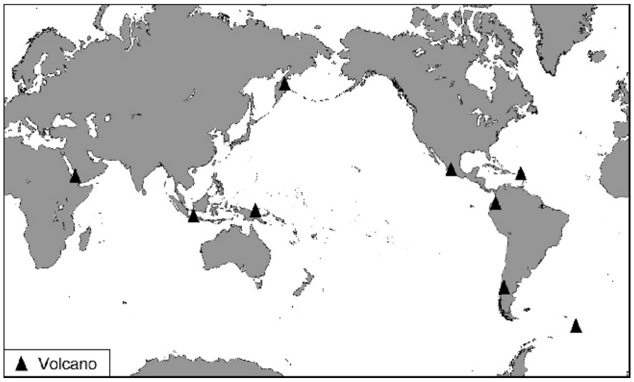
Bulletin of the Global Volcanism Network



Volume 33, Number 4, April 2008

Smithsonian
National Museum of Natural History

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).

Chaitén

Southern Chile
42.833°S, 72.646°W; summit elev. 1,122 m
All times are local (= UTC - 4 hours)

The first historical eruption at Chaitén began on the morning of 2 May 2008, following increased seismicity in the region the day before. Chaitén, located W of the larger Minchinmávida (or Michinmahuida) stratovolcano, is a small 3-km-diameter post-glacial caldera or explosion crater (figure 1) which probably was formed ~ 9.4 ka BP, based on dating of scoria-rich surge deposits (Naranjo and Stern, 2004). Within the explosion crater lies an obsidian lava dome of rhyolite composition.

Servicio Nacional de Geología y Minería (SERNAGEOMIN) reported that a pulsating white-to-gray ash plume on 2 May rose to an estimated altitude greater than 21 km and drifted SSE. Based on observations of satellite imagery and pilot reports, the Buenos Aires VAAC reported an ash plume at altitudes of 13.7-16.8 km that drifted NE. According to news articles, Chile's government declared a state of emergency on 2 May and several hundred people were evacuated from the coastal town of Chaitén (10 km SE).

According to news sources, ashfall was reported during 2-6 May both locally and up to hundreds of kilometers away, affecting water supplies and roads. Based on observations of satellite imagery and pilot reports, the Buenos Aires VAAC reported that during 3-6 May ash plumes rose as high as 10.7 km altitude and drifted variably to the SE (figure 2), E, W, and NE. News sources indicated that about 4,000-5,000 people were evacuated from the town of Chaitén and surrounding areas as the eruption continued. On 5 May, ONEMI (Oficina Nacional de Emergencia - Ministerio del Interior) reported that evacuations also took place in Futaleufú, about 65 km ESE of Chaitén, where ~ 30 cm of ash accumulated. One elderly person died during the evacuation efforts. On 6 May, ONEMI and SERNAGEOMIN reported that the eruption became more forceful and generated a wider and darker gray ash plume rising to an estimated altitude of 30 km. All remaining people in Chaitén were ordered to evacuate, as well as anyone within 50 km of the volcano.

Activity continued, and a lava dome began growing from a vent on the upper flank of the old dome. Lahars and floods also inundated the town of Chaitén, causing widespread destruction. Additional details will be provided in future reports.

References: Naranjo, J.A., and Stern, C.R., 2004, Holocene tephrochronology of the southernmost part (42°30'-45°S) of the Andean Southern Volcanic Zone: Revista Geológica de Chile, v. 31, no. 2, p. 225-240.

Geologic Summary. Chaitén is a small, glacier-free caldera with a Holocene lava dome located 10 km NE of the town of Chaitén on the Gulf of Corcovado. A pyroclastic-surge and pumice layer that was considered to originate from the eruption that formed the elliptical 2.5 x 4 km wide summit caldera was dated at about 9400 years ago. A rhyolitic, 962-m-high obsidian lava dome occupies much of the caldera floor. Obsidian cobbles from this dome found in the Blanco River are the source of prehistorical artifacts from archaeological sites along the Pacific coast as far as 400 km away from the volcano to the north and south. The

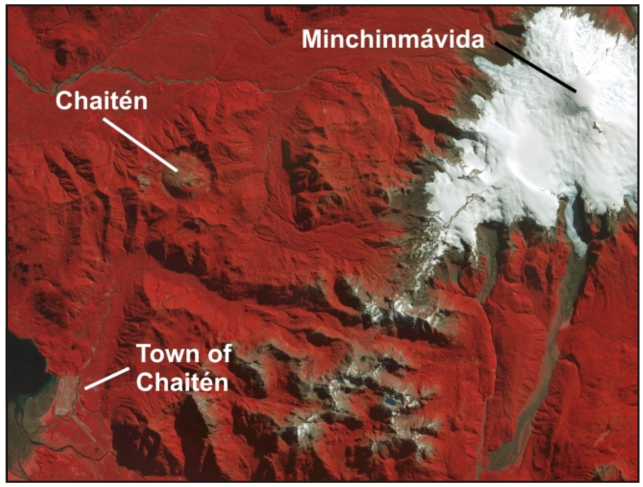


Figure 1. Orthorectified 15-m ASTER infrared (VNIR) satellite image from 1 April 2006 showing Chaitén volcano (upper left), ice-covered Minchinmávida volcano (right), and the town of Chaitén (lower left). Courtesy of Rick Wessels, Alaska Volcano Observatory.

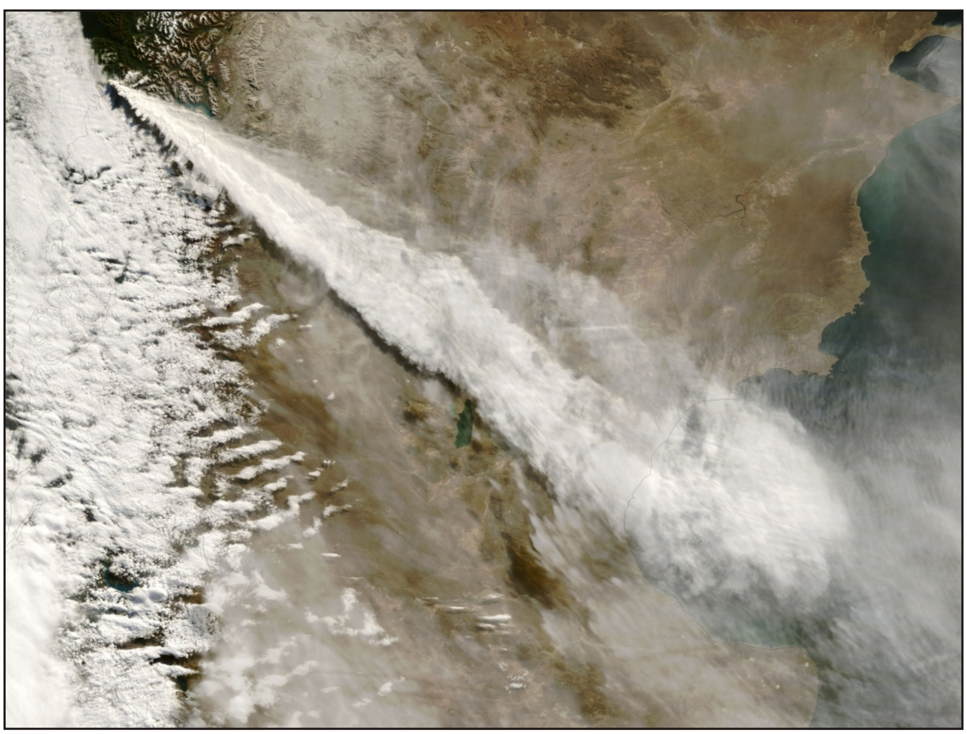


Figure 2. The Moderate Resolution Imaging Spectroradiometer (MODIS) on NASA's Terra satellite captured this image of a long, cloud-like plume extending about 700 km SE from Chaitén on 3 May at 1035 local time. The plume rises high over the Andes mountains, drifts across Argentina, and thins over the Atlantic Ocean. Courtesy of NASA Earth Observatory and the MODIS Rapid Response System.

caldera is breached on the SW side by a river that drains to the bay of Chaitén, and the high point on its southern rim reaches 1,122 m. Two small lakes occupy the caldera floor on the west and north sides of the lava dome.

Information Contacts: *Servicio Nacional de Geología y Minería (SERNAGEOMIN)*, Avda Sta María No 0104, Santiago, Chile (URL: http://www.sernageomin.cl/); *Oficina Nacional de Emergencia - Ministerio del Interior (ONEMI)*, Beaucheff 1637 / 1671, Santiago, Chile (URL: http://www.onemi.cl/); *José Antonio Naranjo*, Departamento de Geología Aplicada, SERNAGEOMIN; *Buenos Aires Volcanic Ash Advisory Center (VAAC)*, Buenos Aires, Argentina (URL: http://www.ssd.noaa.gov/VAAC/OTH/AG/messages.html); *Rick Wessels*, Alaska Volcano Observatory, U.S. Geological Survey, Anchorage, AK, USA (URL: http://www.avo.alaska.edu/); *NASA Earth Observatory* (URL: http://earthobservatory.nasa.gov/); *Associated Press* (URL: http://www.ap.org/); *Agence France-Presse* (URL: http://www.afp.com/).

Michael

South Sandwich Islands, Antarctica
57.78°S, 26.45°W; summit elev. 990 m
All times are local (= UTC - 2 hours)

The frigid, remote, and uninhabited region of Michael volcano is seldom visited. Thermal anomalies detected by satellite-based MODIS instruments, processed using the MODVOLC algorithm by the Thermal Alerts System of the Hawai'i Institute of Geophysics and Planetology, provide some data about possible eruptive activity (*BGVN* 28:02, 29:03, 31:04, and 31:10). During 3-6 October 2005 there were three days with thermal anomalies (*BGVN* 31:04). MODIS data indicates that anomalous pixels were also detected on 19 December 2005 (20 December UTC) and on 20 January 2006 (21 January UTC) (*BGVN* 31:10). The most recently reported MODIS thermal anomalies indicated activity during 19-21 October 2006 (20-21 October UTC) and again on 31 October-1 November 2006 (*BGVN* 31:10). The source of these anomalies was an inferred lava lake in a central vent as shown on an Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) image collected 28 October 2006 (*BGVN* 31:10). Additional anomalies occurred on 13 November and 6 December 2006 (7 December UTC). No anomalies were measured after that date through May 2008. Since August 2000 there have been six periods when thermal anomalies were detected in satellite imagery (table 1).

Date (UTC)	Thermal pixel data	*Bulletin* reference
30 Aug 2000-03 Feb 2001	3 days with pixels	BGVN 28:02
05 Aug 2001-21 Nov 2001	10 days with pixels	BGVN 28:02
05 Jul 2002-01 Nov 2002	12 days with pixels	BGVN 28:02
07 May 2003	2 anomalous pixels	BGVN 29:03
03 Oct 2005-21 Jan 2006	5 days with pixels, three during 3-6 Oct	BGVN 31:04, 31: 10
09 Jun 2006-07 Dec 2006	9 days with pixels	BGVN 31:10, 33:04

Table 1. Eruptive periods at Michael as inferred from MODIS thermal data from January 2000 through May 2008. Courtesy of the Hawai'i Institute of Geophysics and Planetology Thermal Alerts System.

Geologic Summary. The young constructional Mount Michael stratovolcano dominates glacier-covered Saunders Island. Symmetrical 990-m-high Mount Michael has a 700-m-wide summit crater and a remnant of a somma rim to the SE. Tephra layers visible in ice cliffs surrounding the island are evidence of recent eruptions. Ash clouds were reported from the summit crater in 1819, and an effusive eruption was inferred to have occurred from a N-flank fissure around the end of the 19th century and beginning of the 20th century. A low ice-free lava platform, Blackstone Plain, is located on the N coast, surrounding a group of former sea stacks. A cluster of parasitic cones on the SE flank, the Ashen Hills, appear to have been modified since 1820 (LeMasurier and Thomson 1990). Vapor emission is frequently reported from the summit crater. Recent AVHRR and MODIS satellite imagery has revealed evidence for lava lake activity in the summit crater of Mount Michael.

Information Contacts: *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/).

Reventador

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

Our previous report on Reventador documented intermittent explosive eruptions through September 2005, with Strombolian activity and short-duration Vulcanian events. These events were accompanied by small pyroclastic flows, small lava flows, large bombs, and ash columns (*BGVN* 30:08). This report discusses reported events into 2008.

According to the Instituto Geofísico (Escuela Politécnica Nacional) (IG), seismicity at Reventador was low at the end of December 2005. There were no reports on this volcano during January 2006 through February 2007. The volcano was apparently only weakly eruptive or non-eruptive around this interval. MODVOLC thermal alerts were absent during late December 2005 to late March 2006.

In early March 2007, however, the IG reported an increase in the number of tectonic earthquakes at Reventador. 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 residents saw ash plumes and incandescent material near the crater and heard roaring noises. An explosion produced a plume that rose to an altitude of 6.6 km and 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, observers reported roaring noises and an ash column from Reventador 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, 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 from Reventador 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 from Reventador 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 Meteorological Watch Office (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 from Reventador rose to an altitude of 3.6 km and drifted to the NW. The plume was visible on satellite imagery. On 18 May, strong rains 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.

On 18 May, an ash plume from Reventador rose to an altitude of 3.7 km and drifted NW. Ash was not observed on satellite imagery. Lahars occurred on the flanks of Reventador on 15, 19, 20, 21, and 23 June. Clouds inhibited visual observations during 20-24 June.

MODVOLC thermal alerts were frequent during late March and throughout April 2007. One alert occurred in late May 2007; two also appeared on 6 August 2007 (local dates and times). No further alerts were issued in data accessed 9 June 2008.

A VAAC report noted an eruption on 11 October 2007. It emitted 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 western Amazon basin. A 4-km-wide caldera widely breached to the east was formed by edifice collapse and is partially filled by a young, unvegetated stratovolcano that rises about 1,300 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).

Soufrière Hills

West Indies
16.72°N, 62.18°W; summit elev. 915 m
All times are local (= UTC - 4 hours)

Our previous report on Soufrière Hills characterized the eruptive behavior and monitoring between 16 June 2006 and 25 May 2007 (*BGVN* 32:04). The current report describes activity between the end of May 2007 through May 2008.

Summary report. A report of a 14 and 16 April 2008 meeting by an advisory committee provides a convenient summary of recent behavior (SAC10, 2008). With minor stylistic changes, important paragraphs are quoted below.

The report indicated that by about mid-March 2007 the volcano stopped extruding dome lava. The authors said that since about October 2007 volcanism at the surface of the volcano has been at a very low level. Further, they noted, "Whilst there have been no major collapses of the dome, or explosions, rockfalls and minor pyroclastic flows [traveling E] into the Tar River Valley have occurred that have eroded the eastern side of the dome. However, the main mass of the 2006-2007 lava dome remains intact, and whilst it remains so it is capable of generating major pyroclastic flows for years to come. Also, the flow of gas continues to stream through the dome from the magma deep in the Earth, forming the visible plume.

"A lidar survey of the shape of the dome undertaken in March 2008 gave an estimate of 195 million cubic meters for the volume of the dome. This figure is within the bounds of uncertainty of the volume estimate of 203 million cubic meters derived from photogrammetry in April 2007.

"The three distinct lobes of lava at the summit of the dome, present at the end of lava extrusion in April 2007, remain. There have been a number of rockfalls and a few minor pyroclastic flows from the dome into the Tar River Valley. As a result of these, the uppermost part of the talus has been removed on the eastern side exposing a steep band of core lava below which a chute channels material to lower levels. Similarly, erosion of talus has begun to re-expose the buried northern crater rim.

"Gases escape from the dome in several areas. On the southern and northern talus slopes multiple gas vents release mainly water-rich gas. Sulphur deposits are evident around the southern vents. These locations have been a common feature for much of the eruption. On the western side of the upper dome, just inside the buried Gage's Wall, is a vent releasing a large flux of gas with a pale blue tint, indicative of sulphur dioxide. This vent formed in February 2006 and has been the source of weak ash generation in the past, roaring noises, and the cause of minor erosion of the Gage's Wall (September 2006).

"The low levels of rockfall seismicity seen in 2007 declined even further during 2008. There were two minor swarms of long-period earthquakes on 23 November 2007 and 28 January 2008, the latter being co-incident with roaring from the Gage's Wall vent. Volcano-tectonic earthquakes occurred between the surface and 4 km below the dome. These may be caused by stress changes around the conduit.

"The reference GPS line between the South Soufrière (SOUF) and old MVO (MVO1) receivers continued the same extensional trend that began when extrusion stopped in April 2007. This extension is slower than the equivalent contracting trend seen during lava extrusion, but is comparable to the extension measured during the first year of the last pause in activity. This pattern is confirmed by most of the other GPS stations and the EDM lines on the northern side of the volcano. This extension is consistent with an island-wide pattern of surface inflation due to the magma reservoir re-charging at depth. Any deformation due to the effects of surface loading by the dome dies away over a much shorter distance from the volcano than that being monitored between MVO1 and SOUF.

"The lack of any fresh, degassing andesite magma high in the conduit was confirmed by low measured HCl/SO_2 ratios. Sulphur dioxide was emitted at a rate above the long-term average (about 500 tonnes/day). Because several instruments in the measurement network have failed, there are some doubts about the absolute values, but a gradually increasing long-term trend seems real. This indicates not only that basalt degassing is ongoing, but also that the system may be becoming more permeable to deep gas loss or that gas production has increased. High values of sulphur dioxide measured by ground-based diffusion tubes to the west of the volcano have been recorded, as was also seen during the previous pause in 2005.

"Ongoing retrospective petrological analysis of the lava erupted over the last few years indicates that the amount of the basalt magma incorporated into the andesite lava that appears at the surface may be greater than previously appreciated. Understanding the mass balance of this interchange and being able to monitor it through time would help to understand the dynamics of the magma chamber.

"The current pause is 13 months long. Previous pauses have lasted 20 months (March 1998–November 1999) and 24 months (July 2003–August 2005). Despite the presence of a large dome, the "residual" surface activity now is far less than was the case during the first pause, when there was also a dome, and is much more like the second pause when there was no dome. The main difference between the first year of this pause and the first year of the second pause is the increasing trend of sulphur dioxide output in 2007-8. A few months prior to the ends of both previous pauses, the level of seismicity, and particularly long period seismicity, increased and there was a resumption of steam-rich explosions."

MVO and other reports. In accord with the summary above, the Montserrat Volcano Observatory (MVO) noted very low seismicity since May 2007. However, at the end of this reporting interval (May 2008), monitoring suggested that volcanic activity seemed headed for an upturn.

Despite the lack of dome growth (or dome destruction) during the entire period of this report the Alert Level remained at 4 (on a scale of 0-5). Authorities prohibited access to many areas near the volcano, including some areas ranging from 2 to 4 km offshore.

The Washington Volcanic Ash Advisory Center (W-VAAC) noted several ash plumes during mid-May 2007 through December 2007 (11 June, 22-28 August, 16 September, 12 October, 15-19 November) and 2008 (7 and 10 January, 10 April, 5 May, 13 -19, 23 and 29 May). Some of the plumes resulted from rockfalls (19 November, and 7 January).

Plumes on 11 June and 15-16 November may have reached 3.7 km altitude. Those on 13 and 29 May rose to 3 km altitude.

Pyroclastic flows were indicated in MVO reports for the May-December 2007 part of the reporting interval on at least 16 days. Particularly noteworthy were days with multiple pyroclastic flows, including 11 June (2), 23 August (4), and 29 November (4). The latter sequence of pyroclastic flows followed minutes after a regional M 7.4 earthquake. A 30 July pyroclastic flow traveled N for a 1.5 km runout distance.

Pyroclastic flows during January-May 2008 occurred on at least five days, and on one of those days, two occurred. One on 15 January had a 2 km runout distance.

A pyroclastic flow on 29 May 2008 descended a few hundred meters to the W of the dome and was associated with the above-mentioned ash plume rising to 3 km altitude. An overflight the next day suggested that the explosion and pyroclastic flow originated from the Gages vent.

Figure 3. Photo of the Soufrière Hills lava dome taken on 7 January 2008 from the S with the crater rim in the foreground. Courtesy of Greg Scott, Caribbean Helicopters (from MVO website).

Lahars were indicated in MVO reports, often one or more per month and sometimes one or more per week, during the 2007-8 reporting interval, typically associated with heavy rains and fresh deposition. Lahars were numerous on 23 October 2007 (descending all drainages), vigorous around 25-26 October 2007, abundant the week of 13-19 February 2008, and noteworthy on 5 May 2008.

A photo shows the little-changing dome as it appeared on 7 January 2008 (figure 3). The photo emphasizes the dome's steep sides and craggy summit, as well as wide areas with emerging plumes. SAC (2008) noted that, although seemingly static, the dome is far from stable and large pyroclastic flows are possible from dome disruptions in the future. In the past, many of the pyroclastic flows traveled E. SAC (2008) noted the possibility (and discussed probabilities) for their transit from the dome towards the WNW along various areas just N of Plymouth.

According to MVO, the level of volcano-tectonic (VT) earthquakes at Soufrière Hills increased during the week of 25 April-2 May 2008, and was the highest since February 2006. During this week, degassing from a vent above Gages Wall was audible in the St. George's Hill area to the NW, and steaming from the area above Tyre's Ghaut to the NW was visible. Light ashfall was reported in the Old Town area about 9 km NW, and in other nearby areas.

During 9-19 May 2008, activity increased. On 13 May a single long-period earthquake occurred, accompanied by a blue sulfur-dioxide plume. An ash plume that rose to an altitude of 3 km drifted NW (dropping ash over much of Iles Bay, Belham, Old Town, and Olveston). Ash emissions from two areas in the Gages vent to the W were observed on 15 May, but may have started the previous day. The resultant ash plume rose about 200 m above the lava dome and drifted W. Both a small rockfall and gentle roaring noises were reported. A new fumarolic area was seen on the SE side of Chances Peak. Ash emissions from Gages vent continued on 16 May. During the week of 17-23 May, activity decreased slightly.

A weekly summary of seismicity and SO_2 fluxes between 25 May 2007 and 30 May 2008 is indicated in table 2. In addition to the rockfall data in the table, there was one long-period rockfall event during each of the weeks of 23-30 November, 4-11 January, and 11-18 January. The long-term SO_2 average is 550 tons/day.

Report Date 2007-2008	Hybrid (HB) earthquakes	VT earthquakes	LP earthquakes	Rockfall signals	Avg SO_2 flux (metric tons/day)
25 May-01 Jun	1	1	—	5	230
01 Jun-08 Jun	—	1	1	5	175
08 Jun-15 Jun	—	1	—	10	288
15 Jun-22 Jun	—	1	1	10	165
22 Jun-29 Jun	—	1	—	3	203
29 Jun-06 Jul	—	1	1	10	200
06 Jul-13 Jul	—	1	—	4	—
13 Jul-20 Jul	—	1	1	6	300
20 Jul-27 Jul	—	3	—	5	—
27 Jul-03 Aug	—	2	2	11	639
03 Aug-10 Aug	—	2	—	5	—
10 Aug-17 Aug	—	2	—	4	818
17 Aug- 24 Aug	—	4	—	4	509
24 Aug-31 Aug	—	13	1	17	740
31 Aug-07 Sep	—	1	1	7	575
07 Sep-14 Sep	—	5	—	6	688
14 Sep-21 Sep	—	12	—	8	—
21 Sep-28 Sep	—	4	—	9	300
28 Sep-05 Oct	—	1	2	3	384
05 Oct-12 Oct	—	—	—	10	508
12 Oct-19 Oct	—	5	—	3	691
19 Oct-26 Oct	—	—	1	9	518
26 Oct-02 Nov	—	—	—	9	618
02 Nov-09 Nov	—	12	—	16	596
09 Nov-16 Nov	—	2	—	11	698
16 Nov-23 Nov	—	—	20	7	685
23 Nov-30 Nov	—	—	46	4	868
30 Nov-07 Dec	—	—	—	4	405
07 Dec-14 Dec	—	1	—	2	811
14 Dec-21 Dec	—	9	—	2	865
21 Dec-28 Dec	—	4	—	8	861
28 Dec-04 Jan	—	1	—	2	615
04 Jan-11 Jan	—	8	1	2	513
11 Jan-18 Jan	—	13	2	3	568
18 Jan-25 Jan	—	—	—	2	734
25 Jan-01 Feb	—	3	25	—	468
01 Feb-08 Feb	1	3	—	2	881
08 Feb-15 Feb	1	—	—	1	1004
15 Feb-22 Feb	1	—	1	1	872
22 Feb-29 Feb	4	—	—	—	972
29 Feb-07 Mar	1	1	—	—	824
07 Mar-14 Mar	—	4	—	3	766
14 Mar-21 Mar	2	2	—	3	1,070
21 Mar-25 Apr	No data	No data	No data	No data	No data
25 Apr-02 May	—	48	3	1	574
02 May-09 May	—	10	5	5	630
09 May-16 May	—	25	1	17	506
16 May-23 May	—	3	2	11	653
23 May-30 May	—	8	2	10	—

Table 2. Soufrière Hills seismicity between 25 May 2007 and 30 May 2008. (Earthquakes; VT: volcanic- tectonic; LP: long-period. In the last two columns, "—" indicates data were not available.) Courtesy of MVO.

Since 2002, MVO has been monitoring the SO_2 emission rate in real-time, with spectra telemetered back to the observatory from an array of three fixed, scanning UV spectrometers. MVO has also calculated the $HCl:SO_2$ ratio by measuring the HCl emission rates indirectly using an open-path Fourier Transform Infrared spectrometer (FTIR). These ratios may be used to evaluate changes in the eruption rate and dome growth. Such mass ratios determined since August 2007 ranged from 0.28 to 0.46, with one ratio at 0.67 (during 9-16 November 2007).

MVO's weekly report for the third week of May states "observations show continuing unrest ... with a gradual increase over the last few weeks. The events of this week suggest that fresh magma is rising beneath the dome. There is now a distinct possibility that lava extrusion will start from the Gages vent without any warning. If this happens, it will probably not be long before there are small pyroclastic flows to the W. Even if lava extrusion does not restart, the dome is still a very large mass of very hot material which is capable of collapsing or exploding at any time."

Seismic signals. Five main seismic signal types have been recognized at many volcanoes, including Soufrière Hills. These include volcano-tectonic (VT) earthquakes, long-period (LP) earthquakes, hybrid earthquakes, rockfall or pyroclastic flow signals, and explosion signals. McNutt (2000) presents illustrations of characteristic seismic traces.

MVO defines a VT earthquake as having an impulsive (i.e., large amplitude) start and then rapidly decreasing in amplitude. These earthquakes often appear in swarms and are predominantly high-frequency signals (over 2 Hz). They are interpreted as due to rock fracturing.

An LP earthquake, as defined by MVO, has a more emergent start (i.e., amplitude growing with time) and generally low, narrow-band frequency content (1-2 Hz). These are interpreted as the result of signal resonance due to gas or magma inside the volcanic conduit.

MVO defines a hybrid (HB) earthquake as a mixture between VTs and LPs; hence they tend to have impulsive starts but contain significant amount of low-frequency signal. They are thought to represent magma forcing its way to the surface. These signals are often associated with periods of rapid dome growth, and are sometimes precursors to major dome collapses or switches in the direction of lava extrusion at the surface. These signals often merge into continuous tremor, which sometimes occurs in bands spaced 4-24 hours apart.

According to MVO, rockfall or pyroclastic flow signals have often been a dominant type of seismic signal recorded here (e.g., table 2). They have an emergent start and a gradual tapering towards the end of the signal and a wide frequency range. They are interpreted as being due to material falling off the dome and traveling down the flanks. Pyroclastic flow signals are similar to those of rockfalls but are generally of longer duration and higher amplitude.

Pyroclastic deposits in the ocean. Trofimovs and others (2006) reported that more than 90% of the pyroclastic material erupted at Soufrière Hills has been deposited in the ocean. The authors describe the characteristics of the deposits at different distances from shore. The coarse material forms steep-sided, near-linear ridges that intercalate to form a submarine fan. The finer materials form turbidity currents that flow to distances greater than 30 km from the shore.

MVO management. For almost 10 years the British Geological Survey (BGS) managed MVO. Beginning 1 April 2008, this service shifted to the Eastern Caribbean's two major geo-hazard organizations, the Seismic Research Unit (SRU) of the University of the West Indies, Trinidad and Tobago and the Institut de Physique du Globe de Paris (IPGP), France. The SRU carried out long-term monitoring prior to the 1995 eruption episode. They were assisted by others as the eruption began. A statement on the new situation included the following paragraph.

"The SRU monitors earthquakes and volcanoes for most of the English-speaking Eastern Caribbean countries. The IPGP has volcano observatories on Martinique and Guadeloupe, i.e. the main French-speaking Antilles. Island arcs such as the Lesser Antilles are regions where complex real-life hazards exist, not only the better known volcanic eruptions, but also the generation of a tsunami by a submarine earthquake or a volcanic landslide. The linking of these two research institutions will provide greater opportunities for studying volcanism and earthquake activity at arc-scale rather than the scale of individual islands, a logical and innovative step towards disaster risk reduction regionally and globally."

Reference: McNutt, S.R., 2000, Volcanic seismicity, *in* H. Sigurdsson (ed), Encyclopedia of Volcanoes, Academic Press, San Diego, p. 1015-1033.

Trofimovs, J., Amy, L., Boudon, G., Deplus, C., Doyle, E., Fournier, N., Hart, M.B., Komorowski, J.C., Le Friant, A., Lock, E.J., Pudsey, C., Ryan, G., Sparks, R.S.J., and Talling, P.J., 2006, Submarine pyroclastic deposits formed at the Soufrière Hills volcano, Montserrat (1995-2003): What happens when pyroclastic flows enter the ocean?: Geology, v. 34, no. 7, p. 549-552.

SAC10, 13 May 2008, Assessment of the hazards and risks associated with the Soufriere Hills volcano, Montserrat, Tenth Report of the Scientific Advisory Committee on Montserrat, Volcanic Activity, based on a meeting held between 14 and 16 April 2008 at the Montserrat Volcano Observatory, Montserrat (Part I: Main Report), 23 pp. (URL: http://www.mvo.ms/).

Geologic Summary. The complex, dominantly andesitic Soufrière Hills volcano occupies the southern half of the island of Montserrat. The summit area consists primarily of a series of lava domes emplaced along an ESE-trending zone. English's Crater, a 1-km-wide crater breached widely to the E, was formed during an eruption about 4,000 years ago in which the summit collapsed, producing a large submarine debris avalanche. Block-and-ash flow and surge deposits associated with dome growth predominate in flank deposits at Soufrière Hills. Non-eruptive seismic swarms occurred at 30-year intervals in the 20th century, but with the exception of a 17th-century eruption that produced the Castle Peak lava dome, no historical eruptions were recorded on Montserrat until 1995. Long-term small-to-moderate ash eruptions beginning in that year were later accompanied by lava-dome growth and pyroclastic flows that forced evacuation of the southern half of the island and ultimately destroyed the capital city of Plymouth, causing major social and economic disruption.

Information Contacts: *Montserrat Volcano Observatory (MVO)*, Fleming, Montserrat, West Indies (URL: http://www.mvo.ms/); *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/).

Figure 4. Photo of the dome at Colima looking NE, taken on 1 February 2007 by Jalisco Civil Protection. Courtesy of Jalisco Civil Protection and Colima Volcano Observatory.

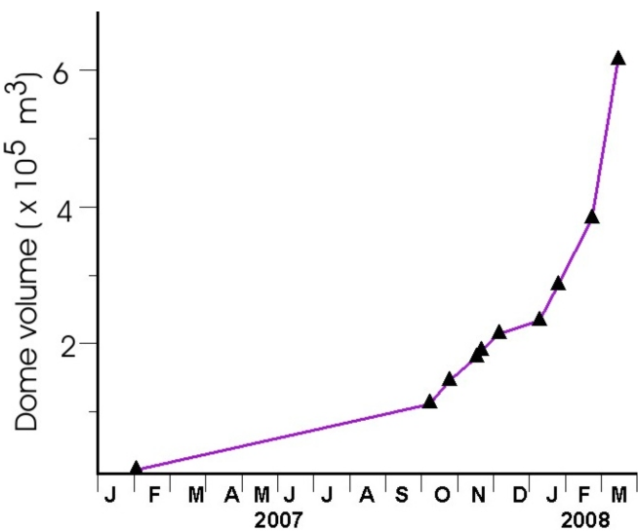


Figure 5. A plot portraying the dome growth rate at Colima during February 2007-8 March 2008. The data point in early February 2007 had a volume of 115,000 m^3. Courtesy of Colima Volcano Observatory.

Figure 6. Photo of Colima's dome looking NE, taken on 8 March 2008 by Colima Volcano Observatory. Courtesy of Jalisco Civil Protection and Colima Volcano Observatory.

Colima

México
19.514°N, 103.62°W; summit elev. 3,850 m
All times are local (= UTC - 6 hours)

A new episode of lava dome growth in the crater was first observed on 1 February 2007 (figure 4). Dome growth continued during February-September, changing its volume from 15,000 m^3 to 110,000 m^3, with a low mean-effusion rate of about 0.0045 m^3/s (figure 5).

During October 2007, Colima's effusion rate began to increase significantly (up to 0.033 m^3/s) and on 8 March 2008 the dome's volume reached about 600,000 m^3, filling ~ 30% of the crater (figure 6). This dome growth was accompanied by 3-5 small explosions daily.

Geologic Summary. The Colima volcanic complex is the most prominent volcanic center of the western Mexican Volcanic Belt. It consists of two southward-younging volcanoes, Nevado de Colima (the 4,320 m high point of the complex) to the N and the 3,850-m-high historically active Volcán de Colima at the S. A group of cinder cones of late-Pleistocene age is located on the floor of the Colima graben W and E of the Colima complex. Volcán de Colima (also known as Volcán Fuego) is a youthful stratovolcano constructed within a 5-km-wide caldera, breached to the S, that has been the source of large debris avalanches. Major slope failures have occurred repeatedly from both the Nevado and Colima cones, and have produced a thick apron of debris-avalanche deposits on three sides of the complex. Frequent historical eruptions date back to the 16th century. Occasional major explosive eruptions (most recently in 1913) have destroyed the summit and left a deep, steep-sided crater that was slowly refilled and then overtopped by lava dome growth.

Information Contact: *Observatorio Vulcanológico de la Universidad de Colima*, Colima, Col., 28045, México (URL: http://www.ucol.mx/volcan/; Email: ovc@cgic.ucol.mx).

Shiveluch

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

From the January to May 2008, dome growth at Shiveluch has consistently been accompanied by shallow, low-amplitude earthquakes, satellite thermal anomalies, and tremor. According to the Kamchatka Branch of the Geophysical Service of the Russian Academy of Sciences (KB GS RAS), several cases of elevated magnitude seismic signals occurred (figure 7). In some cases, these signals took place during times of zero visibility and the signals were interpreted to suggest a plume above to 4 km altitude.

On 3 March a plume of gas stretched 31 km to the SW of the volcano, and ash clouds rose up to ~ 4.5 km altitude. During the last two weeks of March, reports noted gas-and-ash emissions to ~ 3.5-4.5 km altitude; hot avalanches occurred each day (figure 8).

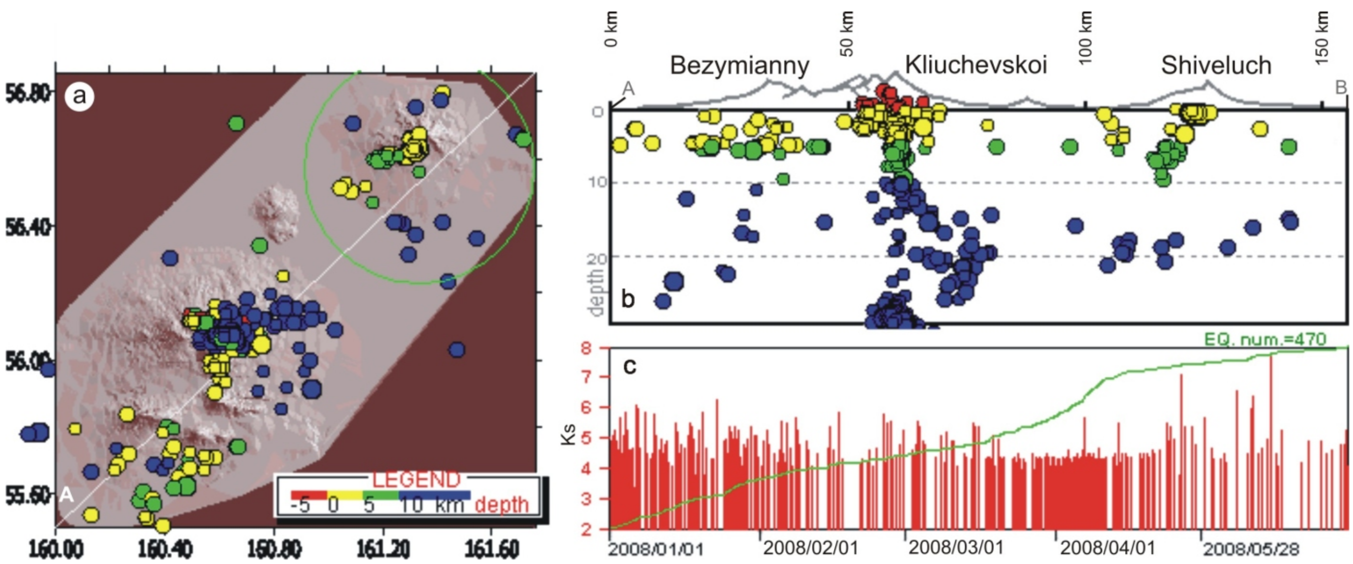


Figure 7. Seismicity at Bezymianny, Kliuchevskoi, and Shiveluch (the Northern Group of Volcanoes, Kamchatka) recorded during 1 January to 1 May 2008, presented in three panels. (a) A map of the region showing location and depths of earthquakes (white line is trace of cross section AB); the 50-km-diameter circle encloses Shiveluch epicenters of earthquakes plotted in (c). (b) Earthquakes projected onto the vertical plane of cross section AB. (c) Histogram showing Shiveluch's daily earthquakes with respect to time (bar height shows class (Ks) from seismic amplitude (after S.A. Fedotov)), ascending curve is the cumulative number of earthquakes. Courtesy of KB GS RAS.

Background on the edifice and deposits. Shiveluch is the northern-most active volcano of the Kamchatka peninsula, Russian Far East (figure 9a). The volcano forms a large isolated edifice surrounded by lowlands of the northern part of the Central Kamchatka depression. Two basic structural elements of the volcano are clear on figure 9b where Young Shiveluch is seen located inside the caldera of Old Shiveluch.

Old Shiveluch includes a thick sequence of basaltic and andesitic pyroclastic layers exposed in the base of the caldera wall; the NE and SW parts of the complex contain a folded sequence of pyroclastic deposits overlapped by basaltic-basaltic andesite flows and broken through by numerous radial dikes. The lava flows and domes of Young Shiveluch are richer in silica (59.5-62.5%) than those of Old Shiveluch (54.5-56.5%). Young Shiveluch (figures 9 and 10) has produced numerous Plinian tephras.

References: Belousov, A., Belousova, M., and Voight, B., 1999, Multiple edifice failures, debris avalanches and associated eruptions in the Holocene history of Shiveluch volcano, Kamchatka, Russia: *Bulletin of Volcanology*, v. 61, p. 324-342.

Gorbach, N., 2007, Bulletin of activity at Shiveluch volcano, (title approximate translated from Russian issued 31 July 2007) available (in Russian) at URL: http://www.kscnet.ru/ivs/volcanoes/inform_messages/2007/Shiveluch_072007/Shiveluch_072007.html).

Geologic Summary. The high, isolated massif of Sheveluch volcano (also spelled Shiveluch) 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 S. 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

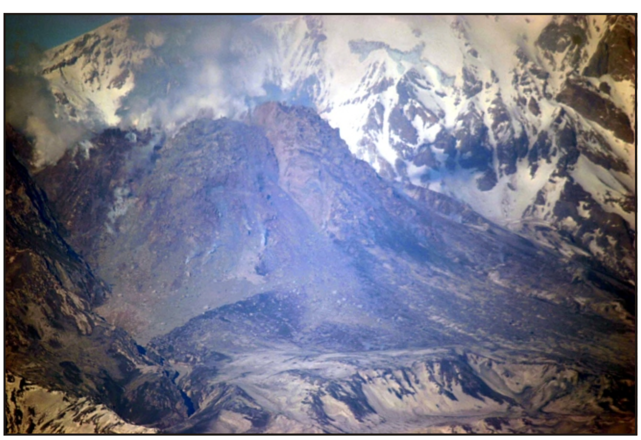


Figure 8. The lava dome of Young Shiveluch as seen from the SE on 18 March 2008. A thick lava flow had recently extruded from the left (SW) side. Photo by Yuri Demyanchuk.

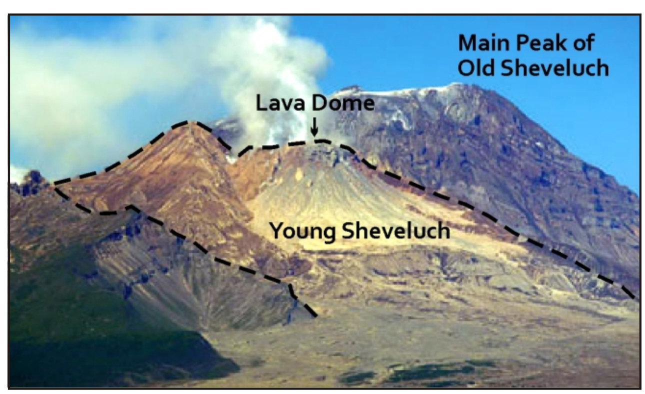


Figure 9. Photo of the Shiveluch volcano complex in a view from the S. The dotted line divides the two structures of Old Shiveluch and the growing dome of Young Shiveluch. From Gorbach (2007).

Figure 10. An aerial photo of Shiveluch volcano from the SW taken in October 1994. The 9-km-diameter, horseshoe-shaped caldera of Old Shiveluch opens widely to the S. Inside the caldera edifice of Young Shiveluch resides a smaller horseshoe-shaped crater formed in 1964. Degassing (right center) comes from the 1980–1994 dome complex, which is nested in the crater. Photo from Belousov and others, 1999.

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.

Information Contacts: *Yuri Demyanchuk, Natasha Gorbsch*, and the *Kamchatka Volcanic Eruptions Response Team (KVERT)*, Institute of Volcanology and Seismology, Far East Division, Russian Academy of Sciences, Piip Ave. 9, Petropavlovsk-Kamchatsky, 683006, Russia (email: kvert@kscnet.ru, URL: http://www.kscnet.ru/ivs/); *Kamchatka Branch of the Geophysical Service of the Russian Academy of Sciences (KB GS RAS)*, Russia (Email: ssl@emsd.iks.ru; URL: http://wwwsat.emsd.ru/alarm.html#VOLCANIC; http://wwwsat.emsd.ru/~ ssl/monitoring/main.htm); *Alaska Volcano Observatory (AVO), a cooperative program of the U.S. Geological Survey*, 4200 University Drive, Anchorage, AK 99508-4667, USA (email: tlmurray@usgs.gov; URL: http://www.avo.alaska.edu/), *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 99709, USA (email: cnye@giseis.alaska.edu).

Slamet

Java, Indonesia
7.242°S, 109.208°E; summit elev. 3,428 m
All times are local (= UTC + 7 hours)

Our last review of Slamet's activity was in November 2000, reporting a white, gas-rich plume from the stratovolcano (*BGVN* 25:11). We are unaware of subsequent reporting until 28 March 2007. Starting that day and through 3 April, a volcano observer reported that plumes had increased in intensity and frequency. This 7-day interval took place after two weeks of heavy rains. The plumes were of sufficient magnitude to be visible in the provincial capital, Semarang, over 138 km to the ENE. The plumes did not significantly impact residents in vicinity of the volcano. Thermal anomalies (MODVOLC) have been absent on the upper cone during 2000 through 5 June 2008.

Geologic Summary: Slamet, Java's second highest volcano at 3,428 m and one of its most active, has a cluster of about three dozen cinder cones on its lower SE-NE flanks and a single cinder cone on the western flank. Slamet is composed of two overlapping edifices, an older basaltic-andesite to andesitic volcano on the W and a younger basaltic to basaltic-andesite one on the E. Gunung Malang II cinder cone on the upper eastern flank on the younger edifice fed a lava flow that extends 6 km to the E. Four craters occur at the summit of Gunung Slamet, with activity migrating to the SW over time. Historical eruptions, recorded since the 18th century, have originated from a 150-m-deep, 450-m-wide, steep-walled crater at the western part of the summit and have consisted of explosive eruptions generally lasting a few days to a few weeks.

Information Contacts: *Dali Ahmad*, Center of Volcanology and Geological Hazard Mitigation, Saut Simatupang, 57, Bandung 40122, Indonesia (URL: http://portal.vsi.esdm.go.id/joomla/); *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/).

Manam

Northeast of New Guinea, SW Pacific
4.080°S, 145.037°E; summit elev. 1,807 m
All times are local (= UTC + 10 hours)

Low-level seismicity and mild eruptions occurred from mid-May 2007 through mid-September 2007 (*BGVN* 32:08). This report addresses activity between the end of September 2007 through mid-May 2008, with gaps in reporting as noted. For the most part, Manam remained at a low eruptive level, but four fatalities from the early 2007 activity were noted in news reports.

According to the Rabaul Volcano Observatory (RVO), ash plumes were occasionally emitted both during the first half of October 2007, during 5-8 November 2007, and on 27 December 2007. The Darwin Volcanic Ash Advisory Centre (VAAC) noted that one plume rose to 3.7 km during 3-9 October and another rose to 3 km on 27 December. White vapor plumes were also emitted occasionally during October and November, and incandescence was reported on 29 September, 1 October, 10-11 October, 30 October, and 4-5 November. Roaring noises were heard on 30 October.

Manam remained quiet during January and February 2008. Both the Main Crater and South Crater continued to release thin to thick white vapor. At Main Crater, a weak red glow was visible at night on 10 January, and a fluctuating red glow was visible from the Main Crater during 8-11 February and 22-25 February. Seismic activity was at the low-to-moderate level through 14 January, when lightning struck the monitoring equipment. The number of daily low-frequency volcanic earthquakes up through the lightning strike ranged between 500 and 970. The equipment was fixed on 28 February. On 29 February, 770 low frequency earthquakes were recorded. On 9-10 February, pale gray ash clouds were emitted from the Main Crater.

RVO reports covering the interval March and April 2008 were unavailable at the time of this writing. RVO reported Manam as quiet during May 2008, emitting only variable amounts of white vapor. Glow was reported from Main Crater on the nights of 16-20 May.

Editors searched MODVOLC thermal alerts on 10 June 2008 and found that they occurred on six days during the interval April-July 2007. After previously mentioned alerts on 16 and 23 May 2007 (UTC)(*BGVN* 32:08), the only subsequent alerts occurred on 8 June and 26 July 2007 (UTC).

The Darwin VAAC reported plumes to altitudes of several kilometers from Manam on 2 April, 14-15 April (ash-and-steam), 23-29 April, and 11-12 May 2008. The plumes during 11-12 May rose to an altitude of 3 km and extended ~ 36 km laterally.

Fatalities and injury. To supplement our previous report (*BGVN* 32:08), we note that an article by *Reuters News Service* on 20 March 2007 reported that during the past week a mudslide on Manam killed four people in "an avalanche of ash and mud," and that a fifth person was seriously injured. RVO noted that they received word of the event on the 15th, suggesting the event was probably on 14 or 15 March. It occurred in a valley on the island's N side.

The news account quoted Health Minister Sir Peter Barter as saying, "The valleys are very dangerous and I am appealing to everyone not to venture into any of the valleys as there are huge quantities of ash and mud deposited on higher slopes. After heavy rain that has been experienced, the mud and loose material becomes a major risk for anyone venturing into the potential path of an avalanche."

Geologic Summary. The 10-km-wide island of Manam, lying 13 km off the northern coast of mainland Papua New Guinea, is one of the country's most active volcanoes. Four large radial valleys extend from the unvegetated summit of the conical 1,807-m-high basaltic-andesitic stratovolcano to its lower flanks. These "avalanche valleys," regularly spaced 90 degrees apart, channel lava flows and pyroclastic avalanches that have sometimes reached the coast. Five small satellitic centers are located near the island's shoreline on the northern, southern and western sides. Two summit craters are present; both are active, although most historical eruptions have originated from the southern crater, concentrating eruptive products during much of the past century into the SE avalanche valley. Frequent historical eruptions, typically of mild-to-moderate scale, have been recorded at Manam since 1616. Occasional larger eruptions have produced pyroclastic flows and lava flows that reached flat-lying coastal areas and entered the sea, sometimes impacting populated areas.

Information Contacts: *Herman Patia* and *Steve Saunders*, 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/).

Jebel at Tair

Red Sea
15.55°N, 41.83°E; summit elev. 244 m
All times are local (= UTC + 3 hours)

On 30 September 2007 an eruption began on the island of Jebel at Tair (*BGVN* 32:10) that generated a large SO_2 plume, sent lava flows into the sea, and resulted in the deaths of Yemeni soldiers. Observations of continuing activity were made in late November-early December 2007, and also in mid-January 2008, but no other eyewitness reports have been received since that time. However, satellite data indicated continuing thermal anomalies, indicative of hot lava flows, into mid-May 2008.

Thermal anomalies detected by the MODIS instrument on the Terra and Aqua satellites were recorded daily from the beginning of the eruption through 14 January 2008 (figure 11). After that time the detections of anomalies became more intermittent, and fewer alert pixels were recorded each time. Only single-pixel anomalies were observed after

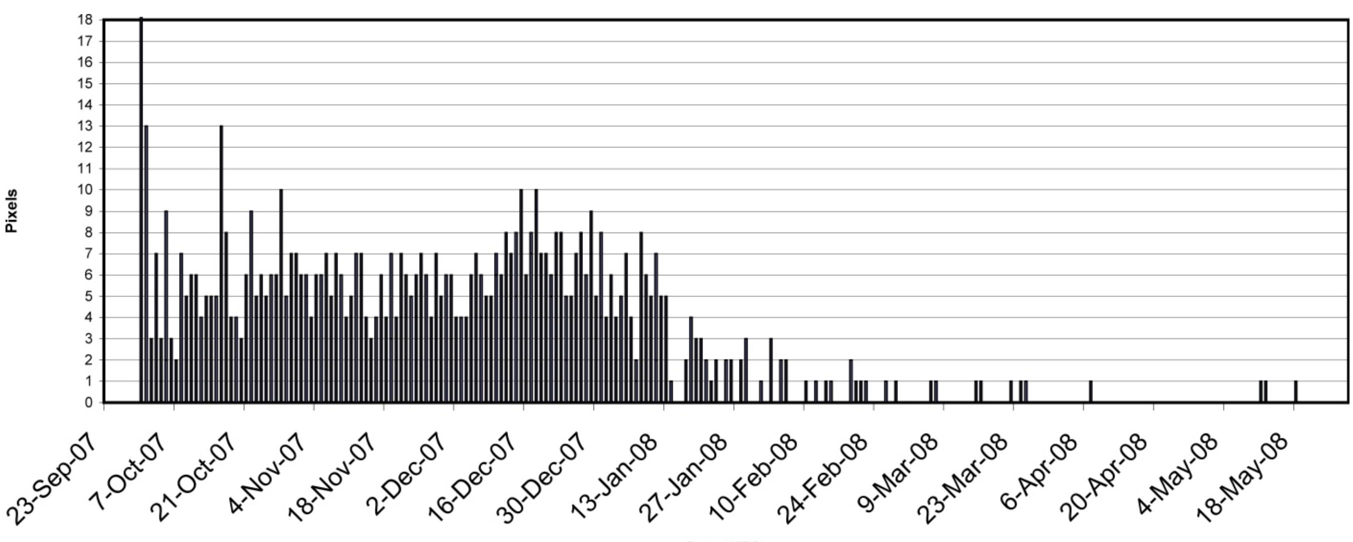


Figure 11. Plot showing the maximum number of daily MODVOLC thermal alert pixels detected at Jebel at Tair using MODIS data from Aqua and Terra satellites, September 2007-May 2008. Data courtesy of Hawai'i Institute of Geophysics and Planetology (HIGP) Thermal Alerts System.

19 February, and the 19-22 February period was the last time anomalies were recorded for more than two consecutive days. Single anomalous pixels were later noted on 13 days from 26 February through May 2008, all apparently located on the N or NW slopes; the last one was on 18 May.

News media reports about the continuing eruption published in early December 2007 stated that at least eight soldiers had been killed during the initial activity on 30 September. Following a magnitude 2.7 earthquake in the Red Sea on 3 December reported by the Yemen Earthquake Observation Center (EOC), other officials were quoted as saying the eruption was "strong" with lava "shooting high in the air." The news stories also noted that two seismic stations had been installed on the Red Sea islands of Zuqar and Hunaish in late November 2007.

A later news report from 13 January 2008 indicated that a third seismic station was placed on the island of Kamaran. The 13 January story in the Yemen Times also included information from the head of the General Authority for Developing Yemeni Islands (GADYI), a government agency, indicating that "smoke steam" plumes were still rising from the crater.

Satellite data analysis. Eckhardt and others (2008) developed an "inverse modeling technique for estimating the vertical profile of SO_2 emissions from a volcanic eruption, using total column measurements of SO_2 from satellites and a Lagrangian particle dispersion model." Cloud-free satellite views of the 30 September 2007 eruption at Jebel at Tair and the long-range SO_2 transport made for an "ideal" test case of the model. Modeling results will not be presented here, but the data analysis undertaken to initialize and test the model produced additional information about the eruption itself. The eruption began earlier than previously reported, and the plume reached stratospheric altitudes.

The onset of the eruption was not well documented, but soldiers reported entering the water to escape the eruption at 1530 local time (*BGVN* 32:10). By that time the water was described as "boiling" by survivors. Eckhardt and others (2008) looked for signs of the eruption onset using SEVIRI (Spinning Enhanced Visible and Infra-red Imager) satellite imagery (12µ channel). Their analysis of the temperature data suggested that the initial eruption took place before 1427 local time (1127 UTC). Temperature profiles also showed that the eruption cloud penetrated the tropopause, the atmospheric boundary found here at 15.3 km altitude (Eckhardt and others, 2008). Their initial eruption findings were summarized as follows: satellite observations combined with ECMWF (European Center for Medium range Weather Forecasting) and radiosonde profiles suggested an initial eruption no later than 1427; the plume reached neutral buoyancy no earlier than 1500; the minimum value of the 12µ brightness temperature was at 1557, and the plume reached an altitude above 16 km.

Total SO_2 column measurements from AIRS (Atmospheric Infrared Sounder), OMI (Ozone Monitoring Instrument), and SEVIRI enabled Eckhardt and others (2008) to estimate a total emission of 80 (± 20) kt of SO_2 into the atmosphere. Some instruments observed the plume dispersion for over a week, as it stretched across Asia and the Pacific Ocean.

Reference: Eckhardt, S., Prata, A.J., Seibert, P., Stebel, K., and Stohl, A., 2008, Estimation of the vertical profile of sulfur dioxide injection into the atmosphere by a volcanic eruption using satellite column measurements and inverse transport modeling: Atmospheric Chemistry and Physics Discussions, v. 8, p. 3761-3805.

Geologic Summary. The basaltic Jebel at Tair volcano rises from a 1200 m depth in the south-central Red Sea, forming an oval-shaped island about 3 km long. Jebel at Tair (one of many variations of the name, including Djebel Teyr, Jabal al Tayr, and Jibbel Tir) is the northernmost known Holocene volcano in the Red Sea and lies SW of the Farisan Islands. Youthful basaltic pahoehoe lava flows from the steep-sided central vent, Jebel Duchan, cover most of the island. They drape a circular cliff cut by wave erosion of an older edifice and extend beyond it to form a flat coastal plain. Pyroclastic cones are located along the NW and southern coasts, and fumarolic activity occurs from two uneroded scoria cones at the summit. Radial fissures extend from the summit, some of which were the sources of lava flows. The island is of Holocene age, and explosive eruptions were reported in the 18th and 19th centuries.

Information Contacts: *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/); *Yemen Times* (URL: http://yementimes.com/); *Yemen Observer* (URL: http://www.yobserver.com/).