overall deflation implied that the deeper source was being depleted. The deformation measurements were made at Matupit. Constant expansion and degassing of magma in the recent weeks had apparently kept the conduit open. Pressure and debris have started to block the mouth of the vent by compaction and partial welding of molten material. This would lead to pressure build-up causing periodic explosions, in a plausible waning explosive phase.

April-May 2008. On 2 April ground deformation was stable with small and continued rapid fluctuations due to the repeating sealing and rupturing of the shallow conduit. Seismicity generally became moderate, but still generally dominated by low-frequency earthquakes. Activity was no longer preceded by notable explosions. The vent would be clear for a period of time. On 7 April a high-frequency event occurred NE of the caldera. On 9-10 April 9 mm of uplift occurred. On 11 April moderate ashfall was noted in Rabaul Town. Fine ashfall occurred in Matupit island. Seismic activity returned to a high level dominated by low-frequency earthquakes. On 11 April a total of 1,000 earthquakes were recorded. At 1100 on 22 April a modest explosion occurred. On 23 April 1-2 mm of non compacted flocculated pale ash was deposited in a sector from Malaguna E to S of Matupit. The cone was obscured to vision. On 28 April ground deformation was in a deflated but stable state. Ashfalls on 2 May left 3-4 cm in eastern Rabaul and 1-2 cm in western Rabaul.

Geologic Summary. The low-lying Rabaul caldera on the tip of the Gazelle Peninsula at the NE end of New Britain forms a broad sheltered harbor utilized by what was the island's largest city prior to a major eruption in 1994. The outer flanks of the 688-m-high asymmetrical pyroclastic shield volcano are formed by thick pyroclastic-flow deposits. The 8 x 14 km caldera is widely breached on the E, where its floor is flooded by Blanche Bay and was formed about 1400 years ago. An earlier caldera-forming eruption about 7100 years ago is now considered to have originated from Tavui caldera, offshore to the S. Three small stratovolcanoes lie outside the northern and NE caldera rims of Rabaul. Post-caldera eruptions built basaltic-to-dacitic pyroclastic cones on the caldera floor near the NE and W caldera walls. Several of these, including Vulcan cone, which was formed during a large eruption in 1878, have produced major explosive activity during historical time. A powerful explosive eruption in 1994 occurred simultaneously from Vulcan and Tavurvur volcanoes and forced the temporary abandonment of Rabaul city.

Information Contacts: *Steve Saunders* and *Herman Patia*, Rabaul Volcanological Observatory (RVO), Department of Mining, Private Mail Bag, Port Moresby Post Office, National Capitol District, Papua New Guinea (Email: hguria@global.net.pg, URL: http://www.pngndc.gov.pg/Volcano%20Bulletins.htm); *NASA Earth Observatory* (URL: http://earthobservatory.nasa.gov/).

Bagana

Papua New Guinea
6.140°S, 155.195°E; summit elev. 1,750 m
All times are local (= UTC + 10 hours)

Lava flows, pyroclastic flows, loud noises, and repeated forceful emissions were witnessed during June 2007-March 2008. Previously, there were brief periods of effusive activity and almost daily thermal anomalies during June 2006 through May 2007 (*BGVN* 32:04). Emissions during June 2007 consisted largely of steam of variable density.

On 12 June, there was a particularly forceful emission. Glow was observed on the night of 14 June. This kind of behavior continued into July. On 8 July observers saw glow and watched a single forceful release of pale gray ash.

On 14 July, Bagana generated a particularly forceful release that generated a pyroclastic flow. The release spewed out thick, dark-gray ash. The pyroclastic flow descended the S flank of the volcano stopping at the base near a small hot-spring-fed lake located at the head of the Torokina river. Since that event, rock falls from the edge of the active lava flow triggered thin ash clouds of light brown color from the S flank. This was accompanied by a loud roaring noise persisting into 15 July.

On 6 August, some emissions occasionally contained gray ash. The lava flow from the summit crater on the SE flank became active again and continued through 23 August. Thick white plumes escaped forcefully during 13-16 August. Ash clouds seen then were attributed to rock falls from collapse at the edges of the active lava flow. The Darwin VAAC reported that a diffuse plume rose to an altitude of 3.7 km on 23 August.

A particularly forceful emission occurred on 25 August and 12 September and the latter generated thin gray ash clouds directed over the SE flank.

Into October, the summit continued to release gentle emission of thin to thick white vapor. A weak to bright fluctuating glow was visible at night from 2-5 October and a continuous rumbling noise that lasted about an hour was heard on 5 October. On 6 October, there was a particularly forceful emission and the lava flow on the SE flank became active. Observers saw the lava flow emitting glow as it

passed down the SE flank on 6-7, 10-12, and 17 October. Occasional thin pale gray ash clouds observed at the edges of the active lava flow were visible on 9-10, and 14-15 October. Based on satellite imagery, the Darwin VAAC reported that ash plumes drifted N then NW on 19 October.

White vapor escaped through November and into December. It was occasionally accompanied by plumes containing ash that were generated along the lava flow.

Two explosions sent forth ash plumes on 19 and 27 November. The SE-flank lavas descended almost continuously and lava fragments vented at the summit on 7 and 9 December. On 9 December an ash plume rose to an altitude of 2.8 km; another on 17 December rose to uncertain height; and one on 26-27 December rose to 3 km altitude and drifted W.

Activity in January through March was generally weak but persistent, with earthquakes absent. Satellite imagery and information from RVO led the Darwin VAAC to report a diffuse plume on 3 March. It rose to an altitude of less than 3 km and drifted SW. Later that day, an ash-and-steam plume drifted SW.

Throughout the reporting period, the MODVOLC satellite system typically detected multiple thermal anomalies monthly. The system uses MODIS (the Moderate Resolution Imaging Spectroradiometer) and a processing algorithm and staff at HIGP (see Information Contacts, below).

Geologic Summary. Bagana volcano, occupying a remote portion of central Bougainville Island, is one of Melanesia's youngest and most active volcanoes. Bagana is a massive symmetrical, roughly 1750-m-high lava cone largely constructed by an accumulation of viscous andesitic lava flows. The entire lava cone could have been constructed in about 300 years at its present rate of lava production. Eruptive activity at Bagana is frequent and is characterized by non-explosive effusion of viscous lava that maintains a small lava dome in the summit crater, although explosive activity occasionally producing pyroclastic flows also occurs. Lava flows form dramatic, freshly preserved tongue-shaped lobes up to 50-m-thick with prominent levees that descend the volcano's flanks on all sides.

Information Contacts: *Herman Patia*, Rabaul Volcano Observatory (RVO), P.O. Box 386, Rabaul, Papua New Guinea; *Darwin Volcanic Ash Advisory Centre (VAAC)*, Bureau of Meteorology, Northern Territory Regional Office, PO Box 40050, Casuarina, Northern Territory 0811, Australia (URL: http://www.bom.gov.au/info/vaac/); *Hawai'i Institute of Geophysics and Planetology (HIGP) Hot Spots System*, University of Hawai'i, 2525 Correa Road, Honolulu, HI 96822, USA (URL: http://hotspot.higp.hawaii.edu/).

Erebus

Antarctica
77.53°S, 167.17°E; summit elev. 3,794 m

The Mt. Erebus Volcano Observatory (MEVO) website activity log gives information on each eruption of the volcano detected. Daily activity that usually includes several eruptions. Erebus eruption sizes are measured in the pressure unit of Pascals (Pa) from the infrasonic overpressure (at Station E1S.IS1). The eruption size index scale is divided into events classified as small (0-19 Pa), medium (20-39 Pa), large (40-59 Pa), and very large (more than 60).

Table 3 lists large and very large eruptions for the period December 2006 through 23 October 2007 (*BGVN* 31:12 gave a similar list for the year 2006 through November). The absence of recorded eruptions from 13 April 2007 to 29 August 2007 is notable. No eruptions were reported on the website during 23 October 2007 to 29 April 2008.

Thermal anomalies over Erebus, measured from the MODIS (Moderate Resolution Imaging Spectroradiometer) satellite images were analyzed by the Hawai'i Institute of Geophysics and Planetology (HIGP) MODVOLC algorithm. They commonly appeared throughout the 2007 due to the presence of a molten lava lake within the crater.

Geologic Summary. Mount Erebus, the world's southernmost historically active volcano, overlooks the McMurdo research station on Ross Island. The 3,794-m-high Erebus is the largest of three major volcanoes forming the crudely triangular Ross Island. The summit of the dominantly phonolitic Mount Erebus has been modified by one or two generations of caldera formation. A summit plateau at about 3,200-m altitude marks the rim of the youngest caldera, which formed during the late-Pleistocene and within which the modern cone was constructed. An elliptical 500 x 600 m wide, 110-m-deep crater truncates the summit and contains an active lava lake within a 250-m-wide, 100-m-deep inner crater. The glacier-covered volcano was erupting when first sighted by Captain James Ross in 1841. Continuous lava-lake activity with minor explosions, punctuated by occasional larger strombolian explosions that eject bombs onto the crater rim, has been documented since 1972, but has probably been occurring for much of the volcano's recent history.

Information Contacts: *Philip R. Kyle* and *Kyle Jones*, Mt. Erebus Volcano Observatory (MEVO), New Mexico Institute of Mining and Technology, Socorro, NM 87801, USA (Email: kyle@nmt.edu; URL: http://ees.nmt.edu/Geop/mevo/mevo.html and http://ees.nmt.edu/kyle/); *Hawai'i Institute of Geophysics and Planetology (HIGP) MODIS Thermal Alerts*, School of Ocean and Earth Science and Technology (SOEST), Univ of Hawai'i, 2525 Correa Road, Honolulu, HI 96822, USA (URL: http://hotspot.higp.hawaii.edu/).

Month	Large eruptions	Very large eruptions
Dec 2006	2	0
Jan 2007	29	24
Feb 2007	8	39
Mar 2007	7	11
Apr 2007	2	7
May 2007	0	0
Jun 2007	0	0
Jul 2007	0	0
Aug 2007	0	1
Sep 2007	0	2
Oct 2007	1	1

Table 3. Eruptions recorded at Erebus in the instrumentally derived categories "large" and "very large" during December 2006-23 October 2007. Courtesy of MEVO.

Monowai Seamount

Kermadec Islands, SW Pacific
25.887°S, 177.188°W; summit elev. -100 m
All times are local (= UTC + 12 hours)

On 28 March 2008, reporter Michael Field noted that an eruption of the submarine volcano Monowai was taking place. Olivier Hyvernaud was quoted in the article as saying that they recorded on the Polynesian Seismic Network (Réseau Sismique Polynésien, or RSP) a "big acoustic event" on 8 February. The news article went on to say that , according to geologist Cornel de Ronde, the French Polynesian RSP currently receives submarine hydrophone signals from Monowai eruptions more easily than stations in New Zealand. The article concluded that this activity went unnoticed as its location is off the main shipping routes.

Ian Wright of the New Zealand National Institute of Water and Atmospheric Research (NIWA) informed us about new volcano discoveries along the S-central Kermadec arc and some recent mapping results from Monowai. In recent years, New Zealand scientists have mapped, using soundings made by multibeam acoustic arrays, most of the Kermadec arc, with the consequent discovery and naming of a number of 'new' arc volcanoes. Some of the more recent work for the 30°-35°S latitude sector was published in Wright and others (2006). A second manuscript detailing the 25°- 30°S latitude sector will be completed soon for publication by Graham and others.

Wright and his colleagues mapped Monowai using the multibeam system in 1998 and again in 2004, identifying drastic changes in morphology during that 6-year period.

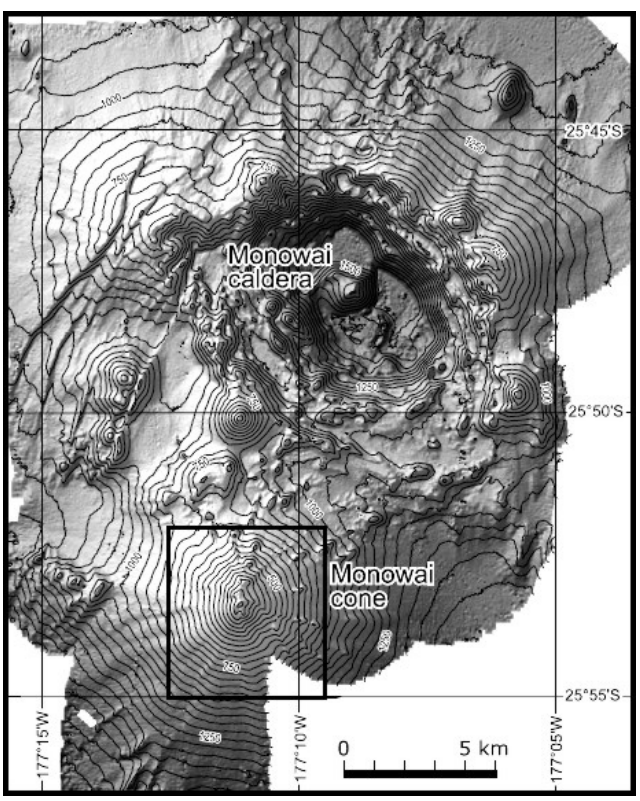

Figure 15. Multibeam bathymetry and shaded terrain model of the Monowai volcanic complex, including its caldera and cone. Isobaths are shown at 50 m intervals. Courtesy of Wright and others, 2008 (in press).

They found edifice collapse and cone regrowth. They interpreted these changes in morphology in the context of T-wave data recorded by Hyvernaud and his colleague Dominique Reymond [Wright and others, 2008 (in press); *BGVN* 32:01].

As indicated on figures 15 and 16, the group subsequently re-mapped Monowai in mid-2007 for a third time, again finding drastic changes coinciding with a period of ongoing and high T-wave activity (). They are currently preparing a manuscript detailing these latter changes (Chadwick and others, in preparation). According to Bill Chadwick, while the research ship was on site conducting the 2007 survey and attempting some remotely operated vehicle (ROV) dives, scientists heard booming sounds and saw slicks and bubbles on the surface.

Bob Dziak of NOAA informed the *Bulletin* staff that Monowai T-phases are recorded on the NOAA East Pacific Rise hydrophone arrays, but analysis of data from those arrays await their retrieval of recording packages from ocean deployment sites. (In contrast, Hyvernaud of LDG in French Polynesia recovers data in real-time.) Dziak also mentioned that, from time to time, T-phase events from what is likely volcanic activity in the Izu-Bonin Mariana region are recorded by the NOAA real-time system in the North Pacific. He offered to provide a later *Bulletin* report.

A recent paper by de Rhonde and others (2008) noted that all the major submarine volcanic centers on the Kermadec intraoceanic arc and the Aeolian island arc N of Raoul Island, NE of New Zealand (including Monowai) are hydrothermally active. The Monowai volcanic complex has two separate and extensive hydrothermal fields associated with the Monowai caldera and the Monowai cone, respectively.

References: Wright, I.C., Worthington, T.J., and Gamble, J.A., 2006, New multibeam mapping and geochemistry of the 30°-35°S sector, and overview, of southern Kermadec arc volcanism, Journal of Volcanology and Geothermal Research, v. 149, p. 263-296.

Wright, I. C., Chadwick, W., de Ronde, C. E. J., Reymond, D., Hyvernaud, O., Gennerich, H., Stoffers, P., Mackay, K., Dunkin, M., and Bannister, S., 2008 (in press), Collapse and reconstruction of Monowai submarine volcano, Kermadec arc, 1998-2004, Journal of Geophysical Research, doi:10.1029/2007JB005138.

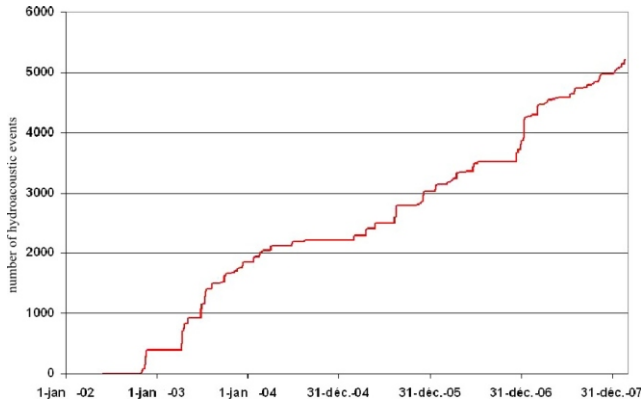

Figure 16. Cumulative number of T-wave events centered at Monowai during the latter half of 2002 into early 2007 from monitoring data at RSP (covering the times of the September 2004 and May 2007 bathymetric surveys, and the anomalous 24 May 2002 swarm, as reported in *BGVN* 27:05 and 32:01). Courtesy of Hyvernaud and Reymond, Laboratoire de Geophysique (LDG); from Chadwick and others (in preparation).

de Ronde, C.E.J., Baker, E.T., Lupton, J.L., Sprovieri, M., Bruno, P.P., Faure, K., Leybourne, M.I., Walker, S.L., Italiano, F., Embley, R.W., Graham, I., Greene, R.R., Wright, I.C., and NZAPLUME III & Aeolian'07 shipboard parties, 2008, Contrasting examples of submarine hydrothermal venting along the Kermadec intraoceanic arc and the Aeolian island arc, Geophysical Research Abstracts, v. 10, EGU2008-A-05597, 2008 (SRef-ID: 1607-7962/gra/EGU2008-A-05597).

Geologic Summary. Monowai seamount, also known as Orion seamount, rises to within 100 m of the sea surface about halfway between the Kermadec and Tonga island groups. The volcano lies at the southern end of the Tonga Ridge and is slightly offset from the Kermadec volcanoes. Monowai rises from a depth of about 1,500 m and was named for one of the New Zealand Navy bathymetric survey ships that documented its morphology. Small parasitic cones occur on the N and W flanks of the basaltic submarine volcano. The complex includes a large 8- x 13-km wide submarine caldera with a depth of more than 1,500 m lying to the NNE of the summit. Numerous eruptions from Monowai have been detected from submarine acoustic signals since it was first recognized as a volcano in 1977. A shoal that had been reported in 1944 may have been a pumice raft or water disturbance due to degassing. Surface observations have included water discoloration, vigorous gas bubbling, and areas of upwelling water, sometimes accompanied by rumbling noises.

Information Contacts: *Ian Wright*, New Zealand National Institute of Water and Atmospheric Research (NIWA), Private Bag 14-901, Wellington, 6003, New Zealand (Email: i.wright@niwa.co.nz); *Cornel de Ronde*, GNS Science, Lower Hutt, 5040 New Zealand (Email: cornel.deRonde@gns.cri.nz); *Olivier Hyvernaud* and *Dominique Reymond*, Laboratoire de Géophysique, Commissariat à l'Energie Atomique (CEA/DASE/LDG), PO Box 640, Papeete, Tahiti, French Polynesia (Email: hyvernaud@labogeo.pf, reymond.d@labogeo.pf); *GNS Science*, Wairakei Research Center, Private Bag 2000, Taupo 3352, New Zealand (URL: http://www.gns.cri.nz/); *Michael Field*, Fairfax Media, Auckland, New Zealand (Email: http://www.michaelfield.org/); *William Chadwick* and *Robert Dziak*, NOAA and Cooperative Institute for Marine Resources Studies at Oregon State University, 2115 SE OSU Drive, Newport, OR 97365 (Email: Robert.P.Dziak@noaa.gov, William.W.Chadwick@noaa.gov).

Montagu Island

South Sandwich Islands
58.42°S, 26.33°W; summit elev. 1,370 m

An ASTER (Advanced Spaceborne Thermal Emission and Reflection Radiometry) satellite image became available, showing a Montagu Island plume blowing NNE on 17 December 2006 (figure 17). A persistent ash plume over Montagu was previously noted in October 2006 ASTER imagery (*BGVN* 31:11)

Thermal anomalies from Montagu were often detected by MODIS satellite instruments nearly weekly from at least 2006 until 20 September 2007. However, during that interval anomalies were absent for more than two months, from January 2007 through late March 2007. Anomalies were also absent from 1 September 2007 to 17 April 2008). The absence of anomalies could be due to lack of visibility, or the chilling of lava flows after the end of an eruptive phase.

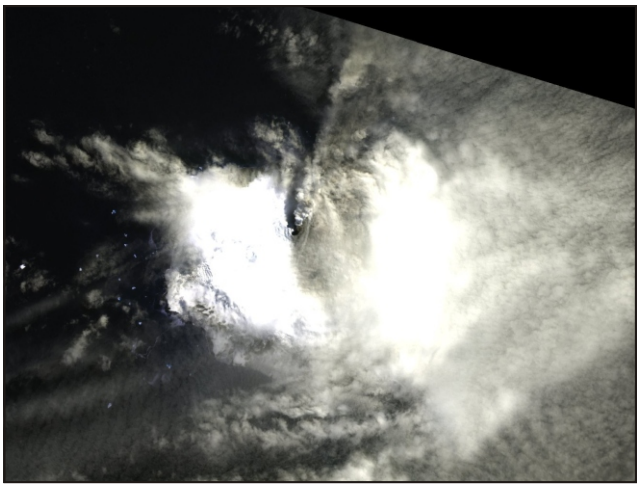

Figure 17. ASTER near-infrared image of Montagu Island volcano at 1115 UTC on 17 December 2006. Courtesy of ASTER Volcano Archive.

Geologic Summary. The largest of the South Sandwich Islands, Montagu consists of a massive shield volcano cut by a 6-km-wide ice-filled summit caldera. The summit of the 10 x 12 km wide island rises about 3000 m from the sea floor between Bristol and Saunders Islands. Around 90% of the island is ice-covered; glaciers extending to the sea typically form vertical ice cliffs. The name Mount Belinda has been applied both to the high point at the southern end of the summit caldera and to the young central cone. Mount Oceanite, an isolated 900-high peak with a 270-m-wide summit crater, lies at the SE tip of the island and was the source of lava flows exposed at Mathias Point and Allen Point. There was no record of Holocene or historical eruptive activity at Montagu until MODIS satellite data, beginning in late 2001, revealed thermal anomalies consistent with lava lake activity that has been persistent since then. Apparent plumes and single anomalous pixels were observed intermittently on AVHRR images during the period March 1995 to February 1998, possibly indicating earlier unconfirmed and more sporadic volcanic activity.

Information Contacts: *ASTER Volcano Archive* (URL: http://ava.jpl.nasa.gov/); *Hawai'i Institute of Geophysics and Planetology (HIGP) Thermal Alerts System*, School of Ocean and Earth Science and Technology (SOEST), Univ. of Hawai'i, 2525 Correa Road, Honolulu, HI 96822, USA (URL: http://hotspot.higp.hawaii.edu/);.

Sangay

Ecuador
2.002°S, 78.341°W; summit elev. 5,230 m
All times are local (= UTC - 5 hours)

Our previous report on Sangay (*BGVN* 21:03) described occasional, but sometimes conspicuous, steam and/or ash plumes between January 2004 and January 2006. The current report continues coverage of plume emissions through December 2007.

Sangay has continued to erupt, sending ash plumes up to an altitude of about 11 km. A summary of plume activity is indicated in table 4. The information is from the Washington Volcanic Ash Advisory Center (VAAC), and is based on reports from the Guayaquil Meteorologic Watch Office, pilot reports, satellite imagery, and the Instituto Geofísico-Departamento de Geofísica (Escuela Politécnica Nacional). We did not receive any report of activity during the period February 2006 through September 2006, or during the first three months of 2008.

According to a report from the Instituto Geofísico, activity at Sangay increased at the end of 2006 through the beginning of 2007. They reported that a thermal anomaly was detected by satellite imagery during several days in December 2006. During that time, mountain guides near the volcano observed the fall of incandescent rocks down the volcano's flanks at night and a recent deposit of ash that was sufficiently deep to affect birds, rabbits, and other small animals. The report indicated that the Instituto Geofísico has not installed monitoring instrumentation near Sangay because of a significant logistics problem in maintaining them in this inhospitable area, and also because the area is uninhabited and thus poses no direct human risk. However, the report notes that because ash emissions from Sangay may pose problems for aircraft in the S, SE, and SW parts of the country, the Instituto maintains contact with the civil aviation authority.

Date	Altitude (km)	Bearing	Remarks
11 Oct 2006	2.7	W	
21 Oct 2006	6.7	—	
22 Nov 2006	—	WNW	Hotspot visible on satellite imagery
02 Dec 2006	8.5	SW	
23 Dec 2006	7.6	—	
01 Jan 2007	5.2	—	
14 Jan 2007	6.1	SW	
28 Jan 2007	6.4	—	
06 Feb 2007	9.1	SW	
06-10 Feb 2007	6.1-9	Several	Hotspot at summit visible on satellite imagery
13 Feb 2007	—	—	Hotspot at summit visible on satellite imagery
23 Feb 2007	10.7	S	
25 Feb 2007	6.4	SW	
28 Feb 2007	7.6	—	
02 Mar 2007	—	—	Weak hotspot visible on satellite imagery
05 Mar 2007	5.2-6.1	W	
12-13 Mar 2007	7	W	Hotspot visible on satellite imagery
17 Mar 2007	5.2	—	Hotspot visible on satellite imagery
04 May 2007	5.2 - 7.6	—	
05 May 2007	—	W	Possible narrow plume on satellite imagery
24 May 2007	7.3	—	
03 Jul 2007	5.2 - 7.9	W	
23 Jul 2007	5.5	W	Ash not detected by satellite imagery
24 Jul 2007	5.2	SW	
28 Jul 2007	6.7 - 8.2	—	Weak hotspot visible on satellite imagery, but ash not detected
02 Aug 2007	5.5	W	Ash not detected by satellite imagery
19 Aug 2007	—	—	Clouds inhibited satellite imagery
08-09 Sep 2007	—	—	Ash not detected by satellite imagery
12 Oct 2007	7	W	
26 Dec 2007	6.1	SW	
26-27 Dec 2007	—	—	Thermal anomaly seen on satellite imagery

Table 4. Ash plume advisories about Sangay activity, October 2006 through December 2007. Courtesy of the Washington VAAC.

Geologic Summary. The isolated Sangay volcano, located E of the Andean crest, is the southernmost of Ecuador's volcanoes, and its most active. The dominantly andesitic volcano has been in frequent eruption for the past several centuries. The steep-sided, 5,230-m-high glacier-covered volcano grew within horseshoe-shaped calderas of two previous edifices, which were destroyed by collapse to the E, producing large debris avalanches that reached the Amazonian lowlands. The modern edifice dates back to at least 14,000 years ago. Sangay towers above the tropical jungle on the E side; on the other sides flat plains of ash from the volcano have been sculpted by heavy rains into steep-walled canyons up to 600 m deep. The earliest report of a historical eruption was in 1628. More or less continuous eruptions were reported from 1728 until 1916, and again from 1934 to the present. The more or less constant eruptive activity has caused frequent changes to the morphology of the summit crater complex.

Information Contacts: *Washington Volcanic Ash Advisory Center*, 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/VAAC/); *P. Ramón*, Instituto Geofísico-Departamento de Geofísica (IG), Escuela Politécnica Nacional, Casilla 17-01-2759, Quito, Ecuador (Email: pramon@igepn.edu.ec).

Reventador

Ecuador
0.077°S, 77.656°W; summit elev. 3,562 m
All times are local (= UTC - 5 hours)

An apparent hiatus in activity starting in late 2005 ended with an eruption during March 2007. Previous reports documented intermittent explosive eruptions through September 2005, with Strombolian activity and short-duration Vulcanian events (*BGVN* 30:08). These events were accompanied by small pyroclastic flows, small lava flows, large bombs, and ash columns.

According to the Instituto Geofísico (Escuela Politécnica Nacional) (IG), seismicity at Reventador was at a low level at the end of December 2005. No IG reported

were received between January 2006-March 2007. In early March 2007 the IG noted that the number of tectonic earthquakes from Reventador had increased. Steam-and-ash plumes were sporadically visible and occasionally rose to altitudes of 4 km during 8-22 March. On 21 March, noises were reported. The next day, seismic signals changed that indicated possible emissions. On 24 March, local people saw ash plumes and incandescent material near the crater and heard roaring noises. An explosion produced a plume to an altitude of 6.6 km that drifted W. Based on reports from IG, the Washington VAAC reported an ash plume during 26-27 March that reached an altitude of 3.7-7 km and drifted NE and WNW. A thermal anomaly was present on satellite imagery during 24-27 March.

On 28 March 2007, observers reported roaring noises and an ash column that rose to an altitude of 5.6 km and drifted W. A small lava flow traveled 200 m down the S flank. Incandescent material and ash emissions were observed during 29-31 March. On 1 April, ash plumes rose to an altitude of 7.6 km and incandescent rocks were ejected about 50 m above the crater. Incandescent material was again seen at the summit on 2 April. The Washington VAAC reported that a strong hotspot was present on satellite imagery during 1-3 April. Based on pilot reports, IG reported that a steam-and-gas plume with little ash content rose to an altitude of 6.1 km and drifted W on 3 April.

On 3-4 April 2007, incandescent blocks ejected from the summit subsequently rolled down the S flanks. Satellite imagery revealed ash plumes drifting W and a large thermal anomaly over the crater. On 4 April, a plume rose to an altitude of 4.6 km. Crater incandescence was observed on 4 and 6 April and "cannon shots" were heard on 6 April. Ash-and-steam emissions were observed during 8-9 April. Steam emissions from the flanks on 8 April possibly originated from a lava flow.

On 11 April, a steam plume rose to an altitude of 3.8 km. Visual observations were hindered during 12-17 April due to inclement weather. On 13 April, the lava flow on the S flank, first observed on 28 March, was 15 m thick and possibly active. On 18, 20, and 23 April, steam-and-gas emissions hung near the summit. On 18 April, a plume was seen drifting NW on satellite imagery. On 20 April, a bluish haze of gases was observed. Clouds occasionally inhibited views of the summit during 18-24 April.

On 27 April, a steam plume from Reventador rose to an altitude of 3.7 km. Later that night, incandescent material was ejected from the crater. On 30 April, a steam plume was observed on satellite imagery drifting NW. Based on the Guayaquil MWO and satellite imagery, the Washington VAAC reported that an ash plume rose to an altitude of 3.7 km and drifted NW. Visual observations were hindered during 25 April-1 May due to inclement weather.

On 16 May the IG reported that a steam plume rose to an altitude of 3.6 km and drifted to the NW. An ash plume on 18 May rose to an altitude of 3.7 km and drifted NW, but ash was not observed on satellite imagery. Strong rains that day resulted in a lahar that lasted approximately 40 minutes. A lahar was also noted on 22 May. Visual observations were hindered during most of the reporting period due to inclement weather.

Lahars occurred on the flanks on 15, 19, 20, 21, and 23 June. An eruption on 11 October 2007 produced an ash plume that rose to an altitude of 4.6 km and drifted S. Ash was not observed on satellite imagery due to cloud cover.

Geologic Summary. Reventador is the most frequently active of a chain of Ecuadorian volcanoes in the Cordillera Real, well E of the principal volcanic axis. The forested, dominantly andesitic Volcán El Reventador stratovolcano rises to 3,562 m above the jungles of the W Amazon basin. A 4-km-wide caldera widely breached to the E was formed by edifice collapse and is partially filled by a young, unvegetated stratovolcano that rises about 1300 m above the caldera floor to a height comparable to the caldera rim. Reventador has been the source of numerous lava flows as well as explosive eruptions that were visible from Quito in historical time. Frequent lahars in this region of heavy rainfall have constructed a debris plain on the eastern floor of the caldera. The largest historical eruption at Reventador took place in 2002, producing a 17-km-high eruption column, pyroclastic flows that traveled up to 8 km, and lava flows from summit and flank vents.

Information Contacts: *Washington Volcanic Ash Advisory Center*, 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/VAAC/); *P. Ramón*, Instituto Geofísico-Departamento de Geofísica (IG), Escuela Politécnica Nacional, Casilla 17-01-2759, Quito, Ecuador (Email: pramon@igepn.edu.ec).

Galeras

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

As reported in (*BGVN* 31:07) Galeras displayed dome growth and elevated seismicity from November 2005 through mid-August 2006; ~ 10,000 residents evacuated but the crisis later abated. The key source of this report was the Instituto Colombiano de Geologia y Mineria (INGEOMINAS). This report follows the August 2006 events and covers the period through April 2008.

In September 2006, INGEOMINAS recorded continuing low-level minor earthquakes, M 1.4, corresponding to the movement of fluids at depths between 4 and 8 km and low SO_2 fluxes. A fly-over observed gas and steam emissions from the periphery of the active cone with diminished intensity through early November.

Beginning in late November and continuing through December 2006, an increase in the level of the volcanic activity occurred indicating the movement of solid material at focal depths to 9.6 km and at intensities to M 2.1. INGEOMINAS raised the Alert Level from 3 to 2 elevating the hazard status to "likely eruption in days or weeks" on 22 November 2006. The scale extends from 4 (lowest) to 1 (highest hazard). The change was based on the increase in activity, behavior resembling characteristics that preceded earlier eruptions, i.e., increased earthquake activity associated with rock fractures within 2 km of the surface and weak gas emissions caused by the apparent capping of the lava dome.

On 2 March 2007, a tectonic earthquake was recorded ~ 2 km NNW of Galeras at M 3.5 and focal depth of 8.2 km. On 15 March, observations made with the support of the Colombian Air Force (FACE), showed continuing low

rates of gas discharge continuing from secondary craters and fumaroles mainly located in the periphery of the main crater. On 20 March, because of decreased seismicity, low gas emissions, and no indication of changes below the surface of the dome, the Alert Level shifted towards less severe, from 2 to 3 (to "changes in the behavior of volcanic activity have been noted").

On 19 and 21 May 2007, two earthquakes registered, M 3.0 and M 2.1 respectively. These earthquakes were located SW of Galeras and felt by residents. The inclinometer to the SW of the active crater continued showing deformation indicating deeper volcanic activity.

Little volcanic activity occurred through September 2007. From October 2007 through January 2008, INGEOMINAS and the Washington Volcanic Ash Advisory Center reported an increase in gas-and steam plumes emitted from Galeras (table 5). During an overflight on 27 November, thermal images recorded by INGEOMINAS indicated an increase in temperatures at the point sources of emissions. The Alert Level remained at 3. Occasional gas and steam eruptions continued through January 2008.

On 11 January 2008, INGEOMINAS noted variations in seismicity associated with greater volumes of gas discharge. On 16-17 January, 5 tremors were recorded near the active cone. Early on 17 January, INGEOMINAS noted the similarity of these events to those preceding the eruptions of 1992, 1993, and 2004-2006.

Later, on the 17th, an explosive eruption was registered by the seismic network and prompted INGEOMINAS to raise the Alert Level from 3 ("changes in the behavior of volcanic activity have been noted") to 1 ("imminent eruption or in course"). The Washington VAAC reported that an ash plume rose to an altitude of 11 km and drifted W. According to a news article, small settlements to the N were ordered to evacuate; about 100 people moved to shelters.

About 2 km away from the main crater, military personnel saw blocks 1.5 m in diameter on a highway. Several impact craters of 17 January were spotted; the largest, ~ 15 m across and ~ 5 m deep (figure 18).

On 19 January 2008, INGEOMINAS lowered the Alert Level to 2 ("likely eruption in days of weeks") because seismic events decreased in occurrence and energy and on 21 January, INGEOMINAS further lowered the Alert Level to 3 and reported that the initial ash plume from the eruption drifted SW, then W. Through February and into March seismic activity remained low. However, in mid-March, a a cluster of earthquakes (several events in a relatively short time interval), associated mainly with movement of magmatic fluids to the interior of the volcanic system were recorded. Volcanic gas and steam columns were routinely observed between the 200 and 450 m from the top of Galeras, with variable directions of dispersion depending on the wind direction. Seismicity decreased in early April and SO2 emissions remained low.

Date	Event	Maximum plume (km)	Plume direction
04 Oct-05 Oct 2007	Steam, ash	5.8-6.3	N, NW
29 Oct-04 Nov 2007	Steam, ash	5.7	—
05 Nov-11 Nov 2007	Ash	4.5-7.2	NW, W
13 Nov 2007	Steam	5.5	S
21-23 Nov 2007	Steam and gas	5.3	—
27 Nov 2007	Steam, gas, ash	4.4	NW
03 Dec 2007	Steam, gas, ash	5.3	NW
31 Dec 2007	Gas and ash	4.9	NW
12 Jan 2008	Steam, gas, ash	6.3	—

Table 5. Summary of activity reported at Galeras from October 2007 through January 2008. Based on information from INGEOMINAS and the Washington Volcanic Ash Advisory Center.

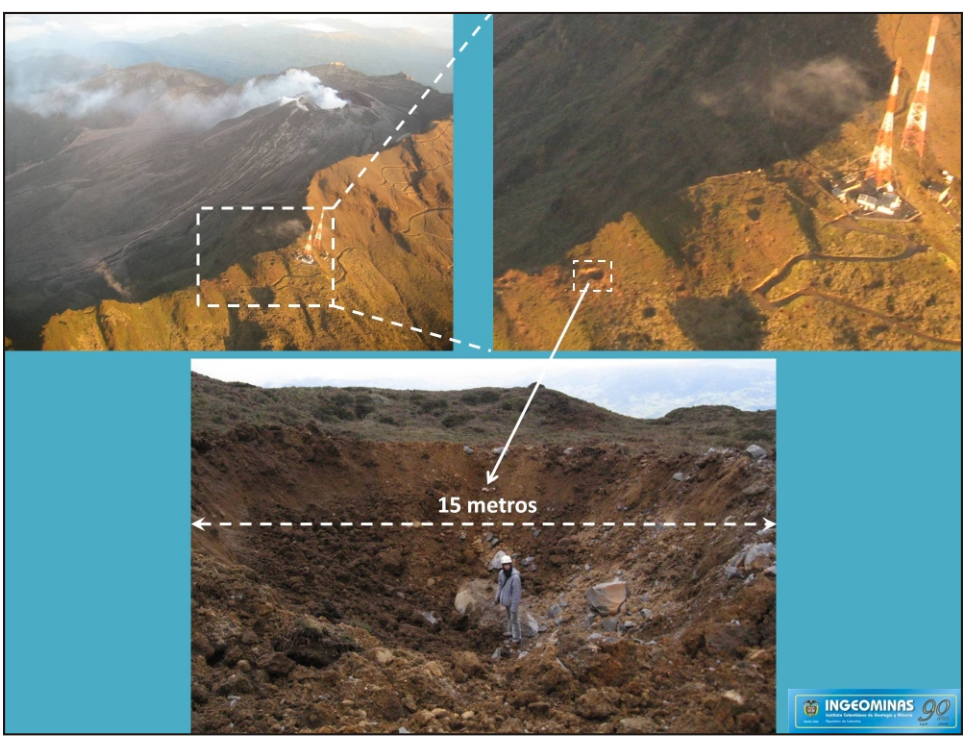

Figure 18. A composite of several photos showing a large impact crater formed by the Galeras eruption of 17 January 2008. The impact site was 1.5 km S of the main crater. Courtesy of INGEOMINAS.

Geologic Summary. Galeras, a stratovolcano with a large breached caldera located immediately W 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 W 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/); *Associated Press* (URL: http://www.ap.org/).

Chikurachki

Kuril Islands, Russia
50.325°N, 155.458°E; summit elev. 1,816 m
All times are local (= UTC + 11 hours)

Olga Girina of the Kamchatka Volcanic Eruptions Response Team (KVERT) reported no eruptive activity at Chikurachki volcano [activity that began 4 March 2007 (*BGVN* 32:05)] after about 18 April 2007. The following report was based primarily on information found on the KVERT website. Chikurachki is not monitored with seismic instruments, but KVERT has satellite monitoring and receives occasional reports of visual observations.

According to observations, no eruptive activity was noted on 12 and 14 August. However, visual information from Podgorny (20 km SSE) indicated that an eruption began on 18 August 2007 at 2200 UTC. Ashfall was noted in Podgorny at that time and on 19-20 August, and satellite data showed an ash plume extending about 120 km SE. An ash plume extending about 100 km SE at an altitude of 5 km was observed by pilots on 20 August 20 at 0140 UTC. An ash plume extending about 160 km to the NNE at an altitude of 3 km and ashfall on Alaid volcano were noted by volcanologists on 21 August. Table 6 lists observations, when available, of the ash plume during this eruption.

Figure 19. Ash plume extending to the ESE from Chikurachki on 8 September 2007. Photo by L. Kotenko, supported by JSPS (Japan Society for the Promotion of Science); courtesy of KVERT Current Activity of Chikurachki website.

The eruption continued through at least 25 October 2007, and perhaps through 8 November. Clouds obscured the volcano on many days, making estimates of the continuity of this eruption and its ending date difficult. KVERT has reported no later plumes observed over Chikurachki to mid-April 2008. No thermal anomalies were measured by the MODIS satellites during 2007 or 2008 to 20 April.

Geologic Summary. Chikurachki, the highest volcano on Paramushir Island in the northern Kuriles, is actually a relatively small cone constructed on a high Pleistocene volcanic edifice. Oxidized basaltic-to-andesitic scoria deposits covering the upper part of the young cone give it a distinctive red color. Frequent basaltic plinian eruptions have occurred from Chikurachki during the Holocene. Lava flows from 1,816-m-high Chikurachki reached the sea and form capes on the NW coast; several young lava flows also emerge from beneath the scoria blanket on the eastern flank. The Tatarinov group of six volcanic centers is located immediately to the south of Chikurachki. In contrast to the frequently active Chikurachki, the Tatarinov volcanoes are extensively modified by erosion and have a more complex structure. Tephrochronology gives evidence of only one eruption in historical time from Tatarinov, although its southern cone contains a sulfur-encrusted crater with fumaroles that were active along the margin of a crater lake until 1959.

Information Contacts: *Olga Girina*, Kamchatka Volcanic Eruptions Response Team (KVERT), a cooperative program

Date (2007)	Plume altitude	Plume distance/ direction	Type of observation
18 Aug	—	—	visual
19-20 Aug	2.4 km	120 km SE	satellite
20 Aug	5 km	100 km SE	visual
21 Aug	4-5 km	160 km NE	visual, satellite
21-26 Aug	1 km	—	visual
28-30 Aug	~ 3 km	150-300 km NE	satellite
31 Aug, 01 Sep	~ 3 km	30-160 km NE	satellite
03 Sep	—	S, SE	satellite
~ 06 Sep	3.2 km	—	visual
07 Sep	—	more than 80 km SE	satellite
08 and 11 Sep	2.3 km	ESE	visual, satellite (figure 19)
18-19 Sep	—	more than 110 km	satellite (figure 20)
19-20 Sep	—	more than 250 km E	visual
21 Sep	—	more than 75 km ESE	satellite
04 Oct	—	more than 100 m ESE	satellite
07 and 10 Oct	—	more than 50 km NE	satellite
17-18 Oct	—	more than 180 km NE	satellite
20 Oct	—	more than 50 km NW	satellite

Table 6. Ash plume observations for the eruption of Chikurachki beginning 18 August 2007. Clouds obscured the volcano on most days not noted. Courtesy of KVERT.

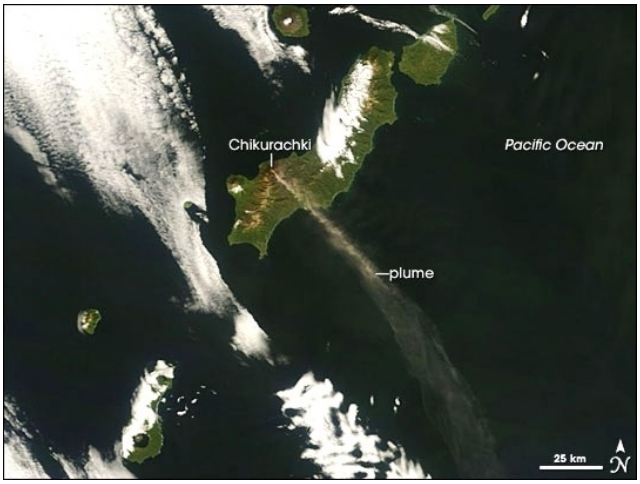

Figure 20. Plume from Chikurachki taken 19 August 2007 by the Moderate Resolution Imaging Spectroradiometer (MODIS) flying on NASA's Aqua satellite. Besides Chikurachki, whose plume blows SE over the ocean, the image captures the summits of neighboring volcanos Atlasova Island and Fuss Peak above the cloud cover. Courtesy of NASA Earth Observatory.

of the Institute of Volcanic Geology and Geochemistry, Far East Division, Russian Academy of Sciences, Piip Ave. 9, Petropavlovsk-Kamchatskii 683006, Russia (Email: girina@kcs.iks.ru), the Kamchatka Experimental and Methodical Seismological Department (KEMSD), GS RAS (Russia), and the Alaska Volcano Observatory (USA) (URL: http://www.kscnet.ru/ivs/kvert/updates.shtml); *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/; Email: tlmurray@usgs.gov), the Geophysical Institute, University of Alaska, P.O. Box 757320, Fairbanks, AK 99775-7320, USA (Email: eisch@dino.gi.alaska.edu), and the Alaska Division of Geological and Geophysical Surveys, 794 University Ave., Suite 200, Fairbanks, AK 99709, USA (Email: cnye@giseis.alaska.edu); NASA Earth Observatory Natural Hazards (URL: http://earthobservatory.nasa.gov/NaturalHazards/); KVERT Current Activity of Chikurachki (http://www.kscnet.ru/ivs/kvert/current/chkr/index.html).