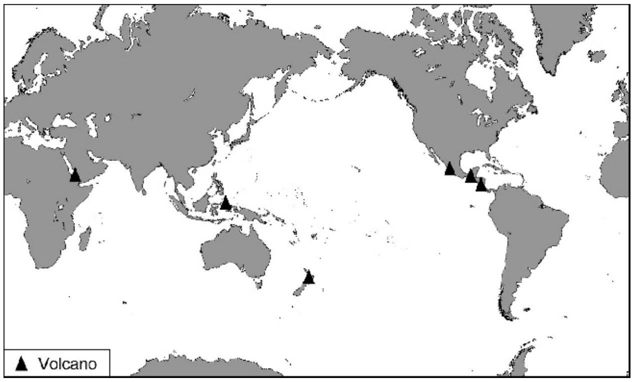
Bulletin of the Global Volcanism Network



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Jebel at Tair

Red Sea, Yemen
15.55°N, 41.82°E; summit elev. 244 m
All times are local (= UTC + 3 hours)

An eruption that began on the afternoon of 30 September 2007 from Jebel at Tair (figure 1) sent lava flows across the NE part of the 2 x 3 km island to the sea, and resulted in fatalities among Yemen military personnel. The eruption continued through at least the end of November. A wide variety of spelling variations have been used to identify this island volcano, which is generally translated as meaning “Bird Island” in English; the name used in this report is based on Gass and others (1973). The following information is based on a compilation of news media reports, observations and reports from NATO (North Atlantic Treaty Organization) ship crews that assisted with search and rescue operations, and satellite data.

A survivor rescued by the HMCS *Toronto*, Ahmad Abdullah al-Jalal, stated that the eruption “started with shocks like quakes, and then we heard huge blasts with lava and rocks spewing out and dropping on us.” Al-Jalal also said that he and six fellow soldiers decided to flee the island by trying to swim through “boiling water” surrounding the island. He claimed to have entered the water at 1530 local time, shortly after the eruption began.

Before the island was visible on the horizon from the NATO ships, the glow of molten rock could be seen lighting up the night sky and a spout of lava was clearly visible. As the ships arrived just after dusk, the crews saw multiple

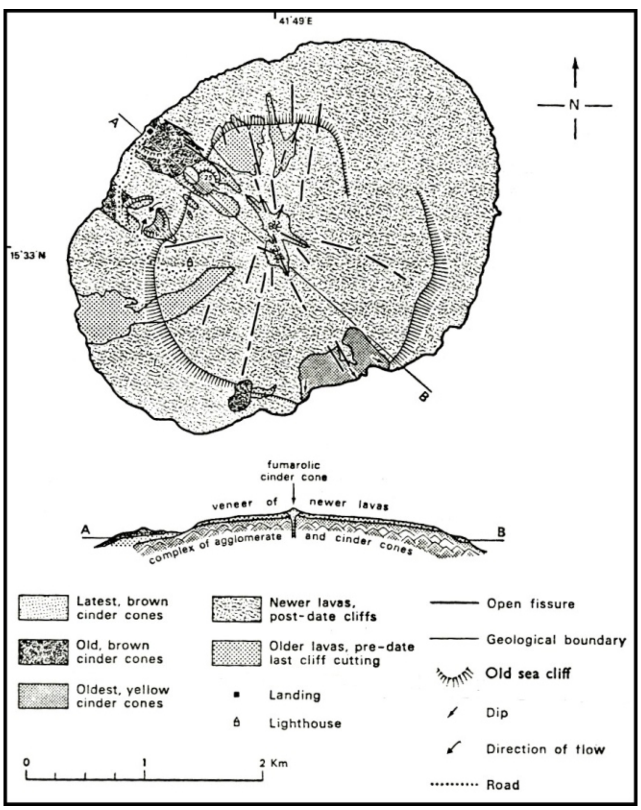

Figure 1. Geologic map and cross-section of Jebel at Tair showing the old sea cliff, areas of older lava flows, and yellow cinder cones. The central highland area contained a fumarolic cinder cone noted at the time of the study. Modified from Gass and others (1973).

Figure 2. Fire fountains rising from a fissure eruption at Jebel at Tair, 30 September 2007. Infrared photo taken from the deck of the Canadian frigate HMCS *Toronto* offshore of the island. Photo by MCpl Kevin Paul, Canadian Forces Combat Camera.

Figure 3. Large floating ash and pumice rafts resulted from the 30 September eruption of Jebel at Tair. One of these rafts can be seen in this photo with the USS *Bainbridge* about 20 km from the island on 2 October 2007. Photo by MCpl Kevin Paul, Canadian Forces Combat Camera.

lava flows moving down the slopes. Lava flows and fire fountains were visible on the infrared camera of the Shipboard Electro-Optical Sensor System (SEOSS), though with the naked eye sailors could make out a faint red glow in the cloud of steam and smoke. The infrared camera allowed sailors to watch the lava flow down the slopes into the water, and the enormous pillar of steam rising above it. Photographs and video clearly showed that the source of the lava flows was not confined to a vent near the summit, but was also originating from NE flank fissures that were producing multiple fire fountains (figure 2). Small boats approached within 15 m of the lava-flow ocean entries, where sailors could feel the heat from the lava, steam plumes, and heated seawater.

Ash plumes were also observed by shipboard observers rising 300 m. Tephra from the activity fell into the water and created floating rafts of ash and pumice that were described in some news reports as extending almost 10 km from the island. NATO ships later encountered the volcanic material 20 km away (figure 3). Lava flows at the shoreline on 2 October remained fluid in some areas (figure 4), while others were steaming (figure 5). Enough steam was rising from the lava flows on the NE side of the island to form a small plume (figure 6).

Conflicting information reported by news media was attributed to the Yemen Earthquake Observation Centre regarding precursory seismicity. It appears that there was at least some level of increased seismicity in the Red Sea, perhaps as early as 7 September. Starting on 22 September earthquakes with magnitude 2.0-3.6 were allegedly recorded, with five of the larger ones occurring on 30 September. Some reports stated that there were three earthquakes up to M 4.3 on the afternoon of 30 September.

Figure 4. Lava entering the ocean at Jebel at Tair, 2 October 2007. U.S. Navy photo by Mass Communication Specialist 3rd Class Vincent J. Street.

Figure 5. Steaming lava flows seen along the NW shoreline of Jebel at Tair, 2 October 2007. U.S. Navy photo by Mass Communication Specialist 3rd Class Vincent J. Street.

Evacuations and fatalities. Statements from Yemeni Coast Guard sources to news media soon after the onset of activity were that “around 50" soldiers had been evacuated from the island. Communications from the Yemeni Coast Guard to the NATO fleet, when assistance was requested on 30 September, indicated that 21 of the 29 soldiers on the island had been rescued with eight missing. Ships later rescued two soldiers and recovered the bodies of four soldiers from the Red Sea. Reports on 1 October by news media quoting evacuated soldiers and sources in the Yemeni Naval Forces indicated that 3-4 soldiers were killed at the onset of the eruption. One soldier stated that his comrades had been ”burned by lava." No official statements were later made about fatalities among the soldiers, so it is unknown if these early reports were accurate.

Assistance from NATO. On the afternoon of 30 September 2007, Standing NATO Maritime Group 1 received a report of an explosion about 150 km N of the force. Two ships scouting ahead were on scene by late afternoon, confirming an eruption. The six NATO ships included Portuguese frigate NRP *Alvares Cabral* with her Lynx Mk95 helicopter, American destroyer USS *Bainbridge*, Dutch frigate HNLMS *Evertsen*, Danish frigate HDMS *Olfert Fischer*, German oiler FGS *Spessart*, and the previously mentioned Canadian frigate HMCS *Toronto*.

Working directly with the Yemen Coast Guard Operations Center, following an official request for assistance, NATO crews searched the volcanic debris-filled waters around the island throughout the night for survivors. After the Yemeni Coast Guard ended the search operation at daybreak and the NATO ships were departing the area, the USS *Bainbridge* sighted and recovered a survivor. He had drifted about 10 km N of the island, and was found at 0845 on 1 October. Shortly thereafter, HMCS *Toronto* recovered a second survivor. The only further discoveries were those of soldiers who perished at sea, two found by NATO and two by the Coast Guard.

Satellite imagery and data. Hot spots were detected in MODIS thermal infrared satellite imagery from Jebel at Tair beginning at 2220 (1920 UTC) on 30 September. Thermal anomalies detected by MODIS-MODVOLC continued on a daily basis through November 2007.

Aqua MODIS imagery taken at 1340 (1040 UTC) on 1 October showed a white plume covering the entire NE half of the island. A small white plume rising from the N end of the island was noticeable in visible MODIS imagery on 8 October. Also on 8 October, a Terra ASTER (Advanced Spaceborne Thermal Emission and Reflection Radiometer) image clearly showed recent lava flows emanating from the summit crater along with a thermal anomaly both in the crater and a small elongate anomaly, probably a lava flow or eruptive fissure, immediately to the NNE. Gas plumes were also rising from the summit crater and near-summit lava flows. Lava flows seen in

Figure 6. Photograph of steam plumes rising from Jebel at Tair, 2 October 2007. View looking N taken from the USS Bainbridge. U.S. Navy photo by Mass Communication Specialist 3rd Class Vincent J. Street.

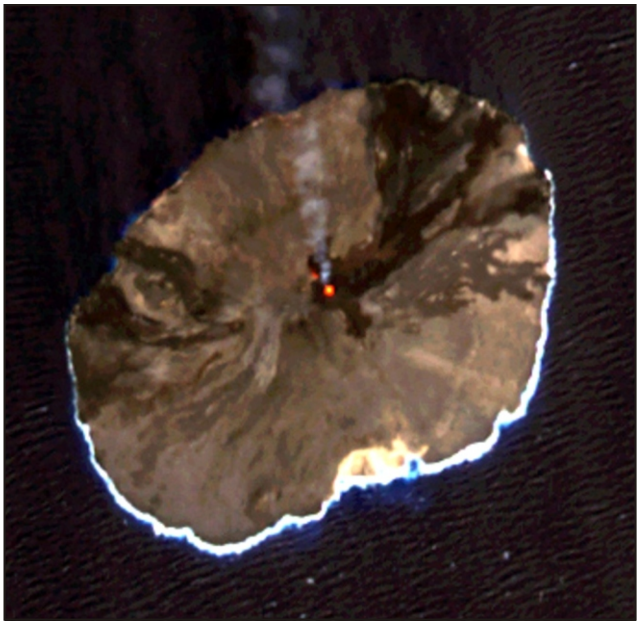

Figure 7. Terra ASTER image of Jebel at Tair on 15 October 2007 showing the active summit crater and fresh lava flows. Recent lava flows can be seen extending 2 km NE to the coast, and small flows not present on imagery from 8 October moved NE, NNW, and SE from the vent. A diffuse gas plume is rising and blowing N from the summit crater. Tonal ranges have been adjusted to enhance lava flows. N is towards the top of the image. Courtesy of NASA Earth Observatory.

the 8 October image had moved NE from the source before branching out and entering the sea across most of the NE coast at a distance of 2 km from the summit.

Another ASTER image acquired on 15 October (figure 7) provided evidence that the eruption was continuing, with a strong thermal anomaly from the summit crater and from summit-area lava flows. Two new areas of lava flows could be seen compared to the 8 October image, to the NNW and SE, each extending more than 400 m from the crater.

Sulfur dioxide emissions. The Ozone Monitoring Instrument (OMI) aboard NASA's Aura satellite detected significant SO_2 emissions associated with the 30 September eruption. No SO_2 emissions were apparent in OMI data collected at 1315 (1015 UTC) on 30 September. On 1 October at 1400 (1100 UTC) a large SO_2 cloud was observed NW of the volcano over NE Sudan and the Red Sea (figure 8), and a less concentrated plume was emanating from the island. The total SO_2 burden measured by OMI at this time was ~ 70 kilotons.

Subsequently, through 5 October, only very weak SO_2 emissions were detected near the volcano. The SO_2 cloud observed on 1 October continued to drift across the Arabian Peninsula and central Asia, and on 5 October the leading edge of the cloud reached Japan. The precise altitude of the SO_2 cloud is currently unknown, but the speed and pattern of its dispersion, coupled with a relatively slow decrease in SO_2 burden, imply that it was transported by the subtropical jet stream at an altitude of at least 10 km. This high altitude

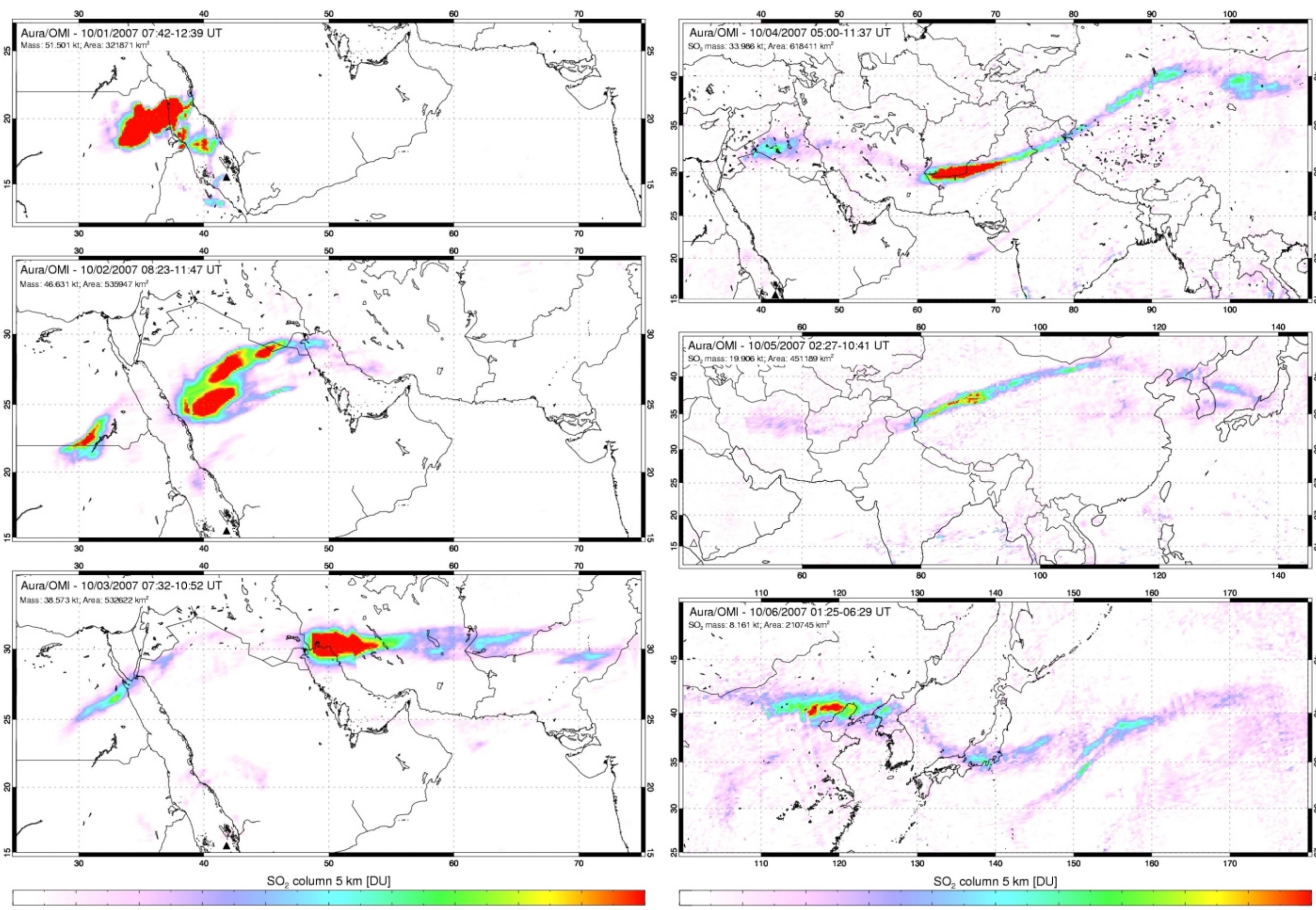

Figure 8. Sequence of maps showing the long-range transport by the subtropical jet stream of the SO_2 cloud from the Jebel at Tair eruption during 1-6 October 2007. The identifiable cloud reached across Asia and well out over the Pacific Ocean. Courtesy of Simon Carn.

suggests an energetic eruption with high lava effusion rates in the early stages of the event.

Observations during November 2007. On 3 November at 0500 Captain Lars Melin and crew aboard the MV *Falstaff* observed the continuing activity. Incandescence and lava fountains (figure 9) were seen on the NW side of the island near the summit from 6-7 km offshore as the ship passed along the W side. Lava fountains were an estimated 20-50 m high.

Geologic Summary. The basaltic Jebel at Tair stratovolcano rises from a 1,200 m depth in the south-central Red Sea, forming an oval-shaped island about 3 km long. Jebel at Tair 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 S 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.

Reference: Gass, I.G., Mallick, D.I.J., and Cox, K.G., 1973, Volcanic islands of the Red Sea: J Geol Soc London, v. 129, p. 275-310.

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/); *Simon Carn*, Joint Center for Earth Systems Technology, University of Maryland Baltimore County (UMBC), 1000 Hilltop Circle, Baltimore, MD 21250 USA (Email: scarn@umbc.edu, URL: http:// www.volcarno.com/, http://so2.umbc.edu/omi/); *Lars Melin*, M/V Falstaff, Sweden (Email: lars.g.melin@telia.com); *NASA Earth Observatory* (URL: http://earthobservatory.nasa.gov/); *Ensign Matthew A. Goetz*, US Navy, Staff Public Affairs Officer (SPAO) (Email: goetzma@ddg96.navy.mil); *Yemen Observer* (URL: http://www.yobserver.com/); *Agence France Presse* (URL: http://www.afp.com/); *Yemen News Agency (SABA)* (URL: http://www.sabanews.net/en/); *Lookout Newspaper* (URL: http://www.lookoutnewspaper.com/); *Navy NewStand* (URL: http://www.navy.mil/swf/index.asp); *Deutsche Presse-Agentur* (URL: http://www.dpa.de/); *The Canadian Press* (URL: http://www.thecanadianpress.com/); *The Chronicle Herald* (URL: http://thechronicleherald.ca/); *Associated Press* (URL: http://www.ap.org/).

Figure 9. Night-time photograph of lava fountains and incandescence from the summit crater at Jebel at Tair, 30 November 2007. Material was estimated to be rising 20-50 m as viewed from 6-7 km offshore during the night. Courtesy of Lars Melin.

Dukono

Halmahera, Indonesia
1.68°N, 127.88°E; summit elev. 1,335 m
All times are local (= UTC + 9 hours)

Based on visual observations, the Center of Volcanology and Geological Hazard Mitigation (CVGHM) reported that during the week of 18-25 June 2007 white-gray ash rose to 50-250 m above the summit. The hazard status of the volcano remained on level 2 (on a scale of 1-4).

No significant change of seismicity was noted with respect to previous weeks, and no thermal anomalies were measured during that week by the MODIS/MODVOLC satellite team (table 1). Subsequently, a sequence of thermal anomalies were measured by satellite between 10 August and 27 October 2007.

Geologic Summary. Reports from this remote volcano in northernmost Halmahera are rare, but Dukono has been one of Indonesia's most active volcanoes. More-or-less continuous explosive eruptions, sometimes accompanied by lava flows, occurred from 1933 until at least the mid-1990s, when routine observations were curtailed. During a major eruption in 1550, a lava flow filled in the strait between Halmahera and the north-flank cone of Gunung Mamuya. Dukono is a complex volcano presenting a broad, low profile with multiple summit peaks and overlapping craters. Malupang Wariang, 1 km SW of Dukono's summit crater complex, contains a 700 x 570 m crater that has also been active during historical time.

Information Contacts: *Center of Volcanology and Geological Hazard Mitigation (CVGHM)*, Jalan Diponegoro 57, Bandung 40122, Indonesia (URL: http://

Date (2007)	Time (UTC)	Pixels	Satellite
09 Mar-09 Aug	—	none	—
10 Aug	1645	1	Aqua
27 Sep	1350	1	Terra
02 Oct	1705	1	Aqua
04 Oct	1355	1	Terra
04 Oct	1650	1	Aqua
11 Oct	1405	1	Terra
13 Oct	1350	1	Terra
13 Oct	1645	2	Aqua
16 Oct	1715	1	Aqua
18 Oct	1410	2	Terra
18 Oct	1705	1	Aqua
27 Oct	1655	1	Aqua
28 Oct-27 Nov	—	none	—

Table 1. Thermal anomalies at Dukono based on MODIS-MODVOLC imaging between 9 March 2007 and 27 November 2007 (continued from the list in *BGVN* 32:03). Courtesy of Hawai'i Institute of Geophysics and Planetology (HIGP) Thermal Alerts System.

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), University of Hawai'i, 2525 Correa Road, Honolulu, HI 96822, USA (http://hotspot.higp.hawaii.edu/).

Gamkonora

Halmahera, Indonesia
1.38°N, 127.53°E; summit elev. 1,635 m
All times are local (= UTC + 9 hours)

According to the Center of Volcanology and Geological Hazard Mitigation (CVGHM), on 8 July 2007 a phreatic eruption from Gamkonora (figure 10) produced a white-gray ash plume that rose to an altitude of 1.8 km. The plume drifted N, and ashfall was reported from villages as far as 7 km downwind. The Alert Level was raised to 2 (on a scale of 1-4). The only two previous *Bulletin* reports on Gamkonora, in 1981 and 1987 (*SEAN* 06:07 and 12:04), described eruptions generating plumes that rose to less than 1 km above the vent.

On 9 July 2007, seismic activity increased and, according to the Darwin Volcanic Ash Advisory Centre (VAAC), eruption plumes rose to altitudes of 2.1-2.6 km. The Alert Level was raised to 3. Later that day, ash plumes rose to an altitude of 5.6 km, and the Alert Level was raised to 4. On 9 July, the Hawai'i Institute of Geophysics and Planetology (HIGP) Thermal Alerts System identified a 1-pixel thermal anomaly recorded by the MODIS Terra satellite. This was the only thermal anomaly measured for this volcano since the beginning of 2007. No further thermal anomalies were measured from 10 July to 27 November 2007.

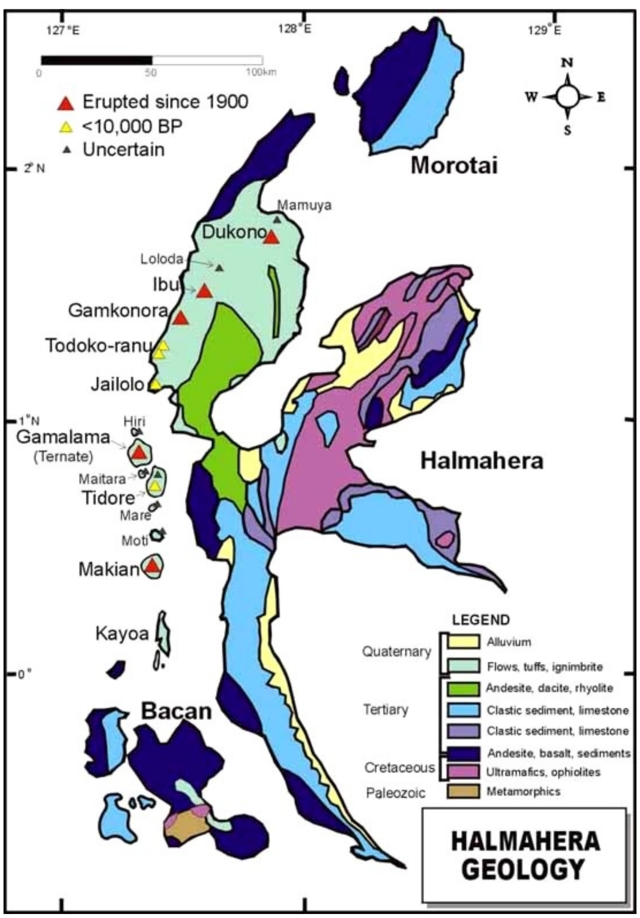

Figure 10. Geology of the island of Halmahera showing the locations of Dukono, Gamkonora, and Gamalama volcanoes. The map distinguishes volcanoes into three groups based on the time of last eruption: erupted since 1900; erupted earlier than 1900 but within 10,000 years before present (BP); and uncertain date of eruption. Courtesy of Volcano World (map by Grant Davey and Dan Olberg, PT Nusa Halmahera Minerals).

During 9-10 July, incandescent material was propelled 5-50 m above the crater and intermittently showered the flank. On 10 July, booming noises were followed by ash plumes that rose to an altitude of 4.1 km. About 8,400 people were evacuated from villages within an 8 km radius of the volcano.

Visual observations of ash plumes during 12-15 July were hindered by cloud cover. On 16 July, the Alert Level was lowered from 4 to 3 due to a significant decrease in seismic activity, a decline in ash-plume altitudes, and the absence of summit incandescence. On 24 July CVGHM further lowered the Alert Level to 2 based on visual observations and another decrease in seismicity. Later, during 16-23 July, when breaks in inclement weather took place, observers saw white plumes rising to altitudes of 5.6 km. Available CVGHM reports issued through late 2007 did not disclose further events. According to Saut Simatupang, the head of Indonesia's Volcanological Survey, local flights on surrounding islands were affected. Longer distance domestic flights to eastern Indonesia were not disrupted.

Geologic Summary. The shifting of eruption centers on Gamkonora, at 1,635 m the highest peak of Halmahera, has produced an elongated series of summit craters along a N-S trending rift. Youthful-looking lava flows originate near the cones of Gunung Alon and Popolojo, S of Gamkonora. Since its first recorded eruption in the 16th century, Gamkonora has typically produced small-to-moderate explosive eruptions. Its largest historical eruption, in 1673, was accompanied by tsunamis that inundated villages.

Information Contacts: *Center of Volcanology and Geological Hazard Mitigation (CVGHM)*, Jalan Diponegoro 57, Bandung 40122, Indonesia (URL: http://portal.vsi.esdm.go.id/joomla/); *Darwin Volcanic Ash Advisory Centre (VAAC)*, Bureau of Meteorology, Northern Territory Regional Office, PO Box 40050, Casuarina, NT 0811, Australia (URL: http://www.bom.gov.au/info/vaac/); *Hawai'i Institute of Geophysics and Planetology (HIGP) Thermal Alerts System*, School of Ocean and Earth Science and Technology (SOEST), University of Hawai'i, 2525 Correa Road, Honolulu, HI 96822, USA (URL: http://hotspot.higp.hawaii.edu/); *Volcano World* (URL: http://volcano.und.edu/).

Gamalama

Halmahera, Indonesia
0.80°N, 127.33°E; summit elev. 1,715 m

On 24 August 2007, the Center of Volcanology and Geological Hazard Mitigation (CVGHM) raised the Alert Level of Gamalama from 1 to 2 (on a scale of 1-4) due to an increase in seismic activity beginning 20 August. Prior to 10 August, diffuse white plumes rose to an altitude of 1.8

km, then increased in altitude to 2 km during 10-23 August. On 23 August, white and gray plumes rose to an altitude of 2.1 km. Concurrent with the increased Alert Level, government officials banned access within a 2-km radius of the active crater. No thermal anomalies were measured by MODIS satellites during this time. CVGHM lowered the Alert Level to 1 on 9 October 2007, based on visual observations of plume altitudes and a decline in seismicity.

Geologic Summary. Gamalama (Peak of Ternate) is a near-conical stratovolcano that comprises the entire island of Ternate off the western coast of Halmahera and is one of Indonesia's most active volcanoes. The island of Ternate was a major regional center in the Portuguese and Dutch spice trade for several centuries, which contributed to the thorough documentation of Gamalama's historical activity. Three cones, progressively younger to the north, form the summit of Gamalama, which reaches 1715 m. Several maars and vents define a rift zone, parallel to the Halmahera island arc, that cuts the volcano. Eruptions, recorded frequently since the 16th century, typically originated from the summit craters, although flank eruptions have occurred in 1763, 1770, 1775, and 1962-63.

Information Contacts: *Center of Volcanology and Geological Hazard Mitigation (CVGHM)*, Jalan Diponegoro 57, Bandung 40122, Indonesia (URL: http://portal.vsi.esdm.go.id/joomla/).

Ruapehu

New Zealand
39.28°S, 175.57°E; summit elev. 2,797 m

There were no reports of activity at Ruapehu following the lahar initiated by the bursting of the tephra dam at Crater Lake on 18 March 2007 (*BGVN* 32:06). On 25 September an explosive, relatively small, eruption prompted GeoNet to raise the Alert level to 2 (on a scale of 0-5). The eruption, which was probably emitted from Crater Lake, was accompanied by an earthquake (M 2.9) lasting eight minutes. The earthquake, preceded by about 10 minutes of minor seismicity, was too weak and short in duration to provide any meaningful warning of the eruption. Pilots reported a plume that rose to an altitude below 4.6 km.

On 26 September, aerial observations (figure 11) revealed that the summit area was covered with ash and mud, mostly directed N, and deposits reached 2 km from Crater Lake. The ballistic rockfall apron exceeded the ashfall zone, indicating the force of ejection. Impact craters caused by large falling blocks (more than 1 m in diameter) were also evident. The ballistic rocks, ejected from the bottom of the lake, were of several types: andesitic flows from the 1945 and 1995/1996 eruptions, a variety of tephra, and

Figure 11. Summit of Ruapehu, taken from a plane on 26 September 2007, showing a lahar on the Whangaehu glacier. Courtesy of GeoNet.

vent-fill debris. To date, there has been no evidence of fresh magma in the ejecta.

Reports from ski-field operators, the Eastern Ruapehu Lahar Alarm and Warning System (ERLAWS), and scientists from GNS Science and Massey University indicated that at least two eruption-associated lahars occurred. The Whakapapa ski field lahar traveled W approximately 1 km down the ski field, reaching halfway down the far west T-bar to an elevation of about 2,100 m. The deposit is about 30 m wide and consists of gray ashy snow, with fragments of rime ice and scattered rocks. Initial estimates suggest the lahar traveled at 20-30 km/hour.

A snow slurry lahar also traveled E down the Whangaehu River, leaving a deposit about 80 m wide and 1-3 m thick near the Round-the-Mountain-Track Bridge 7 km from Crater Lake. The deposits comprise dirty granular snow with a small percentage of Crater Lake water and mud, and scattered ice fragments and pieces of rock. The deposits thin rapidly downstream, with a thickness of ~ 40 cm at the bund (10 km), 30 cm at the Wahianoa aqueduct (23 km), and 10-20 cm at the Rail gauge (28 km). Data from flow monitoring indicated two depositional and one erosional flow phase.

According to scientists from GNS Science and the Department of Conservation who visited on 27 September, the crater lake was 2-3 m below overflow, indicating that about 500,000 m^3 of water was ejected during the eruption. There was a strong upwelling from the northern vent under the lake, and some sulfur slicks and white frothy, gas-rich patches on the lake surface.

A much less active discharge was observed over the usually more active southern vent area. The lake was a uniform gray color, being well-mixed. The lake temperature just after the eruption was 19°C, compared to 13°C before the eruption.

There is evidence for hydrothermal sealing of the vent prior to the eruption. A number of sulfur-bearing rocks show evidence of the sulfur having been molten on ejection, indicating vent temperatures at the base of the lake in excess of 119°C.

According to news articles, the eruption prompted evacuations at several ski lodges and caused train service to be temporarily suspended. A boulder crashed through the roof of a hut and injured one person.

On 9 October, the Alert Level at Ruapehu was lowered to 1 because no further eruptions had occurred since the 25 September event.

This eruption was similar to the 1969, 1975 and 1988 eruptions, although it was smaller than the 1969 and 1975 events, and larger than 1988 event. All available evidence to date indicates the eruption was hydrothermal.

Geologic Summary. Ruapehu, one of New Zealand's most active volcanoes, is a complex stratovolcano constructed during at least 4 cone-building episodes dating back to about 200,000 years ago. The 110 km^3 dominantly andesitic volcanic massif is elongated in a NNE-SSW direction and is surrounded by another 100 km^3 ring plain of volcaniclastic debris, including the Murimoto debris-avalanche deposit on the NW flank. A series of subplinian eruptions took place at Ruapehu between about 22,600 and 10,000 years ago, but pyroclastic flows have been infrequent at Ruapehu. A single historically active vent, Crater Lake, is located in the broad summit region, but at least five other vents on the summit and flank have been active during the Holocene. Frequent mild-to-moderate explosive eruptions have occurred in historical time from the Crater Lake vent, and tephra characteristics suggest that the crater lake may have formed as early as 3,000 years ago. Lahars produced by phreatic eruptions from the summit crater lake are a hazard to a ski area on the upper flanks and to lower river valleys.

Information Contacts: New Zealand GeoNet Project (URL: http://www.geonet.org.nz/); *New Zealand Department of Conservation*, Private Bag, Turangi, New Zealand (URL: http://www.doc.govt.nz/); *Institute of Geological & Nuclear Sciences* (IGNS), Private Bag 2000, Wairakei, New Zealand (URL: http://www.gns.cri.nz/); *Shane J. Cronin*, Volcanic Risk Solutions, Institute of Natural Resources, Massey University, Private Bag 11 222, Palmerston North, New Zealand (URL: http://volcanic.massey.ac.nz/); *Natural Hazards Research Centre*, University of Canterbury, Private Bag 4800, Christchurch 8140 (URL: http://www.nhrc.canterbury.ac.nz/); *Agence France-Presse* (URL: http://www.afp.com/).

Colima

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

Eruptive activity between July 2005 and February 2006 included ash plumes up to 10 km in altitude, lahars to a length of about 10 km, pyroclastic flows, and landslides (*BGVN* 31:03). Periodic eruptions have continued through at least 1 November 2007, with resulting ash or ash-and-steam plumes, some of which reached an altitude of 6.1 km (6.7 km on 30 November 2006). Some plumes have been detected by satellite imagery.

During 21-27 March and 22-30 April 2007, incandescent material from Colima reached as high as 50-150 m above the summit. Information for this report was provided by the Washington Volcanic Ash Advisory Center (VAAC), based on the Mexico City Meteorological Watch Office (MWO), the Volcanological Observatory of Colima University, and satellite imagery.

Figure 12. Photograph showing a typical Vulcanian explosion at Colima, 10 March 2007. Courtesy of Colima Volcano Observatory.

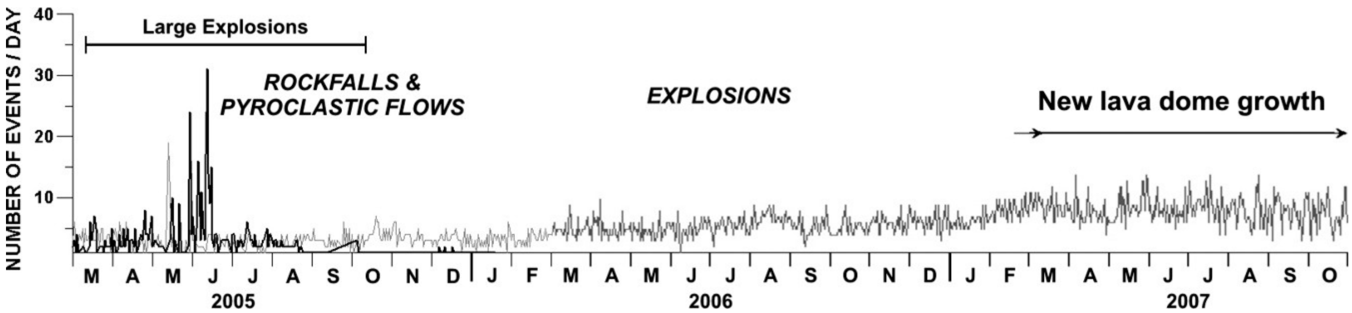

Figure 13. Number of seismic events per day at Colima during March 2006 to October 2007. A heavier line during 2005 indicates events caused by rockfalls and pyroclastic flows; the lighter line represents explosion earthquakes. Episodes of large explosions and lava doem growth are also noted. Courtesy of Colima Volcano Observatory.

In July and November 2006 and August 2007, State government officials warned that the threat of eruptions at Colima continued and that overflights without scientific or civil defense objectives were restricted. The officials also warned population to stay out of ravines near the volcano during the rainy season for fear of lahars.

According to the State government of Colima, on 16-17 November 2006, ashfall was reported in villages near the volcano, including Cuauhtémoc and Colima.

According to Vyacheslav Zobin, the period from October 2005 to January 2007 was characterized by small steam-and-ash Vulcanian explosions (figure 12). Beginning in January 2007, the small explosions increased in number, but decreased in both their energy and the total ash fraction. Zobin explained that this change marked the beginning of a new episode of lava dome growth in the crater (figure 13), first observed on 9 February 2007. Dome growth continued (figure 14) with a low mean effusion rate of about 0.01-0.03 m^3/s during February-October 2007 and reached a volume of about 60,000-80,000 m^3.

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 4320 m high point of the complex) on the north and the 3850-m-high historically active Volcán de Colima at the south. A group of cinder cones of late-Pleistocene age is located on the floor of the Colima graben west and east 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 south, 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.

Figure 14. Photograph of a new lava dome in the crater at Colima, October 2007. Courtesy of Jeff Johnson, New Mexico Institute of Mining & Technology.

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Santa María

Guatemala
14.756°N, 91.552°W; summit elev. 3,772 m
All times are local (= UTC - 6 hours)

Activity during late March 2006 through November 2007 at Santa Maria's Santiaguito lava-dome complex included ash emissions similar to those during October 2005-March 2006 (*BGVN* 31:04). The Instituto Nacional de Sismologia, Vulcanologia, Meterologia, e Hidrologia (INSIVUMEH), the Coordinadora Nacional para la Reducción de Desastres (CONRED), and the Washington Volcanic Ash Advisory Center (Washington VAAC) provided information for this report.

A large number of weak-to-moderate explosions continued at Santiaguito, producing ash plumes that rose above the volcano and depositing ash through the surrounding area. On numerous occasions, short pyroclastic flows and block-and-ash avalanches descended the S and SW flank of Caliente Dome. Several lahars were recorded from June to October 2007 along the Nima I and Samala rivers.

Activity during March-December 2006. A large number of weak-to-moderate explosions occurred during 22-28 March 2006, producing ash plumes that rose to ~ 1 km above the volcano. The plumes drifted SW, depositing ash

8-10 km away. On several days, short pyroclastic flows and block-and-ash avalanches descended the SW flank of Caliente Dome. Explosions on 17 April produced ash plumes 500-900 m high, and pyroclastic avalanches sent material down the S flank.

About two months passed from mid-April until mid-June without reported explosive activity. Then, explosions on 15-16, 18, 21, and 26 June produced gas-and-steam plumes with moderate to no ash content that reached 1 km above the summit. Lahars were observed on 18 and 19 June.

On 1 July small ash plumes noted by the Washington VAAC reached altitudes of 5.8 km and drifted SW. INSIVUMEH reported that another ash plume on 3 July rose 800 m. Steaming from an incandescent avalanche deposit was also visible from the NE base of Caliente cone. Explosions on 9 and 10 August produced gas-and-steam plumes with little-to-no ash content that reached heights of ~ 1.5 km and drifted SW. Two explosions on 21 September caused minor ashfall and small block avalanches. A pyroclastic flow the next day was generated by material coming off of Caliente Dome. Additional explosions on 26 and 29 September again caused ashfall to the SW. Lava extrusion on the 29th triggered avalanches that sent blocks to the base of the crater.

According to the Washington VAAC, minor emissions on 18, 26, 27, and 30 October were visible on satellite imagery. The small plumes of gas and light ash drifted W. Minor emissions seen on satellite imagery on 14 November sent small ash clouds WSW. Explosion plumes reached an altitude of 5.3 km on 15 November, causing ashfall to the N. Lava flows that day moved down the SW, S, and SE flanks of Caliente Dome. On 17 November, explosions produced white-and-gray plumes that drifted SW, where light ashfall was reported. Based on satellite imagery, the Washington VAAC reported more gas-and-ash emissions on 19 November; plumes drifted W.

Satellite imagery revealed ash plumes on 5, 7, and 10 December that drifted SW, NW, and W, respectively. Constant incandescent avalanches on 8 December came from the S and SE edge of dome and from the toe of the active lava flow on the SW flank. Ash plumes caused slight ashfall to the SW. On 28 December a series of small sector collapses from the SW edge of the Caliente Dome produced pyroclastic flows that traveled about 2 km down a ravine. Another collapse produced pyroclastic flows and incandescent blocks on 29 December. Thick ash plumes associated with the pyroclastic flows on both days reached an altitude of 4.3 km and drifted W and NW.

Activity during January-March 2007. Minor emissions of gas and possible ash visible in satellite imagery on 1 and 2 January with narrow plumes drifting WSW were reported by the Washington VAAC. On 4 January there were 37 weak to moderate explosions; the moderate events caused ashfall S and SE in the ranching areas of Monte Bello and Monte Claro. About 21 block-and-ash flows were also observed. Explosions on 5 January produced ash clouds that rose to 4.3-4.8 km, with ashfall noted to the S and SE. Ash puffs were visible on satellite imagery during 7-8 January. Explosions on 12 January sent ash plumes to altitudes of 3. 9-4.2 km. Plumes drifted SW and ashfall was reported downwind. Incandescent blocks rolled SW on 12 and 16 January. Based on satellite imagery, diffuse ash plumes identified on 10, 12, and 14-16 January drifted SW and W.

Explosions on 17, 19, and 23 January sent ash plumes to altitudes of 4.1-4.7 km that drifted SW. Incandescent blocks continuously rolled down the S and SW flanks. Based on satellite imagery, the Washington VAAC reported diffuse ash plumes on 18, 24, and 30 January. Explosions produced minor ashfall on 25, 26, and 29 January. Block-and-ash avalanches descended the SW flank of Caliente Dome on 25 and 29 January. Another ash plume on 31 January rose to 4.8 km and drifted SW

Explosions on 5 February produced ash plumes that rose to altitudes of 4.8 km. On 5 February, plumes drifted SW and S causing ashfall downwind. Block-and-ash avalanches descended the SW and S flanks of Caliente Dome. Fumarolic plumes drifted SW. Based on satellite imagery, the Washington VAAC reported that ash plumes drifted W on 2 February, and that diffuse plumes drifted SW and S in a fan shape on 8 February. A thermal hotspot was also detected on 8 February imagery. Avalanches descended the SW flank to the base of Caliente Dome and explosions produced diffuse ash plumes on 15 February. Explosions on 19 February again produced plumes and ashfall to areas SW.

Diffuse ash plumes seen in satellite imagery drifted mainly W and N during 22, 23, and 25-27 February. Seven explosions on the 26th produced ash plumes that rose to altitudes of 4.4-4.6 km and drifted SW. Avalanches occurred from lava-flow fronts on the SW flanks and from the S edge of Caliente Dome. A hotspot was seen on satellite imagery. On 27 February, explosions occurring at an approximate rate of three per hour produced ash plumes that reached altitudes of 4.8 km. Occasionally explosions were accompanied by pyroclastic flows that traveled SW.

A SW-directed diffuse ash plume on 5 March was followed the next day by another diffuse plume and a hotspot seen on satellite imagery. Explosions produced ash-and-steam plumes that rose to altitudes of 3.8-4.8 km during 21-22 and 25 March and drifted W; ash fell nearby. On 25 and 26 March, avalanches occurred from lava-flow fronts on the SW flanks of Caliente Dome. A 27 March explosion produced a pyroclastic flow that traveled down the SW flank. Explosions produced ash plumes that rose to an altitude of 5 km on 29 March; ashfall was reported near the Observatory Vulcanológico de Santiaguito (OVSAN), about 5 km S. On 30 March diffuse ash plumes were again visible on satellite imagery drifting SW.

Activity during April-June 2007. On 2 April, INSIVUMEH reported that ash plumes rose to 4.4 km and drifted SW. Explosions occasionally produced ash plumes that rose to altitudes of 5.3 km and drifted E on 11 and 16 April. Lava-flow fronts on the SW flanks of Caliente Dome emitted gases on 11 April and produced avalanches of block and ash on 16 April. On 13 April, the Washington VAAC reported that an ash plume was visible on satellite imagery drifting W. Explosions on 20 and 23 April produced ash plumes that rose to altitudes of 5.3 km and caused ashfall up to 9 km SW. On 23 April, lava flows on the SW and NE flanks of Caliente Dome produced small landslides composed of blocks. Diffuse ash plumes were seen in satellite imagery on 18, 23, and 24 April, and gas plumes possibly containing ash on 20 April. Explosions on 26 April produced ash plumes that rose to altitudes of 4.4-4. 8 km and drifted SW. More ash plumes and steam-and-ash plumes drifted S and WSW on 26 and 28 April, respectively. On 30 April, explosions caused ashfall to the SW; lava extrusion was low.

Based on satellite imagery, the Washington VAAC reported that ash plumes drifted S on 9 May. INSIVUMEH reported on 10 May that rain caused landslides S down the Nimá I river, near the Observatory about 5 km S of the lava dome. Explosions from Caliente Dome during 10-11 and 14 May produced gas-and-ash plumes that rose to altitudes of 4.4-5.3 km and drifted SW and E. Ashfall was reported from areas S and SW on 10 May. Avalanches of blocks and ash from the SW edge of Caliente Dome were observed on 14 May.

OVSAN and several seismic stations registered a lahar on 5 June. The lahar descended the Nimá I river and carried blocks 1-1.5 m in diameter and tree branches. The approximately 12-m-wide by 3-m-thick deposit was hot and smelled of sulfur. On 7 June, INSIVUMEH reported explosions of steam and ash that rose to altitudes of 4.3-4.7 km and drifted SW. A plume rose from a cooling lava flow at the NE base of the lava dome. Continuous landslides of blocks and ash were noted on the SW flank.

Activity during July-October 2007. During 11-12 July there were 27 seismically-detected explosions. Additional explosions on 13 July produced ash plumes that rose to altitudes of 4.3-5.3 km. Ash plumes from the explosions drifted SW and caused ashfall. Incandescent avalanches of blocks from Caliente Dome were observed.

On 31 August 2007, INSIVUMEH reported that a lahar, 8 m wide and 1.5 m high, descended S down the Nima I river, carrying fine material, tree branches, and blocks. On 25 September 2007 a lahar about 18 m wide descended S down Santa María's Nima I river. On 12 October 2007, lahars in multiple drainages that carried tree branches, fine sediment, and blocks of multiple sizes, flooded the Samala river (to the E and S) as far as the Pacific coast, 70 km S.

Geologic Summary. Symmetrical, forest-covered Santa María volcano is one of the most prominent of a chain of large stratovolcanoes that rises dramatically above the Pacific coastal plain of Guatemala. The 3772-m-high stratovolcano has a sharp-topped, conical profile that is cut on the SW flank by a large, 1.5-km-wide crater. The oval-shaped crater extends from just below the summit of Volcán Santa María to the lower flank and was formed during a catastrophic eruption in 1902. The renowned plinian eruption of 1902 that devastated much of SW Guatemala followed a long repose period after construction of the large basaltic-andesite stratovolcano. The massive dacitic Santiaguito lava-dome complex has been growing at the base of the 1902 crater since 1922. Compound dome growth at Santiaguito has occurred episodically from four westward-younging vents, the most recent of which is Caliente. Dome growth has been accompanied by almost continuous minor explosions, with periodic lava extrusion, larger explosions, pyroclastic flows, and lahars.

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Rincón de la Vieja

Costa Rica
10.830°N, 85.324°W; summit elev. 1,916 m

During September 2006 through at least May 2007, low-level fumarolic and seismic activity continued at Rincón de la Vieja. At the edge of the crater, Fumarolic gases often irritated the eyes, skin, and throat.

During September 2006, the level of the lake was high, with convection cells and particles of sulfur floating on the surface. The lake displayed yellow color with minor evaporation and a temperature of 39ºC. Fumarolic activity was occurring in the S wall and SW part of the crater. Columns of gases rose above the edge of the crater and were carried by the predominant winds toward the W and SW. The fumaroles on the N side produced only low-level emissions.

By April and May 2007, the level of the lake had descended some 50 cm with respect to September 2006. The lake color turned to gray with minor evaporation. In the S, there were particles of sulfur floating on the surface and a temperature of 45ºC. The fumarolic activity on the SW wall displayed low levels of gas emission and rich sulfur depositions. The fumaroles of the N side were inactive.

Geologic Summary. Rincón de la Vieja, the largest volcano in NW Costa Rica, is a remote volcanic complex in the Guanacaste Range. The volcano consists of an elongated, arcuate NW-SE-trending ridge that was constructed within the 15-km-wide early Pleistocene Guachipelín caldera, whose rim is exposed on the south side. Rincón de la Vieja, sometimes known as the "Colossus of Guanacaste," has an estimated volume of 130 cu km and contains at least 9 major eruptive centers. Activity has migrated to the SE, where the youngest-looking craters are located. The twin cone of 1916-m-high Santa María volcano, the highest peak of the Rincón complex, is located at the eastern end of a smaller, 5-km-wide caldera and has a 500-m-wide crater. A plinian eruption producing the 0.25 cu km Río Blanca tephra about 3500 years ago was the last major magmatic eruption from the volcano. All subsequent eruptions, including numerous historical eruptions possibly dating back to the 16th century, have been from the prominent crater containing a 500-m-wide acid lake (known as the Active Crater) located ENE of Von Seebach crater.

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