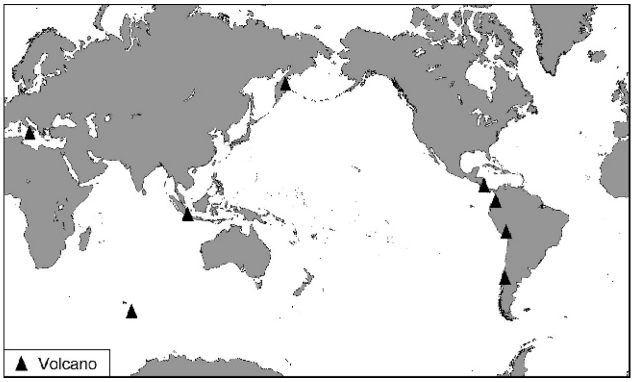
Bulletin of the Global Volcanism Network



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

Nevado del Huila

Colombia
2.93°N, 76.03°W; summit elev. 5,364 m
All times are local (= UTC - 5 hours)

Nevado del Huila was the scene of elevated seismicity during February and May 2000 (*BGVN* 25:05). In 1994, the M 6.4 Paéz earthquake triggered avalanches and lahars along the Paéz river, which took many lives (*BGVN* 19:05, 19:07). A more recent abstract summarized the losses from the Paéz earthquake as 271 reported deaths, 1,700 people missing, and more than 32,000 people evacuated during the crisis (Schuster, 1996). Correa and Pulgarín (2002a, b) wrote reviews of the volcano's geology, hazards, and related topics.

This report discusses the onset of eruptions during February 2007 and repeated eruptions during April and May 2007. During the most active intervals during February and April there were substantial ash plumes, lahars, earthquake swarms (and some individual earthquakes up to M ~ 3), and the growth of fissures, crevasses, and new fumaroles on the volcano's upper, glacier-covered slopes. During the April eruption thousands of residents evacuated. This report draws heavily on material issued by the Instituto Colombiano de Geología y Minería (INGEOMINAS), Observatory Vulcanológico and Sismológico de Popayán.

The andesitic-dacitic edifice (figure 1) is large and elongate (with a footprint of ~ 170 km^2). Located in the Central Cordillera (figure 2), it forms Colombia's highest peak. This area only 3 degrees from the equator experiences periods of high precipitation. In 1995 its alpine glaciers covered ~ 13.4 km^2 with an approximate volume of 800 x 10^6 m^3 (Pulgarín and others, 2005).

The April 2007 activity impacted not only the immediate vicinity of the volcano, but also ten's of kilometers to the S, where rivers carried debris. In order to assess the impact of the lahars, INGEOMINAS compared calibrated Landsat images from before and after the 19 February eruption. They found clear visual evidence that the lahars had discolored the Betania Reservoir, ~ 150 km downstream.

The Símbola joins the Paéz river ~ 28 km (straight-line distance) S of Pico Central (figure 3). Adjacent that intersection sits the town of Belacázar (figure 4). Another ~ 15 km downstream, the Paéz merges into the Magdalena river, the 6th largest river the world in terms of sediment yield (~ 690 t / (km^2 · yr); Restrepo and others, 2005). A straight-line distance of ~ 50 km downslope from the intersection of the Paéz and Magdalena rivers, the Magdalena enters the Betania Reservoir.

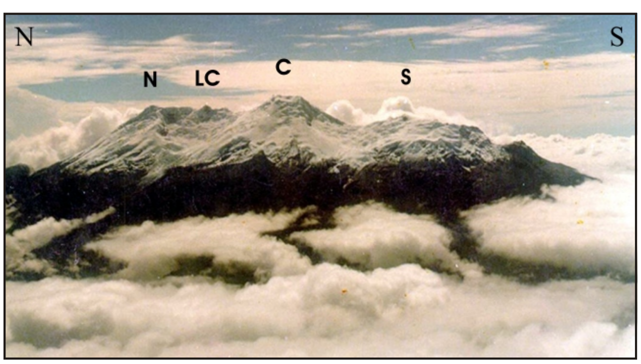

Figure 1. An aerial photo showing the upper slopes of Nevado del Huila from the W. The photo was taken at unknown date prior to 2002 when the volcano was in a non-eruptive state. From N to S the four main peaks consist of Pico Norte ("N"), Pico la Cresta ("LC"), Pico Central ("C"), and Pico Sur ("S"). Heavy cloud banks such as those in the foreground are common, adding to the difficulty of monitoring this remote, high stratovolcano. Taken from Correa and Pulgarín (2002a).

Figure 2. A sketch map showing the three distinct ranges (cordillera) of the Andes in Colombia, with Nevado del Huila indicated. Between the Western and Central cordillera, the valley contains the Cauca river (not shown). It flows N and ultimately joins the Magdalena river (not shown), traveling ~ 1,350 km beyond its starting point to reach Northern Colombia. Between the Central and Eastern cordillera, the valley contains the Magdalena river (not shown). It flows N and travels ~ 1,500 km before entering the Caribbean sea at Barranquilla. After a digital elevation map prepared by the USGS; courtesy of the International Charter "Space and Major Disasters."

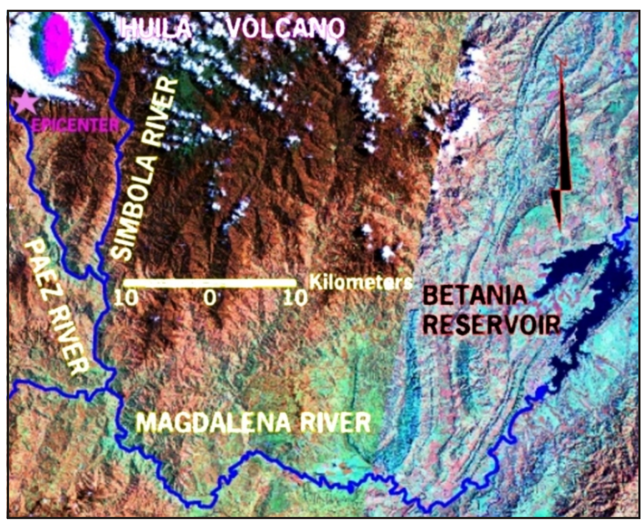

Figure 3. A false-color Landsat TM5 mosaic image showing the Magdalena river and some of its headwaters (eg. the Paéz and Símbola rivers) that feed from Nevado del Huila (upper left corner). Images are Landsat-5, 30-m resolution. Left image acquired 7 August 1989. Right image acquired 2 January 1988. The annotations include the epicenter for the Paéz earthquake (star) and the Betania Reservoir. On the colored version, snow is shown by the elongate magenta region around Huila. Created March 2007 by INGEOMINAS; courtesy of the International Charter "Space and Major Disasters."

Beyond the reservoir, the Magdalena flows NNE; it ultimately reaches the Carribean Sea at a large delta in N Colombia by the large city of Barranquilla (figure 2). According to Restrepo and Kjerfve (2000), "the Magdalena is the largest river discharging directly into the Caribbean sea [228 km^3 water annually], and it has the highest sediment yield of any medium-sized or large river along the entire E coast of South America."

Unrest and 19 February eruption. Since 1994 the volcano has been monitored by multiple telemetered seismometers with data sent to the city of Popayán (~ 100 km SSW). Mumucué (2007) pointed out that people living around the volcano saw the appearance of fumaroles in October 2006.

From 22 November 2006, INGEOMINAS assigned an elevated hazard of Level II ('Eruption probable in the coming days or weeks'). Some fracture-related earthquakes took place at depths of 2 km below the summit. Some of these earthquakes reached M_R 1.6-1.9.

A 13 February flight mainly found steam escaping both secondary craters and fumarole fields on the main crater's margin. The previous day, observers W of the volcano in Consacá saw steam emissions outside the crater.

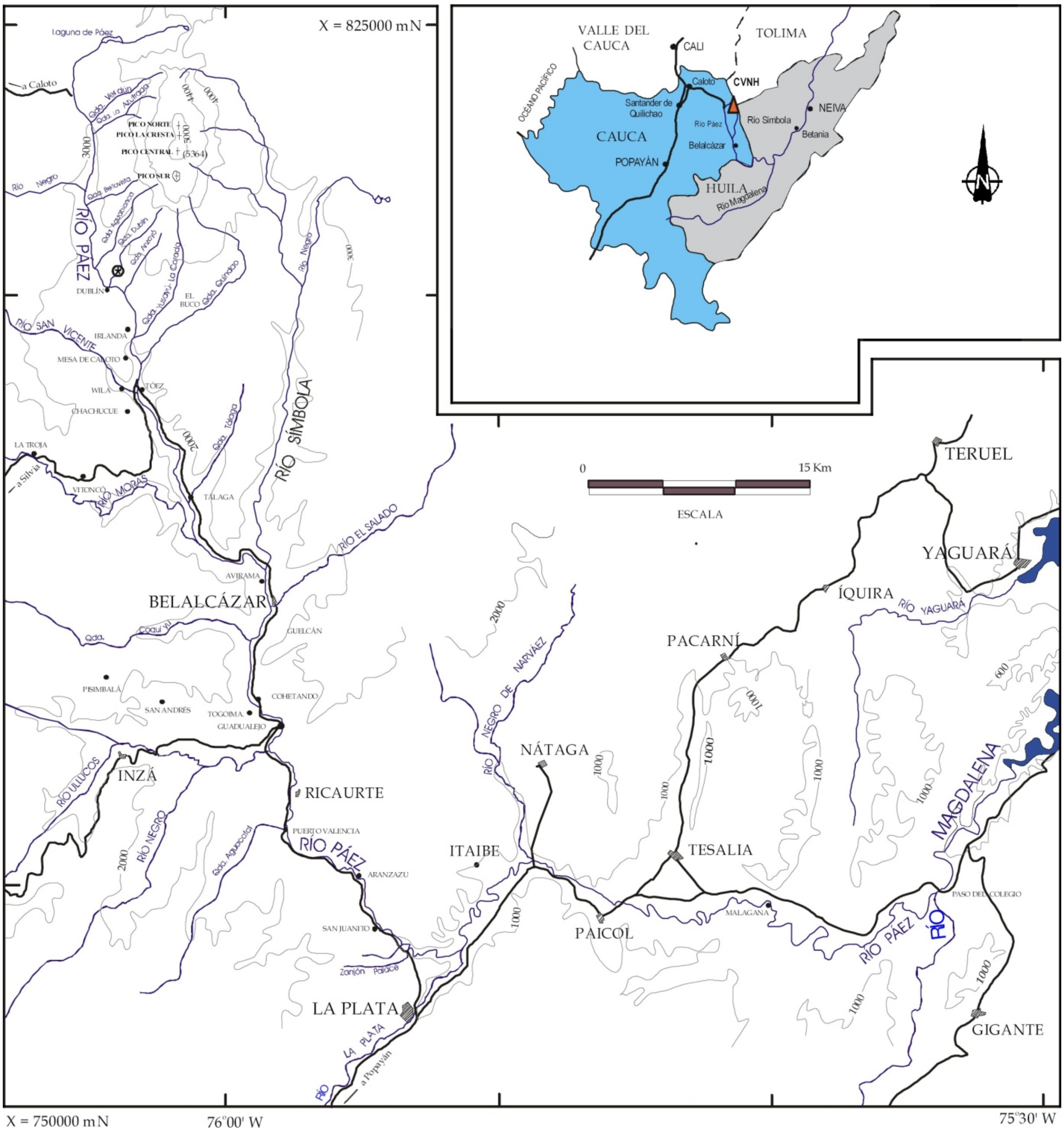

Figure 4. Map indicating the topography and naming conventions on the Huila edifice and some surrounding regions. The inset shows the volcano's location at the triangle labeled CVNH. Note epicenter for the Paéz earthquake. This was modified from a larger map in Correa and Pulgarín (2002a).

A seismometer recorded an earthquake swarm during 1030-1259 on 18 February. The seismometer, located 2 km S of Pico Central (at station 'Cerro Negro') measured 108 earthquakes interpreted as rock fracture events in the upper part of the volcano. An M 3 earthquake followed, and at 0137 on 19 February a new swarm of 53 earthquakes occurred. In this swarm fracture earthquakes were accompanied by those of longer period; the amplitude and number of events increased into the next morning.

Seismic records also contained some long-period earthquakes called *tornillos* (events with long, gradually decreasing codas or tails, so that their seismic trace resembles the tapering profile of a wood screw; tornillo is Spanish for screw). During March 2006-February 2007, instruments had recorded 105 tornillos (an average of 9 per month). In contrast, during 1-19 February 2007, instruments recorded 20 tornillos, more than double the number usually seen during a full month.

INGEOMINAS reported two earthquakes on 19 February 2007, at 0830 and 0853, with probable explosive character. Aviation authorities reported ash-bearing columns over the edifice reaching ~ 0.6-0.7 km above the summit.

A later INGEOMINAS summary of events stated that the eruption began at 0856 on 19 February, manifested as a ~ 1.5 km tall eruption column blowing mainly W. Ashfall was noted by inhabitants of Toribio, Silvia, and Páez (in the Department of Cauca). Small mudflows came down the Bellavista and Azufrada rivers feeding into the Paéz river, but airborne observers found significant fresh deposits at higher elevations. Authorities advised inhabitants to move to higher ground. Inhabitants noticed the rise of the Paéz river at 1150 on 19 February.

A 20 February flight detected significant fresh ash, abundant crevasses in the ice, and a steaming fissure near the summit (figure 5). The fissure extended ~ 2 km between Pico Central and Pico la Cresta to the N. Observers noted that the fissure continually emitted gases along its entire length. The flight was a collaboration between INGEOMINAS and IGEFA (Inspección General de la Fuerza Aérea).

A VAAC report noted an eruption at about 1400 UTC on the 19th to approximately FL 200 (~ 6.1 km altitude) moving W and dissipating quickly. No ash was seen in satellite imagery the next day at either 0045 or 1100 UTC, however, around this latter time, a pilot observed an ash cloud. In addition, a local aircraft reported ash to ~ 6.1 km at 0500 UTC on the 21st.

During 30 March-16 April 2007 INGEOMINAS observers reported the initiation of noteworthy seismicity indicating rock fractures and movement of fluids. The fracture events were located at depths of 4-8 km E and SW from the central peak and at magnitudes of less than 1.0. Low gas columns were again seen on 11 April, moving W.

Seismicity further increased on 17 April, leading up to an eruption on the 18th. Early on 18 April, a cluster of 25 rock-fracture earthquakes occurred, M 0.5 to 1.5. These were located at a depth less than 2 km. Seismicity again increased later that morning.

April 2007 eruption. A brief summary of the 18 April eruption appeared on the website hosted by the International Charter "Space and Major Disasters" on 20 April). It stated, "The Nevado del Huila volcano erupted at 02:57 local time 18 April, causing avalanches and floods [lahars] which affected the villages of La Plata, Paicol, Tesalia, Natagá, [and] Belalcázar. About 5,000 people were evacuated." (That same website hosted more than 10 (Landsat, Radarsat, and Envisat) images shedding light on this remote volcano's behavior, hazards, and impacts).

According to an 18 April 2007 report from the Washington Volcanic Ash Advisory Center (VAAC), a pilot in Colombia saw an ash cloud. Two ash plumes were evident on GOES-10 (split window) satellite imagery for an eruption starting at 0815 UTC on 18 April. They rose to poorly constrained altitudes of ~ 9 and 11 km and drifted E at 9 km/hour. The lower ash cloud was ~ 37 km across and moved SW at 9-18 km/hour. The higher ash cloud was ~ 19 km across and moved E at 0-9 km/hour. These clouds had dissipated by 1034 UTC.

The 18 April eruption sent an a torrent of brown water and rocks down the volcano's sides and into the Paéz and Símbola rivers (figures 6 and 7), causing them to flood, destroying several kilometers of highway and endangering or sweeping away what some government reports stated were 15 bridges (although it is uncertain how many of those were footbridges, and new reports tended to indicate a slightly higher numbers). In an evaluation the lahars of 18 April, INGEOMINAS staff found them quite similar, though smaller, than those of the earthquake and disaster of 1994.

Videos. At least three videos taken chiefly from Colombian military or national guard helicopters were posted on the web during April-May 2007 (see Videos, under References). They featured either the volcano or the powerful lahars or both, as follows.

Video 1("Avalancha . . ."; posted 18 April 2007) contains lahar footage from a television newscast, much of it taken from a helicopter. The shots include several bridges destroyed or impacted by lahars and the dialog mentioned nineteen bridges affected. Segments also show closeups of sediments and considerable flooding. Few if any flooded or damaged buildings were shown. Footage shows segments of the river with various gradients; the dark water carrying considerable debris. In one scene of a threatened bridge taken from shore, the turbulent river races by and among the passing logs seemingly floats a large farm animal.

Video 2 ("Sobrevuelo . . ." [Overflight . . .]) was taken by INGEOMINAS on 3 March 2007. It shows the volcano in modest eruption. A dense, dark plume emerges from the complex ice-bound summit area. Somewhat surprisingly, the plume immediately descends one flank of the volcano.

Video 3 (Erupcion . . . 18 Abril) shows vigorous white plumes escaping from multiple vents and forming a dense white plume. The text says that the footage was taken hours after the eruption on 18 April 2007. The base of the volcano is shrouded in weather clouds. The footage credits "Ejercito Nacional-INGEOMINAS-FAC."

Further observations and assessments. Seismicity escalated during 19-20 April but decreased on the 21st. Two larger earthquakes soon took place, on the 22nd and 27th. Their respective seismic signals appeared to come from rock fracturing at shallow depths; they had epicenters at Pico Central, and they were M 3.0 and M 3.2. On 23 April instruments detected continuous low-frequency tremor, interpreted as continuing instability and possible eruptions.

On 22 April, the Colombian Air Force flew INGEOMINAS staff past the volcano. They observed the N-trending fissure seen in February and found it had extended to reach a length of 2.3 km and a width of ~ 200 m. It emitted a white, sulfurous smelling gas column to 5 km altitude. The 22 April observers also saw a second new fissure ~ 2 km long across the same region. Strong fumaroles also discharged. Some lahars remained active down both E and W flank drainages.

Associated with the eruptions and as recent as 28 April 2007, there had been a total of 5,708 seismic events. Of those, 2,861 had signals suggesting rock fracture and 2,847 had signals suggesting movement of fluids.

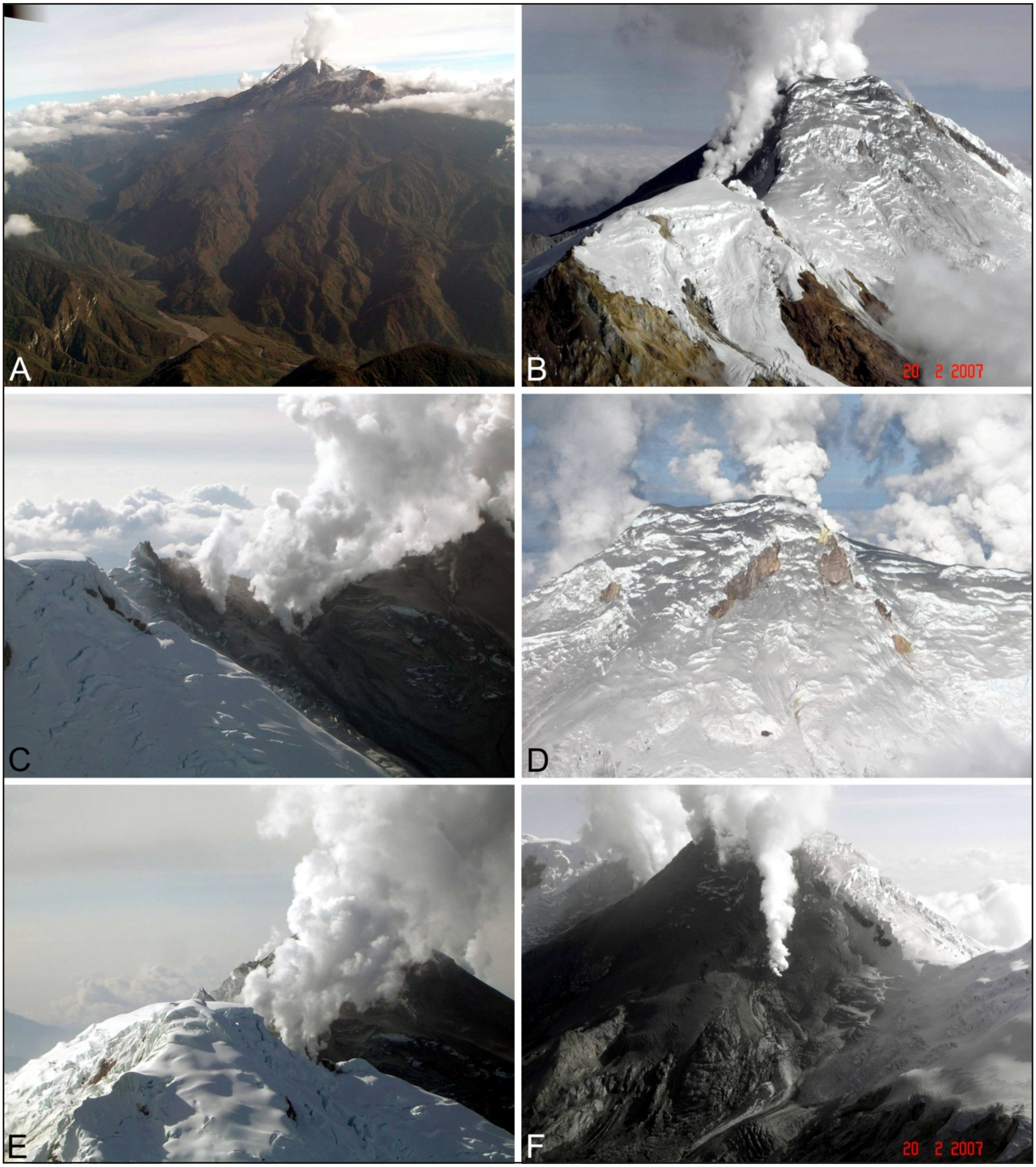

Figure 5. (a-f) Six aerial photos of Nevado del Huila taken from multiple angles and distances on 20 February 2007. A) A view with the Paéz river basin in the foreground and with Nevado del Huila steaming in the background. B) A close up of the SE flank looking NW, showing dark snow on the W side of the volcano and a thinner coating on the E side. C) Contrasting ash-free and thickly ash-covered ice at the N-central side of the summit (Pico Central to the right), with the elongate fissure emitting steam near the ridgeline. D) Pico Central seen at comparatively close range from the E side of the mountain, where a thin coating of ash is apparent over many of the upper slopes. E) A view looking S across Pico la Cresta slightly off the trend of the ridge axis, highlighting steam emissions from the fissure, areas of ash-covered snow, and abundant fresh crevasses in the upslope ice. F) A photo looking NW at the gray ash deposits on glacial ice of Pico Central and again illustrating venting steam. Courtesy of the Colombian Air Force and INGEOMINAS.

During late April and early May 2007 the seismicity generally decreased (except for a 6 May, M 3.2 earthquake). On 5 May, INGEOMINAS staff, using a land-based correlation spectrometer, measured an SO_2 flux from the volcano at 3,000 tons per day.

Early on 14 May, INGEOMINAS recorded a cluster of 54 low magnitude earthquake events, possibly triggering or associated with an ash emission. Based on satellite imagery of 14 May, the Washington VAAC reported an ash plume 8 km wide in an area 45 km W; it drifted SW and dissipated.

Based on seismic interpretation, INGEOMINAS inferred ash emissions during 27 May. Aerial observations later that day confirmed the emissions. Tremor recorded on 28 May possibly indicated another pulse of ash emissions. The SO_2 flux measured on 1 June continued at 3,000 metric tons per day and on 2 June increased to ~ 6,900 metric tons per day. Flights on 3, 6, and 10 June indicated no changes in the existing fissures nor changes in the fumarolic field. Seismicity was relatively quiet during June 2007.

Humanitarian concerns. Luz Amanda Pulido, director of the national disaster office said that there were no reports of deaths or injuries. According to a 22 May report of the UN Office for the Coordination of Human Affairs (OHCA), by 26 April authorities resolved to evacuate 2,307 families affected by the crisis.

A government document issued May 2007 discussed the displaced residents. According to that report (Mumucué, 2007) the number of indigenous inhabitants living around the volcano and affected by lahars or emissions or both totaled 26,949 people. The affected territory he discussed (the Municipio de Páez, which has Belacazar as the main urban center) had an area of ~ 161,000 hectares. The inhabitants losses included cultivated areas and farm animals, including horses and smaller livestock. Photos showed displaced families living in temporary camps with outdoor cooking facilities. Another photo showed workers installing a footbridge where a vehicle bridge was lost to the torrent. That photo, taken ~5 days after the 18 April lahars began showed that by this time the river had greatly receded. The report was also a plea for supplies, including children's clothing and two-way radios with solar panels. Total days of community work devoted to reconstruction after the disaster and as late as May 2007 amounted to 4,264 (Mumucué, 2007).

Figure 7. An aerial photo of part of the Huila lahar shot in sub-vertical orientation on 22 April 2007. Name and location of this settlement is uncertain. Lahars were apparently insufficiently thick to overrun established settlements. Courtesy of INGEOMINAS.

Figure 6. Photo from hillside overlooking the confluence of the Paéz and Símbola rivers, viewed upstream towards Nevado del Huila. One of the battered and partly lahar-covered bridges lies in the left-foreground. Photo was taken 25 April 2007 and came from Mumucué (2007).

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Video references: (1) “Avalancha del Volcan Nevado del Huila” [A newscast from a Colombian television station, www.youtube.com/watch?v=k6nW1DP5mqg

(2) INGEOMINAS, 3 March 2007, Sobrevuelo Ingeominas Nevado Huila pocos dias despues de la erupción” (posted 8 May 2007) [Overflight of summit area] http://www.youtube.com/watch?v=UPP0vzBzZ38 (00:39)

(3) INGEOMINAS, 2007, Erupcion Nevado del Huila Colombia 18 Abril; Video stamped with “Ejercito Nacional-INGEOMINAS-FAC”; http://www.youtube.com/watch?v=xUnYOALOCWg; (00:56) (Posted 8 May 2007)

Geologic Summary. Nevado del Huila, the highest active volcano in Colombia, is an elongated N-S-trending volcanic chain mantled by a glacier icecap. The 5,364-m-high andesitic-dacitic volcano was constructed within a 10-km-wide caldera. Volcanism at Nevado del Huila has produced six volcanic cones whose ages in general migrated from S to N. The high point of the complex is Pico Central. Two glacier-free lava domes lie at the southern end of the Huila volcanic complex. The first historical eruption from this little known volcano was an explosive eruption in the mid-16th century. Long-term, persistent steam columns had risen from Pico Central prior to the next eruption in 2007, when explosive activity was accompanied by damaging mudflows.

Information Contacts: *Instituto Colombiano de Geología y Minería (INGEOMINAS)*, *Observatorio Vulcanológico y Sismológico de Popayán*, Popayán, Colombia (Email: uop@emtel.net.co); *Washington Volcanic Ash Advisory Center (VAAC)*, Satellite Analysis Branch (SAB), NOAA/NESDIS E/SP23, NOAA Science Center Room 401, 5200 Auth road, Camp Springs, MD 20746, USA (URL:http://www.ssd.noaa.gov/VAAC); *Jorge Castilla Echenique*, Salud para desplazados, Programa de Emergencias y Desastres OPS/OMS, PWR Colombia, (URL: www.disaster-info.net/desplazados/informes/pah2/); *Jorge E. Victoria R.*, Salud en Desastres y Emergencias Complejas, Organización Panamericana De La Salud, Oficina de Neiva, Carrera 10 No. 4-72, Huila, Colombia; *International Charter–Space and Major Disasters* (URL: http://www.disasterscharter.org/).

Turrialba

Costa Rica
10.025°N, 83.767°W; summit elev. 3,340 m

Enhanced fumarolic activity accompanied by new fractures at the summit was noted during June-September 2007 (*BGVN* 32:08). The earlier report noted that the fumaroles had spread over a larger area and contained molten sulfur, a condensate previously not seen here in more than 25 years of continuous monitoring by the Observatorio Vulcanológico y Sismológico de Costa Rica-Universidad Nacional (OVSICORI-UNA). By mid-August 2007, acute chemical burning of important patches of natural forest had occurred. This report covers the period from October 2007 through January 2008.

During October, new sites of gas discharge, small landslides, and accelerated vegetation die-off were noted from various locations within and around the crater. Fumaroles were active and widespread across the central crater. Many exhibited sulfur deposits and those in the S, SE, and SW reached a temperature of 91°C.

Areas burned by acute acidification extended during November. Fieldwork conducted by OVSICORI-UNA confirmed an unusual output of gas from several fumaroles along the S outer wall of the volcano. Pastures turned yellowish near the upper areas, and native and exotic tree species were impacted as well as birch tree patches along most drainage basins.

During December, within the W crater, fumarole temperatures reached 280°C and significant sulfur deposits were noted. Local residents confirmed an unusual output of gas from several fumaroles along the S outer wall of the volcano. Areas burned by acute acidification extended during the month. On 5 December, members of the media and local communities observed a gas-and-steam plume from Turrialba that rose to an altitude greater than 5.3 km (figure 8).

On a team visit between 30 and 31 January 2008, OVSICORI staff documented the progression of fumarolic activity in the W crater, the external W crater walls, and distant areas towards the W, NW, and SW. Some of the fumaroles correspond with two fractures. One to the SW of the W crater, trending SW, was 100 m in length and 2 to 3 cm wide, and deposited sulfur. The second crack to the NW of the W crater, also trending SW , had temperatures of 72ºC and discharged steam and gas affecting the adjacent vegetation. To the NW of the W crater, the team studied an area of about 20 x 50 m with constant gas emission and a temperature of 88°C.

Figure 8. Column from Turrialba observed and photographed from Heredia City, located 40 km W of the volcano taken at 0540 on 5 December 2007. Courtesy OVSICORI-UNA.

Geologic Summary. Turrialba, the easternmost of Costa Rica's Holocene volcanoes, is a large vegetated basaltic-to-dacitic stratovolcano located across a broad saddle NE of Irazú volcano overlooking the city of Cartago. The massive 3,340-m-high Turrialba is exceeded in height only by Irazú, covers an area of 500 sq km, and is one of Costa Rica's most voluminous volcanoes. Three well-defined craters occur at the upper SW end of a broad 800 x 2200 m wide summit depression that is breached to the NE. Most activity at Turrialba originated from the summit vent complex, but two pyroclastic cones are located on the SW flank. Five major explosive eruptions have occurred at Turrialba during the past 3,500 years. Turrialba has been quiescent since a series of explosive eruptions during the 19th century that were sometimes accompanied by pyroclastic flows. Fumarolic activity continues at the central and SW summit craters.

Information Contacts: *Eliécer Duarte, Erick Fernández*, and *Vilma Barboza*, Observatorio Vulcanológico y Sismológico de Costa Rica, Universidad Nacional (OVSICORI-UNA), Apdo. 2346-3000, Heredia, Costa Rica (URL: http://www.ovsicori.una.ac.cr); *Tellez and Francois Robichaud*, Université de Sherbrooke, 2500 boul. de l'Université, Sherbrooke, Québec J1K 2R1, Canada.

Ubinas

Perú
16.355°S, 70.903°W; summit elev. 5,672 m
All times are local (= UTC - 5 hours)

Ubinas began erupting ash on 25 March 2006 (BGVN 31:03 and 31:05). As reported in BGVN 31:10, ash eruptions and steam emissions continued through 31 October 2006. This report discusses ongoing eruptions through December 2007 as drawn from Buenos Aires Volcanic Ash Advisory Center (VAAC) reports and the Instituto Geológical Minero y Metalúrgico (INGEMMET).

From November 2006 through December 2007, emissions of volcanic ash, rocks, and gases with water and steam were essentially continuous. INGEMMET authorities indicated that during March 2007 the volcano generated increased ashfall behavior that significantly affected people and the environment. At the beginning of the month, small explosions occurred every 6-8 days but the rate of activity increased toward the end. On 30 March 2007, nearby residents felt a strong explosion. A large ash plume vented from the volcano's summit and local communities were blanketed beneath falling ash. According to INGEMMET authorities, most of Querapi, a town ~ 4.5 km SE of the crater's active vent, was covered in volcanic ash, and the town of Anascapa, 6 km E, also experienced ashfall.

Volcanic ash clouds blown into the atmosphere also presented a hazard to aviation. As summarized in table 1, ash clouds were nearly continuously reported by the Buenos Aires VAAC and the INGEMMET. Plume heights reached as high as 9.1 km in May and again in November 2007. The aviation warning color code was generally Red through the period. The reports were based on satellite imagery and pilot reports. No thermal alerts were noted from the University of Hawaii's Institute of Geophysics and Planetology (HIGP) MODIS satellite-based thermal alert system during 2006 or 2007.

Geologic Summary. A small, 1.4-km-wide caldera cuts the top of Ubinas, Peru's most active volcano, giving it a truncated appearance. Ubinas is the northernmost of three young volcanoes located along a regional structural lineament about 50 km behind the main volcanic front of Perú. The growth and destruction of Ubinas I volcano was followed by construction of Ubinas II volcano beginning in the mid-Pleistocene. The upper slopes of the andesitic-to-rhyolitic Ubinas II stratovolcano are composed primarily of andesitic and trachyandesitic lava flows and steepen to nearly 45 degrees. The steep-walled, 150-m-deep summit caldera contains an ash cone with a 500-m-wide funnel-shaped vent that is 200 m deep. Debris-avalanche deposits from the collapse of the SE flank of Ubinas about 3700 years ago extend 10 km from the volcano. Widespread plinian pumice-fall deposits from Ubinas include one of Holocene age about 1000 years ago. Holocene lava flows are visible on the volcano's flanks, but historical activity, documented since the 16th century, has consisted of intermittent minor-to-moderate explosive eruptions.

Information Contacts: *Instituto Geológical Minero y Metalúrgico (INGEMMET)*, Av. Canadá 1470, San Borja, Lima 41, Perú (URL: http://www.ingemmet.gob.pe/); *Buenos Aires Volcanic Ash Advisory Center (VAAC)*, Argentina (URL: http://www.ssd.noaa.gov/VAAC/OTH/AG/messages.html).

Llaima

Central Chile
38.692°S, 71.729°W; summit elev. 3,125 m
All times are local (= UTC - 4 hours)

From January 2002 through April 2003 (*BGVN* 29:02) there were increases in seismicity and fumarolic activity, along with minor eruptions, pronounced glacial melting, and substantial ash and gas plumes. Renewed activity consisting of minor eruptions was reported in May and possibly August 2007, but a larger eruption began on 1 January 2008. The source for most of the following is the Observatorio Volcanológico de los Andes del Sur (OVDAS)-SERNAGEOMIN (Volcano Observatory of the Southern Andes-Chile National Service of Geology and Mining).

On 26 May 2007, the Buenos Aires Volcanic Ash Advisory Center (VAAC) reported that ash plumes from Llaima rose to altitudes of 3-4.3 km and were visible on satellite imagery drifting E. A pilot reported another ash plume on 28 May that rose to an altitude of 5.5-6.7 km and drifted E. On 29 May, an ash plume rose to an altitude of 3 km and drifted E. No further activity was reported until 8 August, when pilots observed a plume to an altitude of 5.2 km drifting E. Ash was not identified on satellite imagery for this date.

Eruption during January 2008. Based on pilot reports and observations of satellite imagery, the Buenos Aires VAAC reported that on 1 January 2008 an ash plume rose to an altitude of 12.5 km and drifted E and ESE. The eruption began at 1820 hours, according to the Chile National

Emergency Office. Lava was reported to be visible on the E flank and fumaroles at the summit were noted. The strong explosive activity prompted authorities to raise the Alert level to Yellow. According to news media reports, around 700 people were evacuated from local communities following the initial eruption, including about 200 tourists and National Forest Service employees from the Conguillo National Park. Most of the residents returned the following day when activity declined.

SERNAGEOMIN reported that tremor coincided with the onset of the gas and pyroclastic emissions on 1 January. Lava and incandescent material initially emitted were confined to the crater, but within a few hours, a Strombolian phase began. Soon, brightly glowing material covered much of the previously ice-covered summit (figure 9). Around the time of the eruption, an increase in volume of the Captrén river on the N flank was observed; this was likely a response to the glacial melting.

On the following day, observers on an overflight saw small emissions of ash and gas (mainly steam) and three small lahars on the N and W flanks. Tremor decreased, though explosions continued. Based on pilot reports and satellite imagery, the Buenos Aires VAAC reported that an ash plume rose to an altitude of 12.5 km and drifted E (figure 10). A later overflight revealed that the explosion on 2 January occurred at an area high on the E flank, outside the summit crater. A lava flow on the E flank was also noted. On 3 January an ash plume was visible on satellite imagery at an altitude of 3.7 km drifting NE. Airborne observers noted small sporadic gas-and-ash emissions.

In addition to ash, Llaima's eruption released considerable sulfur dioxide (SO_2), identified by satellite instruments in the days following the 1 January eruption (figure 11). The initially intense SO_2 plume dispersed as it moved E. On 4 January, the plume passed over Tristan da Cunha, a remote archipelago in the South Atlantic Ocean (figure 11). According to Charles Holliday, Simon Carn, and Michon Scott, the SO_2 dissipated after 6 January 2008.

Between 1835 and 1915 on 6 January 2008 a helicopter overflight was conducted, coordinated by Jaime Pinto, Director of the Araucania Region Emergency Office (OREMI). Observers noted that main crater vent was clogged with lava (figure 12), which, after the eruption, dropped a few dozen meters inside the crater. During the eruption, lava diverged into two areas in the main crater, draining flows to the W and NE and melting the ice. The melted ice produced three lahars toward the W flank, which merged into one that entered the Calbuco River. To the NE, the melted ice generated a single channel lahar that flowed into the Captrén River, cutting the road in several locations. A small lahar also traveled to the E. The dispersion of ash and gases was mainly to the E, although initially they went ESE. There were abundant cracks seen in the glaciers in the SW and SE of the main crater, particularly in the SE.

SERNAGEOMIN reported that during 10-14 January 2008 seismicity decreased in terms of energy, but increased in the number of events. Based on seismic interpretation, weak explosions produced plumes of gas and ash that drifted NE. On 11 January, the upper surface of lava flows on the W flank that were observed during an overflight were cooled and snow-covered near the crater, but snow-free, and therefore still hot, about 500 m farther downslope. Blocks of incandescent material rolled ~ 1.5 km downslope and caused steam emissions where they contacted the glacier. Abundant cracks in glaciers to the SW of the crater were noted. Based on observations of satellite imagery and pilot reports, the Buenos Aires VAAC reported that ash plumes rose to an altitude of 5.5-6.7 km and

Date	Altitude of Plume (km)	Flight Level (thousands of feet)	Direction of Plume
3-16 Nov 2006	5.5-7.3	190-260	SW, S, SW
25 Nov 2006	5.5	180	NE
2 Dec 2006	5.5	180	N
27-30 Dec 2006	4.9-8.5	160-280	E
28 Jan 2007	5.5-6.9	180-220	SE
2-5 Feb 2007	5.5	180	S, SW
18-21 Feb 2007	5.5-7.0	180-230	E, SW
11, 14 Mar 2007	5.5-6.4	180-210	N, SW
30 Mar 2007	5.5	180	E
5, 7-9, 10-11 Apr 2007	5.5-7.8	180-270	E, SE, S, SW, W
17-18, 22, 24 Apr 2007	5.5-7.2	180-280	NW, SW, SE
2-5 May 2007	5.5-9.1	180/300	N, S, SE, SW
12, 15-16 May 2007	5.5-8.2	180-270	SE, N, SW
17, 19-22 May 2007	5.5-9.1	180-300	E, SE
22-28 May 2007	5.5-7.3	180-240	NE, SE
30 May - 6 Jun 2007	3.7-7.6	120-250	NE, SE
12-17 Jun 2007	5.5-6.7	180-230	NE, E, SW, W
27-28 Jun 2007	5.5-6.7	180-230	SW, NW, E
4 Jul 2007	5.5-6.1	180-200	S
23-25 Jul 2007	5.9-6.1	190-200	SE, S
9 Aug 2007	6.1	200	SE
11-14 Sep 2007	5.5-7.6	180-250	E, SE
20 Sep 2007	5.5-6.4	180-210	E
5-7 Oct 2007	5.5-6.4	180-210	N, S
11-13, 15 Oct 2007	5.5-7.6	180-250	N, SE
19-27 Oct 2007	5.5-8.5	180-280	NW, NE
1, 3-6 Nov 2007	5.5-7.6	180-250	NE, SE
11-12 Nov 2007	5.5-6.7	180-220	NE
16, 18, 20 Nov 2007	5.5-7.9	180-260	NE
24-27 Nov 2007	6.1-9.1	200-300	SE, E, SW
28-29 Nov 2007	6.7-7.6	220-250	SW, NE
4-7, 10 Dec 2007	5.5-8.5	180-280	NE
17 Dec 2007	5.5-6.7	180-220	N

Table 1. Compilation of Volcanic Ash Advisories for aviation from Ubinas during November 2006 through December 2007. Courtesy of the Buenos Aires Volcanic Ash Advisory Center (VAAC) and the Instituto Geológical Minero y Metalúrgico (INGEMMET).

Figure 9. Llaima as seen in eruption on 1 January 2008. Photo taken from W of the volcano between Temuco and Vilcun, Chile. Photo by Antonio Vergara via the flikr website (Creative Commons license).

drifted NE on 11 January and SW on 13 January.

Eruptive activity continued during the second half of January from the main crater and from two craters and a fissure on the E flank. The main crater contained three active pyroclastic cones. On 16 January one of the craters, ~ 15 m in diameter, produced ash plumes that rose to an altitude of ~ 3.6 km. Glaciers on the NE slope and W flank were fractured and dislocated. Ash plumes rising from the E flank attained an altitude of 4.1 km. Ash emissions vented from a NE-trending fissure ~ 80 m long and ~ 10 m wide. On 16-17 January glowing rocks were emitted from the fissure's NE end; ash plumes caused by rolling rocks rose from multiple areas.

At 0732 on 18 January, an explosion from the E flank sent an ash plume to an altitude of 9.1 km that quickly dispersed NE. People later saw a small lateral explosion from the same area, ash-and-gas emissions from several points, and a new fissure.

On 19 January, an explosion produced an ash plume that rose to an altitude of 4.1 km. An overflight revealed Strombolian activity in the main crater from a new pyroclastic cone that was 120 m in diameter and 100 m high; the cone was absent during a 17 January overflight. A second crater to the SW emitted gas. Sporadic ash emissions were noted from the E sector and an explosion produced a pyroclastic flow and an ash plume that quickly dissipated. On 20 January, another explosion produced an ash plume that rose to an altitude of 4.1 km. Gas and ash emissions were again noted from multiple areas. On 21 January, cloud cover prevented visual observations, but one small ash emission was seen at the end of the day.

On 23 January, a brown ash plume rose to an altitude of 3.5 km and drifted W. Observers on an overflight later that day saw Strombolian eruptions from the pyroclastic cone in the main crater accompanied by emissions of brown ash. A small hornito emitting bluish gas and a lava field were noted between the pyroclastic cone and the inner margins of the crater. Explosions from the E flank were detected on 24 January, and on 26 January steam plumes were observed. Strombolian eruptions in the main crater accompanied by gas and ash emissions continued during through 27 January. Ash plumes rose to altitudes of 3.3-4.1 km and drifted NW, E, SE, and S.

MODIS thermal anomalies. Numerous MODIS thermal anomalies were measured almost daily throughout the month of January 2008 (table 2). As shown by the number of pixels for various observing time, the anomalies covered a particularly large area on 2 January (24 pixels). In con-

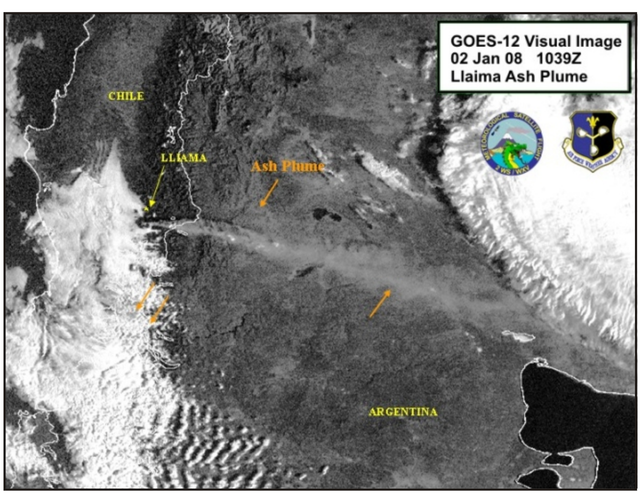

Figure 10. A GOES-12 visual image of Llaima plume, captured at 1039 UTC on 2 January 2008. North is toward the top of the image, and the plume blew to the ESE. Courtesy of Charles Holliday, U.S. Air Force Weather Agency.

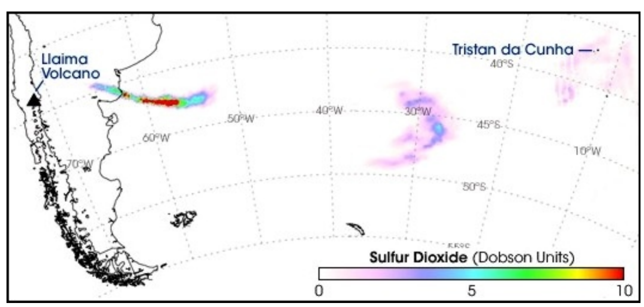

Figure 11. An image acquired by the Ozone Monitoring Instrument (OMI) on NASA's Aura satellite showing the progress of the SO_2 plume from Llaima during 2-4 January 2008. The island of Tristan de Cunha is shown along in the southern Atlantic Ocean. (In the colored version of this image, red indicates the greatest concentration-pathlength of SO_2 and lavender-pink indicates the lowest concentration-pathlength.) OMI measures the total atmospheric column amount of SO_2 in Dobson Units (a common unit used in atmospheric research). NASA image courtesy Simon Carn; text modified from that by Simon Carn and Michon Scott.

trast, anomalies were absent during the previous intervals of 1 January 2002 through 26 April 2007, and 16 June 2007 through 1 January 2008.

Date	Time (UTC)	Pixels	Satellite
27 Apr 2007	1910	3	Aqua
14 Jun 2007	1455	5	Terra
15 Jun 2007	0515	1	Aqua
2 Jan 2008	0250	2	Terra
	0430	9	Terra
	0605	24	Aqua
	1355	2	Terra
	1535	3	Terra
	1810	2	Aqua
3 Jan 2008	0335	4	Terra
	0510	2	Aqua
	1440	1	Terra
	1850	1	Aqua
4 Jan 2008	0555	3	Aqua
5 Jan 2008	0320	1	Terra
6 Jan 2008	0545	1	Aqua
11 Jan 2008	0425	1	Terra
	0600	2	Aqua
12 Jan 2008	0330	1	Terra
14 Jan 2008	0630	1	Aqua
15 Jan 2008	0400	1	Terra
	0535	1	Aqua
16 Jan 2008	0620	2	Aqua
17 Jan 2008	0345	1	Terra
	0525	3	Aqua
	1450	2	Terra
18 Jan 2008	0605	1	Aqua
20 Jan 2008	0555	1	Aqua
22 Jan 2008	0405	1	Terra
	0545	2	Aqua
23 Jan 2008	0625	1	Aqua
24 Jan 2008	0530	3	Aqua
	1455	1	Terra
25 Jan 2008	0255	3	Terra
	0615	4	Aqua
26 Jan 2008	0340	2	Terra
	0520	2	Aqua
	1445	1	Aqua
27 Jan 2008	0425	2	Terra
	0600	2	Aqua
	1525	1	Terra
28 Jan 2008	0330	4	Terra
	0505	4	Aqua
	1845	1	Aqua
29 Jan 2008	0410	4	Terra
	0550	2	Aqua
30 Jan 2008	0315	2	Terra
	0630	4	Aqua
	1420	5	Terra
31 Jan 2008	0400	6	Terra
	0535	3	Aqua
	1915	3	Aqua

Table 2. Thermal anomalies measured by MODIS/MODVOLC over Llaima from 27 April 2007 through 30 January 2008. No anomalies were detected from 2002 through 26 April 2007, or 16 June 2007 through 1 January 2008. Courtesy of HIGP Thermal Anomalies Team.

Geologic Summary. Llaima, one of Chile's largest and most active volcanoes, contains two historically active craters, one at the summit and the other, Pichillaima, to the SE. The massive 3,125-m-high, dominantly basaltic-to-andesitic stratovolcano has a volume of 400 km^3. A Holocene edifice built primarily of accumulated lava flows was constructed over an 8-km-wide caldera that formed about 13,200 years ago, following the eruption of the 24 km^3 Curacautín Ignimbrite. More than 40 scoria cones dot the volcano's flanks. Following the end of an explosive stage about 7,200 years ago, construction of the present edifice began, characterized by Strombolian, Hawaiian, and infrequent subplinian eruptions. Frequent moderate explosive eruptions with occasional lava flows have been recorded since the 17th century.

Information Contacts: *Servico Nacional de Geologia y Mineria (SERNAGEOMIN)*, Avda Sta María Nº 0104, Santiago, Chile (Email: oirs@sernageomin.cl; URL: http://www2.sernageomin.cl/ovdas/); *Buenos Aires Volcanic Ash Advisory Center (VAAC)*, Servicio Meteorológico Nacional-Fuerza Aérea Argentina, 25 de mayo 658, Buenos Aires, Argentina (URL: http://www.meteofa.mil.ar/vaac/vaac.htm); *Simon Carn*, Joint Center for Earth Systems Technology (JCET), University of Maryland Baltimore County (UMBC); *Charles Holliday*, U.S. Air Force Weather Agency (AFWA)/XOGM, Offutt Air Force Base, NE 68113, USA (Email: hollidac@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/); *Associated Press* (URL: http://www.ap.org/); *United Nations Office for the Coordination of Humanitarian Affairs (OCHA)* (URL: http://www.reliefweb.int/); *Antonio Vergara*, Temuco, Chile (URL: http://www.flickr.com/people/odiofotolog/).

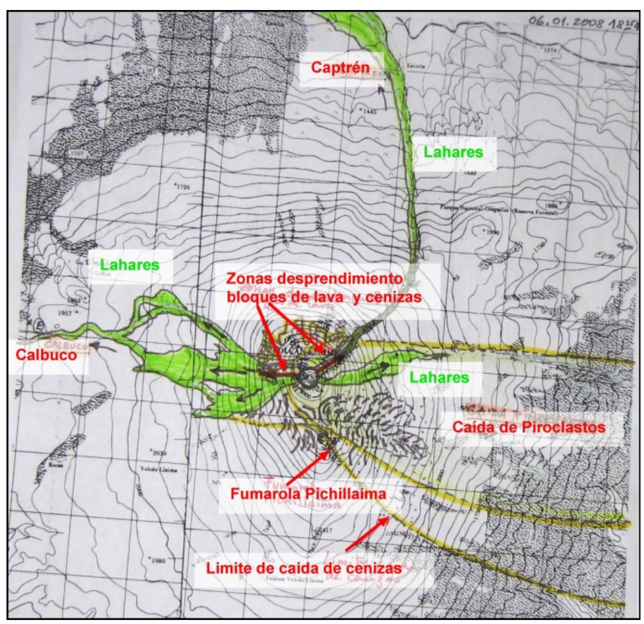

Figure 12. Topographic map showing Llaima and features observed during a helicopter overflight on 6 January 2008. The features include lahars (shaded in green), the Calbuco and Captren rivers, detached areas of lava blocks and ashes, fallen pyroclastics, fumaroles, and limit of falling ash (highlighted dashed lines). Courtesy of SERNAGEOMIN.

Krakatau

Indonesia
6.102°S, 105.423°E; summit elev. 813 m
All times are local (= UTC + 7 hours)

During 23-26 October 2007, minor eruptions occurred at Anak Krakatau (*BGVN* 32:09), an island and active vent on the rim of the famous larger caldera whose name often is misspelled as "Krakatoa." This report continues coverage from late October through November 2007. The Center of Volcanology and Geological Hazard Mitigation (CVGHM) raised the Alert Level to 3 (on a scale of 1-4) for Krakatau on 26 October because of the presence of multiple gray plumes from the volcano and an increase in seismicity. Plumes rose to an altitude of ~ 1 km during 23-26 and 30 October. Villagers and tourists were advised not go within 3 km of the summit.

According to an Associated Press news article, "red-hot lava flares" from Anak Krakatau rose 500-700 m above the S crater on 6 November. Multiple ash clouds were also observed. On 9 November, CVGHM officials in Bandung, West Java, conducted seismic and visual monitoring.

Officials said, that on that day there were 182 eruptions coupled with 11 volcanic earthquakes, 54 shallow volcanic shocks, eight deep volcanic tremors and 44 shallower tremors. The volcano spewed "smoke" 29 times. On 13-14 November, as reported by CVGHM, lava flows and incandescent rocks traveled 400 m down the flanks.

As reported by *VolcanoDiscovery*'s Tom Pfeiffer, who visited there from 21-26 November, emissions were relatively constant. He noted that all activity occurred from the newly formed crater on the upper S flank just below the old summit crater (figure 13). On 21 November, the new crater had an oval shape, approximately 50 x 70 m. Dense, dark brown, billowing ash clouds escaped in pulses from the crater at near-constant intervals of about 2 minutes, rising typically 100-200 m above the crater and drifting E. A few blocks were ejected along with the ash clouds (figure 14).

Pfeiffer also reported that at more irregular intervals, about 10-30 min apart, more violent, small vulcanian explosions interrupted the weaker ash venting events. The more violent explosions consisted of a sudden spray of mostly solid rocks and few incandescent scoria, followed by more powerful and turbulent ash plumes that rose up to 1 km above the crater (figure 15). Generally, these vulcanian explosions occurred after a slightly longer quiet period and, in most cases, the length of the quiet period correlated with the force of the explosion.

Pfeiffer noted that several more powerful explosions occurred at intervals of approximately 16-24 hours. The strongest, on 21-22 November, showered the whole island with incandescent blocks, ignited bush fires, and produced a very loud cannon-shot noise that rattled windows on the W coast of Java, 40 km away (figure 16).

Other, unusually large blasts occurred at around 0200 on 21 November and at around 0900 and 1320 on 23 November (figure 17). Early on 23 November, activity became more ash-rich and the vigor of the individual events increased slightly over the next two days. The pace of single explosions stayed at near-constant intervals of about 2 minutes. During 24-25 November, ash plumes typically rose to over 1 km above the crater and were easily visible from the W coast of Java. Based on a pilot report, on 24 November, the Darwin Volcanic Ash Advisory Center noted that an ash plume rose to an altitude of 3 km and drifted NE.

Based on the University of Hawaii's Institute of Geophysics and Planetology (HIGP) Thermal Alerts System

Figure 13. A sudden explosion ejecting rocks and ash on the S flank of the old Anak Krakatau crater on 22 November, 2007. Courtesy Tom Pfeiffer of Volcano Discovery.

Figure 14. Ballistic blocks land all over the cone of Anak Krakatau where the impacts stir up dust on 22 November 2007. A few also flew as far as the sea. Courtesy Tom Pfeiffer of Volcano Discovery.

Figure 15. Eruption plume at Anak Krakatau rising to ~ 1 km on 23 November 2007. Courtesy Tom Pfeiffer of Volcano Discovery.

Figure 16. On the evening of 21 November 2007, a powerful blast throws bombs and blocks all over the old cone of Anak Krakatau. Courtesy Tom Pfeiffer of Volcano Discovery.

Figure 17. Another very powerful blast occurs at around 0300 on 24 November 2007. Incandescent blocks reach the lower western flanks of the island. Courtesy Tom Pfeiffer of Volcano Discovery.

MODVOLC analysis of MODIS (Moderate Resolution Imaging Spectroradiometer) satellite thermal anomaly data, occasional hot spots were identified by Terra or Aqua satellites. The thermal alerts occurred on twelve occasions between 27 October and 9 December 2007. Seven of these took place between 16 and 26 November 2007.

Geologic Summary. The renowned volcano Krakatau (frequently misstated as Krakatoa) lies in the Sunda Strait between Java and Sumatra. Collapse of the ancestral Krakatau edifice, perhaps in 416 AD, formed a 7-km-wide caldera. Remnants of this ancestral volcano are preserved in Verlaten and Lang Islands; subsequently Rakata, Danan and Perbuwatan volcanoes were formed, coalescing to create the pre-1883 Krakatau Island. Caldera collapse during the catastrophic 1883 eruption destroyed Danan and Perbuwatan volcanoes, and left only a remnant of Rakata volcano. This eruption, the 2nd largest in Indonesia during historical time, caused more than 36,000 fatalities, most as a result of devastating tsunamis that swept the adjacent coastlines of Sumatra and Java. Pyroclastic surges traveled 40 km across the Sunda Strait and reached the Sumatra coast. After a quiescence of less than a half century, the post-collapse cone of Anak Krakatau (Child of Krakatau) was constructed within the 1883 caldera at a point between the former cones of Danan and Perbuwatan. Anak Krakatau has been the site of frequent eruptions since 1927.

Information Contacts: *Center of Volcanology and Geological Hazard Mitigation (CVGHM)*, Saut Simatupang, 57, Bandung 40122, Indonesia (URL: http://portal.vsi.esdm.go.id/joomla/); *Darwin Volcanic Ash Advisory Center*, Bureau of Meteorology, Australia (URL: http://www.bom.gov.au/info/vac), *Tom Pfeiffer*, Volcano Discovery (URL: http://www.decadevolcano.net/, http://www.volcanodiscovery.com/volcano-tours/krakatau/photos.html); *Associated Press* (URL: http://www.ap.org/).

Etna

Italy
37.734°N, 15.004°E; summit elev. 3,330 m
All times are local (= UTC + 2 hours)

After the 10-hour-long episode of sustained lava fountaining from the Southeast Crater (SEC) on 4-5 September 2007 (*BGVN* 32:09), Etna remained quiescent for about three weeks. Ash emissions then resumed from the vent on the eastern flank of the SEC cone, which had been the main focus of activity since mid-August 2007. During October, ash emissions occurred intermittently, at times with minor incandescent ejections. This activity persisted until mid-November, after which there was a week-long pause until the early morning of 22 November. That day around 0500, weak Strombolian activity and ash emission started from the vent on the E flank of the SEC and continued with increasing strength for the following 36 hours.

A series of explosions occurred at the Bocca Nuova between 1658 and 1705 on 23 November, ejecting dark gray ash plumes, and producing strong seismic signals on nearby stations. During the following hours, Strombolian explosions occurred from the SEC vent, ejecting incandescent bombs to several tens of meters high.

After 2020, the vigor increased, with bursts of bombs rising to 100 m high, accompanied by a sharp rise in tremor amplitude. By 2130, a broad, pulsating lava fountain rose from the vent. Then, 15 min later, observers saw sustained fountaining up to 600 m high. The fountains discharged from what appeared to be two closely spaced sources within the depression, often making a V-shape.

Lava spilled over the vent's rim in at least three locations (figure 18), feeding three narrow branches of lava that ran E and coalesced, before spreading down the steep W slope of the Valle del Bove. A fourth lava flow started from an area ~ 150 m NE of the active vent, where fountain-fed spatter rapidly accumulated and ultimately began to flow. This flow joined the main lava flow toward the Valle del Bove at about 2,500 m elevation.

The November lava flowed mostly on top of, or immediately adjacent to, the lava emitted during the eruption of early September 2007 (figure 18). At the base of the Valle del Bove slope, the November eruption's lava fanned out to form several minor lobes, the longest of which advanced to 1,670 m elevation, 4.2 km from the vent (figure 19; Burton and Neri, 2007).

The explosive activity fed a dense tephra plume. It blew NE and caused ash and lapilli falls as far as 80 km away in southern Calabria, (Andronico and Cristaldi, 2007). At Piano Provenzana (~ 6.5 km NNE of the summit), the deposit was about 3 cm thick. Coarse scoriae, up to 5 cm across, fell ~ 10 km NNE from the SEC (in Linguaglossa) during the first hour of the eruption. During the following hours, finer ash fell in areas adjacent Etna and to the W.

Shortly after 0300 on 24 November, the eruptive activity and volcanic tremor amplitude began to diminish gradually, and during the next 20 min the fountain height dropped from ~ 600 m to under 200 m. Subsequently, the fountaining gave way to a series of powerful explosions, which showered the entire SEC cone with meter-sized bombs. The last of these explosions occurred at 0338, and for another 45 min after this, only minor explosive ejections occurred from the vent.

During the following hours, material continued to crumble and collapse on the steep slopes around the vent, exposing incandescent rock in countless spots. By 0600, the tremor amplitude had dropped to background levels, and no further eruptive activity was noted at the vent.

For several days after the eruption, gravitational instability of the new pyroclastic deposit, which had accumulated to thicknesses of several tens of meters, especially on the N side of the vent, caused occasional slides of material, exposing the still-incandescent interior of the deposit. A particularly large collapse from the overhanging W rim of the vent at 1713 on 27 November may have been accompanied by minor explosive activity, with incandescent material rolling to the base of the SEC cone (Calvari, 2007).

Ash emissions from the same vent occurred on 10 January 2008 and again on 1-3 February (figure 20). In mid-February such emissions became more frequent; some produced plumes several hundreds of meters high.

References: Andronico, D. and Cristaldi, A., 2007, Il parossismo del 23-24 novembre 2007 al Cratere di SE: caratteristiche del deposito di caduta. Report published on-line at: http://www.ct.ingv.it/Report/RPTVETCEN20071123.pdf

Burton, M. and Neri, M., 2007, Stato attuale e osservazione dell'Etna 25 novembre 2007. Report published on-line at: http://www.ct.ingv.it/Report/WKRVGREP20071125.pdf

Calvari, S., 2007, Rapporto sull'attività dell'Etna del 27 novembre 2007. Report published on-line at: http://www.ct.ingv.it/Report/WKRVGREP20071127.pdf

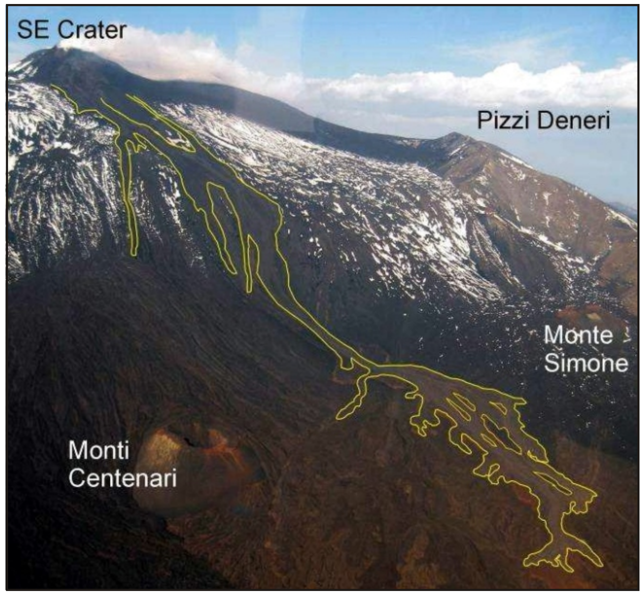

Figure 19. Aerial view, taken on 25 November 2007 from a helicopter of the Italian Civil Defence, of the lava flows erupted at Etna during 23-24 November 2007. View is from SE across the Valle del Bove (foreground). From Burton and Neri (2007), courtesy of INGV-Catania.

Geologic Summary. Mount Etna, towering above Catania, Sicily's second largest city, has one of the world's longest documented records of historical volcanism, dating back to 1500 BC. Historical lava flows of basaltic composition cover much of the surface of this massive volcano, whose edifice is the highest and most voluminous in Italy. The Mongibello stratovolcano, truncated by several small calderas, was constructed during the late Pleistocene and Holocene over an older shield volcano. The most prominent morphological feature of Etna is the Valle del Bove, a 5 x 10 km horseshoe-shaped caldera open to the E. Two styles of eruptive activity typically occur at Etna. Persistent explosive eruptions, sometimes with minor lava emissions, take place from one or more of the three prominent summit craters, the Central Crater, NE Crater, and SE Crater (the latter formed in 1978). Flank vents, typically with higher effusion rates, are less frequently active and originate from fissures that open

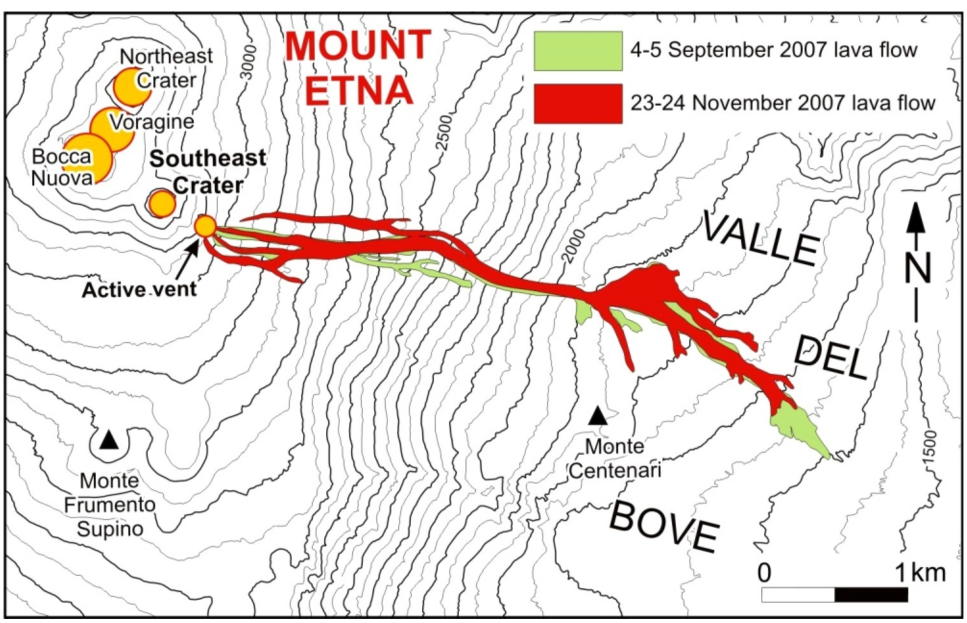

Figure 18. Preliminary map of the lava flows emitted during Etna's lava-fountaining episodes of and 4-5 September 2007 and 23-24 November 2007. Both sets of flows discharged from the active vent on the E flanks of Southeast Crater (SEC). Courtesy of INGV-Catania.

Figure 20. Ash plume rising about 1 km high above the active vent on the eastern slope of Etna's Southeast Crater cone, on the morning of 10 January 2008. View is from Trecastagni, ~ 16 km SSE of the active vent. Courtesy of INGV-Catania.

progressively downward from near the summit (usually accompanied by Strombolian eruptions at the upper end). Cinder cones are commonly constructed over the vents of lower-flank lava flows. Lava flows extend to the foot of the volcano on all sides and have reached the sea over a broad area on the SE flank.

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

Shiveluch

Kamchatka Peninsula, Russia
56.653°N, 161.360°E; summit elev. 3,283 m
All times are local (= UTC +12 hours)

Shiveluch (also spelled Sheveluch), the scene of lava-dome growth, is one of the most active volcanoes on Kamchatka. It was last reported here discussing events through early April 2007 (*BGVN* 32:03). The following report covering the interval early April-December 2007 came from multiple sources.

Shiveluch's eruptions are of an explosive nature and the volcano has been in a state of heightened activity since 5 December 2006. Vigorous activity continued to the time of this report (March 2008). Small lava-dome collapse events produced ash plumes and short block-and-ash flows, which in turn generated mudflows when snow was present. This activity was recorded in shallow volcanic earthquakes and tremor and a large, ever-present thermal anomaly on satellite imagery.

The Level of Concern Color Code remained at Orange throughout this report period (early April through December 2007). The Kamchatka Branch of the Geophysical Service of the Russian Academy of Sciences (KB GS RAS) is monitoring the volcano and believes that it poses little danger for nearby populated localities.

During April 2007 growth of the lava dome continued, and hot lava extruded at the top of the dome. Hot avalanches from the top of the dome occurred daily. Ash and ash-and-steam plumes rose to altitudes of ~ 4.6-6.5 km. Some plumes were seen on satellite imagery drifting E, SE, and S. According to satellite data, ash plumes extended ~ 60 km on 28-29 April, mainly to the S and SW, and ~ 50 km to the E on 5 and 7 May. During 27-28 May, plumes were seen on satellite imagery drifting SW.

A large thermal anomaly was conspicious during the last week of April 2007, and hot avalanches originating from the dome were noted on 30 April, 4 May, and 6-7 May. Gas-steam emissions occurred repeatedly. On 7 May a mudflow traveled down Shiveluch's slope, reaching ~ 20 km beyond the lava dome and blocking ~ 30 m of a road, isolating the district center Ust-Kamchatsk on the E of the

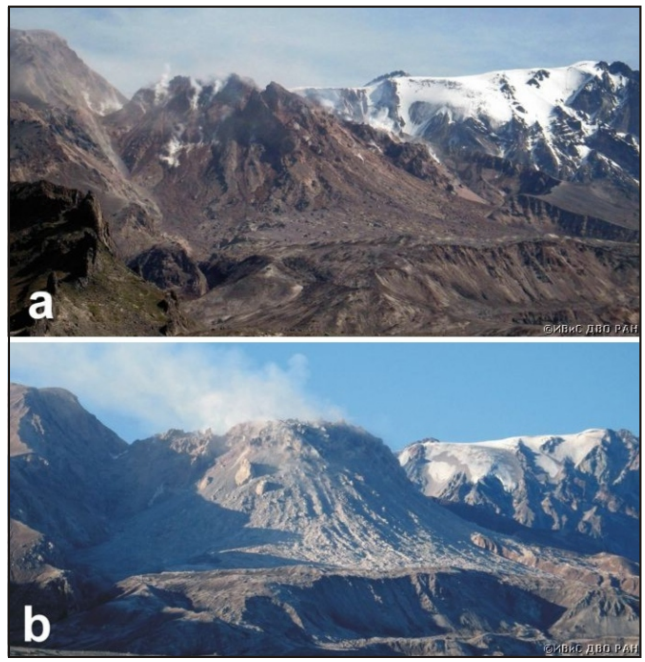

Figure 21. The dome at Shiveluch as seen from the SW at two points in time, July 2006 and July 2007. The dome grew to substantially fill the active crater. The most active lava dome growth took place along in the dome's E sector. Photo by Natasha Gorbach (from Gorbach, 2007).

Figure 22. The lava dome of Shiveluch volcano as seen from the SW on 11 July 2007. The dark dome contrasts with glowing zones where hot avalanches descended. Photo by Y. Demyanchuk.

peninsula. There were no vehicles on this portion of the road when the mudflow descended, and no casualties occurred. Figure 21 contrasts the dome in 2006 and 2007.

During July, gas-steam plumes frequently reached 4.0-6.1 km altitude. Ash was not always identified on satellite imagery because clouds obscured visibility; however, on 16 July satellite imagery detected gas-steam and ash plumes that extended for about 7-40 km to the S and SW of the volcano. Seismic data suggested that gas-and-ash emissions were concurrent with hot avalanches (figure 22).

On 25 September 2007, video observations indicated ash plumes rising to 6 km altitude and drifting E. According to video for 27 September and 2 October 2007, gas-steam plumes rose up to 4.5 and 3.5 km altitude, respectively. Weak fumarolic activity was noted on both 1 and 8 October. KB GS RAS noted that there was no significant variation in the previous ongoing activity through December 2007 that might indicate any impending activity of greater significance. Frequent MODIS thermal alerts continued throughout 2007 into 2008.

Reference: Gorbach, N., 31 July 2007, Bulletin of activity at Sheveluch volcano, issued 31 July 2007 [title approximate (translated from Russian); available in Russian at URL: http://www.kscnet.ru/ivs/volcanoes/inform_messages/2007/Sheveluch_072007/Sheveluch_072007.html).

Geologic Summary. The high, isolated massif of Shiveluch volcano (also spelled Sheveluch) rises above the lowlands NNE of the Kliuchevskaya volcano group. The 1,300 cu km Shiveluch is one of Kamchatka's largest and most active volcanic structures. The summit of roughly 65,000-year-old Stary (Old) Shiveluch is truncated by a broad 9-km-wide late-Pleistocene caldera collapse scar open to the south. Many lava domes dot its outer flanks. The Molodoy (Young) Shiveluch lava dome complex was constructed during the Holocene within the large horseshoe-shaped caldera; Holocene lava dome extrusion also took place on the flanks of Stary (Old) Shiveluch. At least 60 large eruptions of Shiveluch have occurred during the Holocene, making it the most vigorous andesitic volcano of the Kuril-Kamchatka arc. Widespread tephra layers from these eruptions have provided valuable time markers for dating volcanic events in Kamchatka. Frequent collapses of dome complexes, most recently in 1964, have produced debris avalanches whose deposits cover much of the floor of the breached caldera.

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Heard

Southern Indian Ocean
53.106°S, 73.513°E; summit elev. 2,745 m
All times are local (= UTC + 5 hours)

Due to its isolated location in the S Indian Ocean on the Kerguelen Plateau, Heard Island is rarely visited, and satellite imagery provides the only regular information on eruptive activity. The Hawai'i Institute of Geophysics and Planetology (HIGP) Thermal Alerts System MODVOLC provides an analysis of MODIS (Moderate Resolution Imaging Spectroradiometer) satellite thermal anomaly data, with 1-2 daily observations. That system remains the best source of evidence at isolated, glacier-covered volcanoes like Heard, though it is difficult to determine how often meteorological clouds may obscure thermal anomalies.

The last report summarized activity beginning in March 2000 (*BGVN* 32:06), describing three eruptive episodes (based on thermal anomalies). The last thermal anomaly mentioned was on 6 April 2007.

As seen on table 3, the MODVOLC system recorded the next thermal anomaly on 24 July 2007. For the rest of 2007, there were anomalies recorded on two days in August and two days in November. During 2008 as late as 2 March, anomalies occurred in February and March.

Date	Time (UTC)	Pixels	Satellite
24 Jul 2007	1750	1	Aqua
12 Aug 2007	1820	1	Terra
30 Aug 2007	1955	1	Aqua
11 Nov 2007	1800	1	Terra
11 Nov 2007	1945	2	Aqua
22 Feb 2008	1955	3	Aqua
02 Mar 2008	1950	1	Aqua

Table 3. Thermal anomalies measured by MODIS/MODVOLC over Heard Island during 7 April 2007 through 2 March 2008. Courtesy of HIGP Thermal Anomalies Team.

Geologic Summary. Heard Island on the Kerguelen Plateau in the southern Indian Ocean consists primarily of the emergent portion of two volcanic structures. The large glacier-covered composite basaltic-to-trachytic cone of Big Ben comprises most of the island, and the smaller Mt. Dixon volcano lies at the NW tip of the island across a narrow isthmus. Little is known about the structure of Big Ben volcano because of its extensive ice cover. The historically active Mawson Peak forms the island's 2,745-m high point and lies within a 5-6 km wide caldera breached to the SW side of Big Ben. Small satellitic scoria cones are mostly located on the northern coast. Several subglacial eruptions have been reported in historical time at this isolated volcano, but observations are infrequent and additional activity may have occurred.

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