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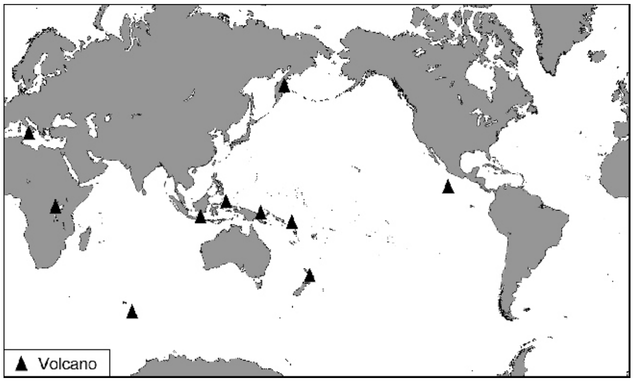

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Nyamuragira

Democratic Republic of Congo
1.408°S, 29.20°E; summit elev. 3,058 m

Nyamuragira last began erupting on 27 November 2006 (*BGVN* 32:01). Figure 1 shows lava flows from the November eruption based on available observations as of 2 December 2006. The flows were on the outer SE flank and covered extensive areas.

This map gives only the broad context of the flows' locations and movements; more detailed mapping was curtailed by armed conflict and a lack of security in the region. The flows were also the source of thermal infrared emissions. A recent article by Tedesco and others (2007) included a geologic map of the region (see Nyiragongo report below).

MODIS/MODVOLC data. The description of the 2006 eruption in *BGVN* 32:01 did not report MODIS satellite thermal anomalies for this eruption as the measured anomalies all fell S of the Nyamuragira crater, covering much of the area between Nyamuragira and Nyiragongo. Further analysis of the University of Hawai'i Institute of Geophysics and Planetology (HIGP) MODIS Hotspot Alert website data revealed that most of a year's anomalies (mid-April 2006 to mid-April 2007) between the two volcanos were measured during the period mid-November to mid-December 2006, probably related to the eruption of Nyamuragira that began on 27 November 2006.

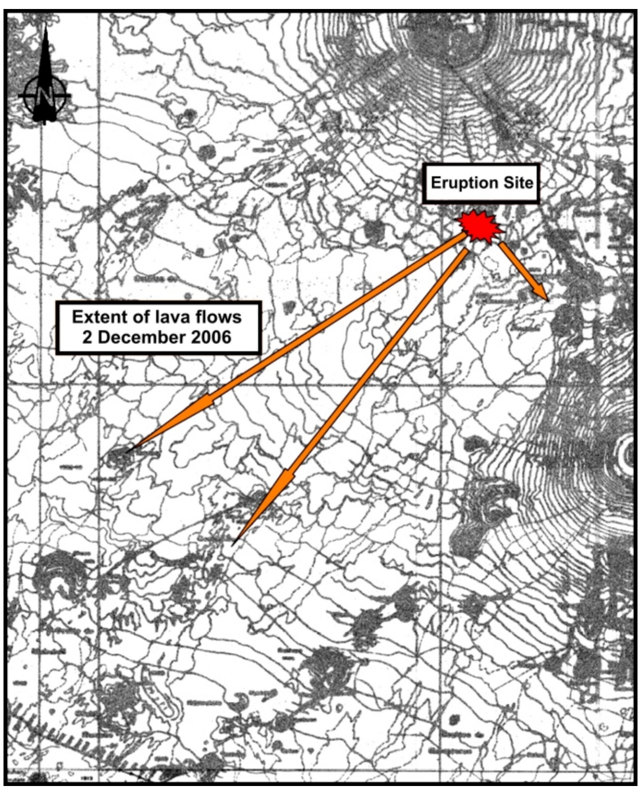

Figure 1. A preliminary sketch map made by the Goma Volcanological Observatory on 2 December 2006 showing lava flows from the eruption site of Nyamuragira during its November 2006 eruption. Nymuragira (top) is abotu 10 km from Nyiragongo (right). Courtesy of Jacques Durieux.

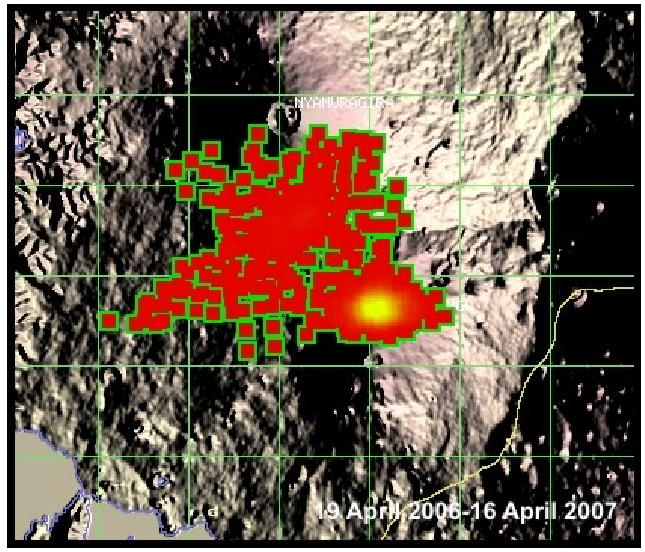

Figure 2. Map showing MODIS/MODVOLC thermal anomalies in the region of Nyiragongo and Nyamuragira measured during 1 year, from 19 April 2006 to 16 April 2007. Courtesy of HIGP MODIS Hotspot Alert System.

A compilation of MODIS thermal anomalies for 1 year, 19 April 2006-16 April 2007 (figure 2), shows both a typical concentration of nearly daily anomalies over Nyiragongo resulting from the lava lake within the volcano's main crater, and also a considerable number of anomalies between Nyiragongo and nearby Nyamuragira (albeit, none over the Nyamuragira crater). Figure 3 shows thermal anomalies measured by MODIS for three 1- month periods: 22 October-18 November 2006; 20 November-18 December 2006; and 20 December 2006-17 January 2007, and 4 December 2006. Most of the anomalies seen between Nyiragongo and Nyamuragira during the year occurred in the mid-November to mid-December 2006 time frame. An analysis of the chronological tabulation of anomaly pixels during this 30-day period showed a concentration from 27 November to 16 December. Typical monthly patterns of thermal anomalies show a concentration over the Nyiragongo crater lava lake.

Anomalies measured on 4 December 2006 (figure 3) appeared along a line nearly perpendicular to a line between the volcanos and about equidistant to the two volcanoes. Rob Wright reported that this linear anomaly corresponded to an extensive lava flow. It was seen for several days prior to and after 4 December in the same region between Nyiragongo and Nyamuragira.

Wright noted that if one looks at the position and orientation of the pattern of thermal anomaly pixels, it seems to vary over the period. This variation could result from a combination of factors, including: (1) clouds—an apparent shape/ orientation of the anomaly can be induced by the fact that some portions of the flow-field may have been obscured at the moment of image acquisition; (2) sensor zenith angle–the data for 4 December 2006 were acquired when the satellite was within 1 to 16° of being directly overhead, whereas on other days (i.e. 1 December 2006) the lava flow field was at the edge of the image swath (i.e. at an angle of about 60°); at these extreme scan angles the pixel geolocation becomes less accurate (and the pixels increase in size, to about 2 by 4 km).

References: Tedesco, D., Badiali, L., Boschi, E., Papale, P., Tassi, F., Vaselli, O., Kasereka, C., Durieux, J., Denatale, G., Amato, A., Cattaneo, M., Ciraba, H., Chirico, G., Delladio, A., Demartin, M., Favalli, G., Franceschi, D., Lauciani, V., Mavonga, G., onachesi, G., Pagliuca, N.M., Sorrentino, D., and Yalire, M., 2007, Cooperation on Congo Volcanic and Environmental Risks, EOS, Transactions, American Geophysical Union, v. 88, no. 16, p. 177, 181.

Geologic Summary. Africa's most active volcano, Nyamuragira is a massive high-potassium basaltic shield volcano that rises about 25 km north of Lake Kivu across the broad East African Rift Valley NW of Nyiragongo volcano. Nyamuragira, also known as Nyamulagira, has a volume of 500 cu km, and extensive lava flows from the volcano blanket 1500 sq km of the East African Rift. The broad low-angle shield volcano contrasts dramatically with its steep-sided neighbor Nyiragongo. The 3058-m-high summit of Nyamuragira is truncated by a small 2 x 2.3 km caldera that has walls up to about 100 m high. Historical eruptions have occurred within the summit caldera, frequently modifying the morphology of the caldera floor, as well as from the numerous fissures and cinder cones on the volcano's flanks. A lava lake in the summit crater, active since at least 1921, drained in 1938, at the time of a major flank eruption. Historical lava flows extend down the flanks more than 30 km from the summit, reaching as far as Lake Kivu.

Information Contacts: *Jacques Durieux*, United Nations Office for Project Services, Unite de Gestion des Risques Volcaniques, Observatoire Volcanologique de Goma; *Hawai'i Institute of Geophysics and Planetology, MODIS Thermal Alert System*, School of Ocean and Earth Sciences and Technology (SOEST), University of Hawai'i, 2525 Correa Road, Honolulu, HI, USA (URL: http://modis.higp.hawaii.edu/); *Rob Wright*, Hawaii Institute of Geophysics and Planetology, University of Hawaii, 1680 East-West Road, Honolulu, HI 96822, USA (URL: http://www.higp.hawaii.edu/~ wright/; Email: wright@higp.hawaii.edu).

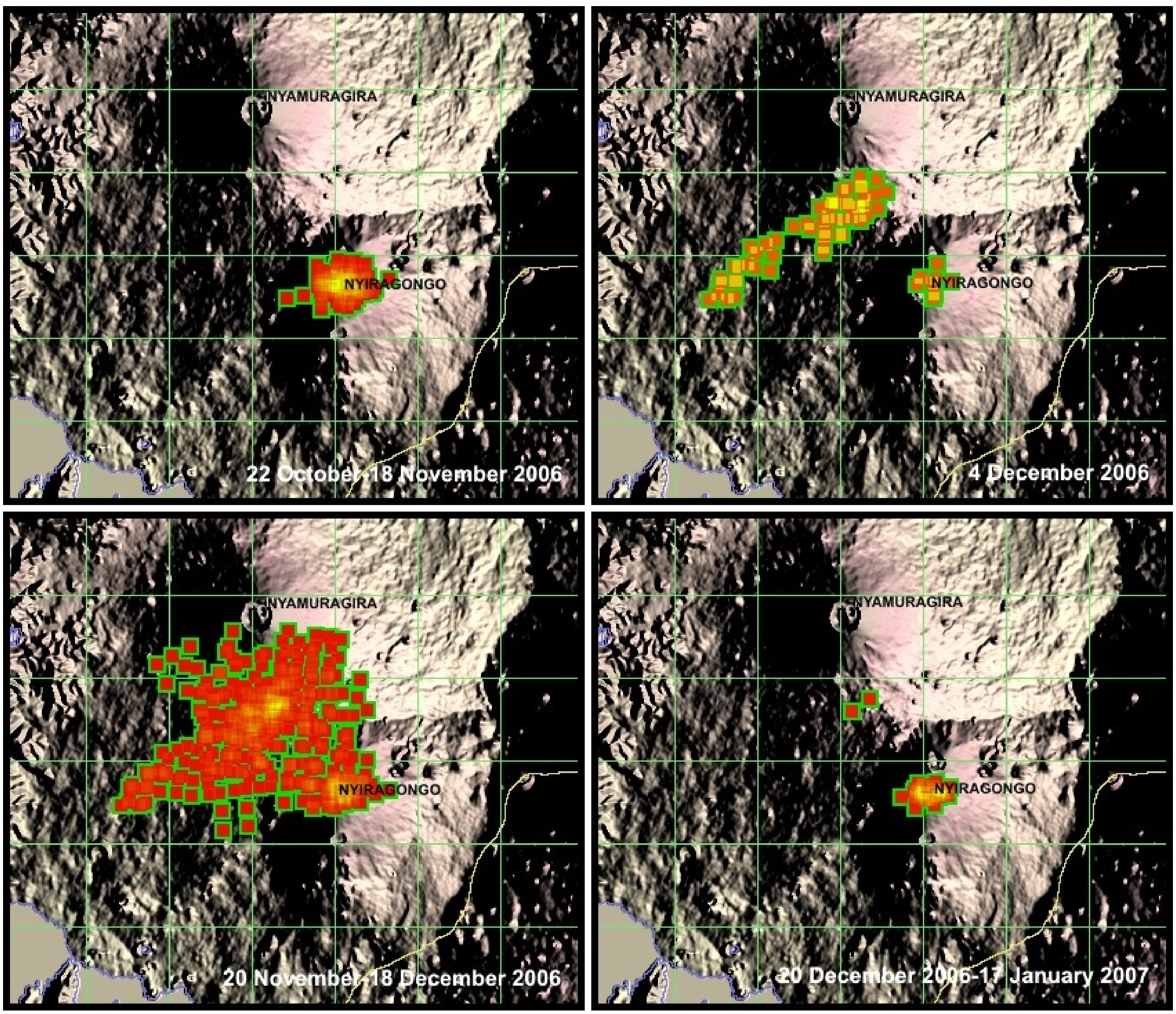

Figure 3. Map showing MODIS/MODVOLC thermal anomalies in the region of Nyiragongo and Nyamuragira measured during selected intervals between 22 October 2006 and 17 January 2007. Courtesy of HIGP MODIS Hotspot Alert System.

Nyiragongo

Democratic Republic of Congo
1.52°S, 29.25°E; summit elev. 3,470 m

Nearly daily thermal anomalies seen from satellites over the crater of Nyiragongo through early 2007 confirm the presence of the lava lake there. These anomalies were acquired from MODIS satellites and are available on the University of Hawai'i Institute of Geophysics and Planetology (HIGP) MODIS Hotspot Alert website. A separate report in this issue discusses MODIS thermal anomalies measured during the 27 November 2006 eruption of Nyamuragira (*BGVN* 32:01), located about 10 km NW of Nyiragongo.

The consistent anomalies from the Nyiragongo crater are the result of the lava lake that formed in May 2002 within the volcano's main crater after the January 2002 eruption (*BGVN* 31:12; Tedesco and others, 2007). Below are brief discussions of several recent articles relevant to risks associated with new efforts in risk monitoring and mitigation at Nyiragongo that have come to our attention.

Giordano and others (2007) describe a multi-disciplinary study involving textural and rheological measurements and numerical simulations of heat transfer during magma ascent for the January 2002 eruption. This study attempted to understand the different behavior of lava flows and their threat to the local population.

Tedesco and others (2007) described activities for monitoring both volcanoes to enhance the capabilities of the Goma Volcanological Observatory (GVO). Owing to difficult security conditions caused by ongoing conflict within the Democratic Republic of Congo, scientists could only install the instruments in seven 'safe havens' that had been established by GVO. To obtain a suitable seismic network geometry (figure 4), three sites (Katale-KTL, Kibumba-KBB, and Kibati-KBT) were located on the eastern side of Nyiragongo. The array of sites allows scientists to distinguish seismic activity at Nyiragongo and Nyamuragira.

In detail, the seismic network incorporates a 24-bit analog-to-digital converting unit, GPS synchronization at the remote station, a radio-modem link on the 444-447 megahertz frequency band, solar panels, and batteries. The network uses broadband seismometers manufactured by Lennartz and Nanometrics. Seismic stations can transmit a 19.2 kilobits per second flow using 25 kHz of bandwidth.

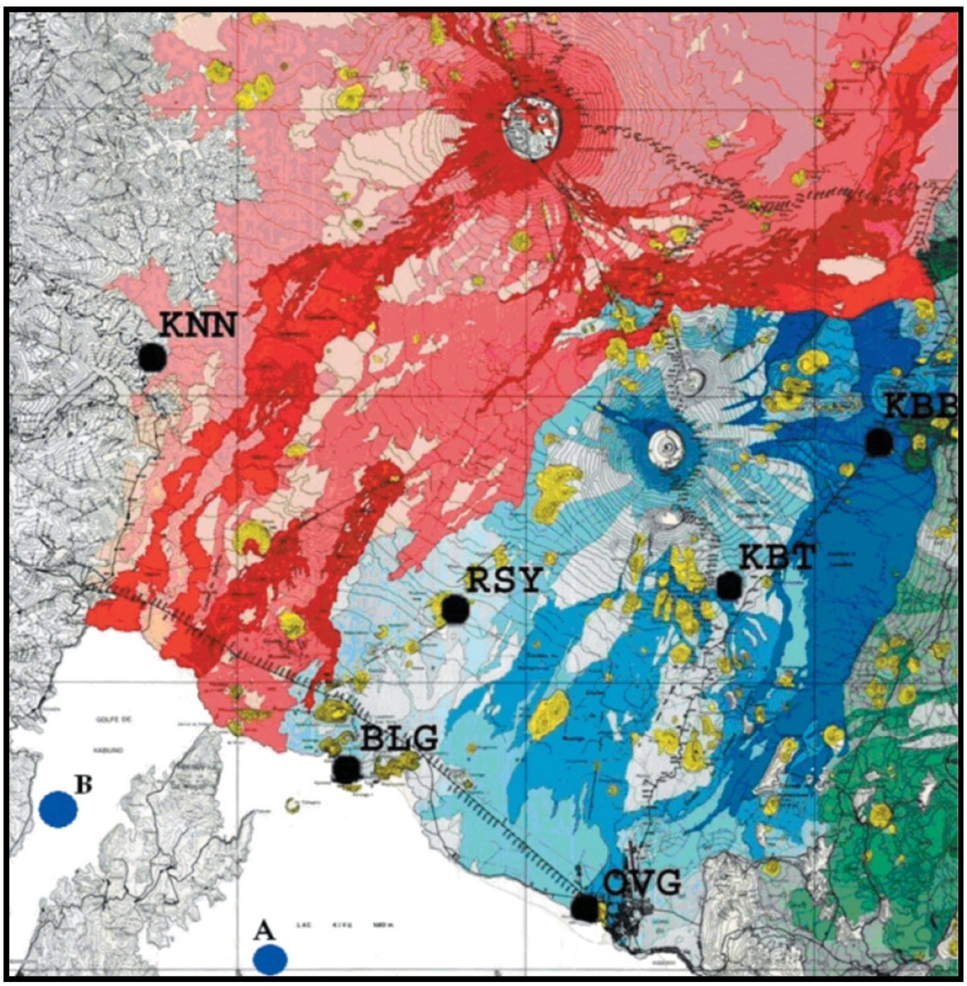

Figure 4. Geologic map of Nyiragongo and Nyamuragira, with respective lava flows shaded. Seven seismic stations are shown (KTL, KNN, RSY, KBB, KBT, BLG, and OVG). The points labeled A and B in Lake Kivu indicate the locations of profiles used to monitor the dissolved methane and carbon dioxide found at depth in the lake. According to Schmid and others (2005) the release of a fraction of these gases, which could be triggered by a magma eruption within the lake, would have catastrophic consequences for the two million people living on its shore. Courtesy of Tedesco and others, 2007.

Another article, by Chirico and others (2007), reported on a systematic study of the mitigating effects of the construction of artificial barriers to protect Goma and nearby Gisenyi, Rwanda, based on the Nyiragongo lava flow of 17 January 2002. That eruption stands as a prime example of lava flows impacting a large town (*BGVN* 26:12, 27:03, 27:04, and 31:12). Major lava flows on the S flank entered the town of Goma and devastated a significant portion of it, leaving more than 50,000 homeless and forcing the spontaneous exodus of nearly all of the residents, mainly into neighboring Rwanda. The study included a computer simulation of the effects of such barriers and found that, depending on the size, shape and orientation of the barriers, their protective effects can be optimized, and the local probability of lava flow invasion into the town can be reduced. The study further indicated that barriers will fail to protect the Goma international airport, an area of maximum flow hazard because of its vulnerable location with respect to the peculiar characteristics of the morphology of the terrain.

References: Chirico, G.D., Favalli, M., Papale, P., and Pareschi, M.T., 2007, Lava flow hazard map and mitigation from artificial barriers at Nyiragongo volcano through numerical simulations of lava flow paths: Geophysical Research Abstracts, European Geosciences Union, v. 9, 02238, SRef-ID: 1607-7962/gra/EGU2007-A-02238.

Giordano, D., Polacci, M., Longo, A., Papale, P., Dingwell, D.B., Boschi, E., and Kasereka, M., 2007, Thermo-rheological magma control on the impact of highly fluid lava flows at Mt. Nyiragongo: Geophysical Research Letters, American Geophysical Union, v. 34, L06301, doi:10.1029/2006GL028459.

Schmid, M., Halbwachs, M., Wehrli, B., and Wüest, A., 2005, Weak mixing in Lake Kivu: New insights indicate increasing risk of uncontrolled gas eruption: Geochemistry, Geophysics, Geosystems, v. 6, Q07009, doi:10.1029/2004GC000892.

Tedesco, D., Badiali, L., Boschi, E., Papale, P., Tassi, F. , Vaselli, O., Kasereka, C., Durieux, J., Denatale, G., Amato, A., Cattaneo, M., Ciraba, H., Chirico, G., Delladio, A., Demartin, M., Favalli, G., Franceschi, D., Lauciani, V., Mavonga, G., Onachesi, G., Pagliuca, N.M., Sorrentino, D., and Yalire, M., 2007, Cooperation on Congo Volcanic and Environmental Risks, Eos, Transactions, American Geophysical Union, v. 88, no. 16, p. 177, 181.

Geologic Summary. One of Africa's most notable volcanoes, Nyiragongo contained a lava lake in its deep summit crater that was active for half a century before draining catastrophically through its outer flanks in 1977. In contrast to the low profile of its neighboring shield volcano, Nyamuragira, 3,470-m-high Nyiragongo displays the steep slopes of a stratovolcano. Benches in the steep-walled, 1.2-km-wide summit crater mark levels of former lava lakes, which have been observed since the late-19th century. Two older stratovolcanoes, Baruta and Shaheru, are partially overlapped by Nyiragongo on the north and south. About 100 parasitic cones are located primarily along radial fissures south of Shaheru, east of the summit, and along a NE-SW zone extending as far as Lake Kivu. Many cones are buried by voluminous lava flows that extend long distances down the flanks of the volcano, which is characterized by the eruption of foiditic rocks. The extremely fluid 1977 lava flows caused many fatalities, as did lava flows that inundated portions of the major city of Goma in January 2002.

Information Contacts: *Hawai'i Institute of Geophysics and Planetology*, MODIS Thermal Alert System, School of Ocean and Earth Sciences and Technology (SOEST), University of Hawai'i, 2525 Correa Road, Honolulu, HI, USA (URL: http://hotspot.higp.hawaii.edu).

Etna

Italy
37.734°N, 15.004°E; summit elev. 3,350 m
All times are local (= UTC + 1 hours)

Recent eruptive episodes occurred between 4 November and 14 December 2006, with small eruptions on 19 and 29 March 2007 (*BGVN* 32:02). According to the Istituto Nazionale di Geofisica e Vulcanologia Sezione di Catania (INGV), there were other noteworthy eruptions on 11 and 29 April 2007.

The eruption of 19 March was captured on video as well as a thermal monitoring system. The thermal data appear on figure 5, which also includes data from a reference site away from the eruption (lower panel). Both sites underwent similar diurnal variations due to solar warming and night-cooling effects. The 19 April 2007 eruption appears as a 37°C upward spike in apparent temperature (computed from the sensor system).

The INGV reported that the 29 March eruption took place at Bocca Nuova. Two new lava streams emerged near the summit, one at 3,180 m elevation, and the other at 3,050 m elevation. The lava flows advanced initially but ultimately halted after related emissions only lasted several hours (ceasing at 1500 local time).

INGV's report on the 11 April event noted an increase in volcanic tremor, followed by lava fountaining. That eruption lasted about 5 hours. A resultant ash plume drifted

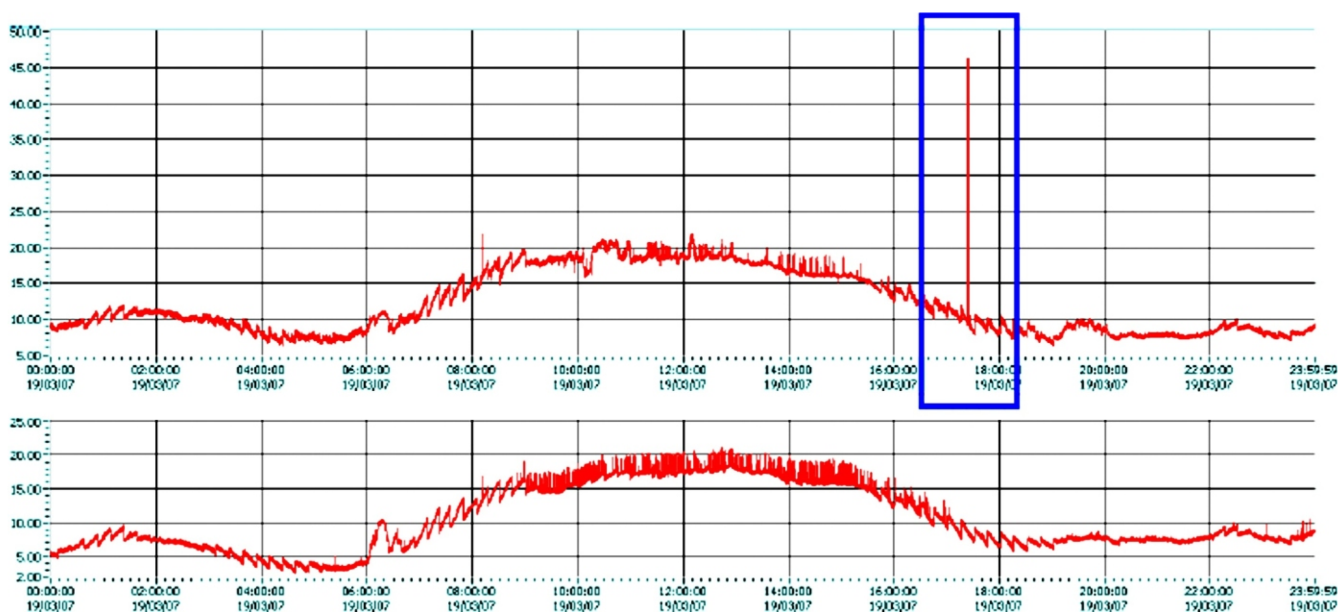

Figure 5. Time-series plot showing the apparent temperatures (in degrees C) at Etna recorded by the NEW SARATER monitoring system during the explosive event at the Bocca Nuova on 19 March 2007. The upper graph shows the thermal data from the summit crater zone (rectangular inset), where the increase in temperature related to the explosive event stands out boldly. The lower graph shows the thermal data for the same period but from a region outside of the summit crater area and notes solely the daily oscillation of apparent air temperature tied to solar warming. Time shown is UTC. Courtesy of INGV.

E with ashfall reported as far as Zafferana, about 10 km E. Two lava flows were observed at the summit of Etna, one to the E within the large depression on the side of the volcano known as the Valle del Bove and the second to the S. The E lava flow stopped 3 km away at the base of the Serra Giannicola Grande, within the W Valle del Bove. The second flow stopped near Mt. Frumento Supino (less than 1 km S of the summit).

A new summit eruption began on 29 April 2007 with a general increase in tremor followed by fire fountaining and a vertical ash cloud. The INGV-CT monitoring webcams showed the evolution of this eruptive phase that lasted about 8-9 hours. At 1600 the thermal webcam at Nicolosi registered a thermal anomaly at the South-East Crater (SEC); there were also reports of rumbling from the summit craters. At 1834, explosions of lapilli and ash were observed almost continuously, together with lava emission very near the explosive vent (figures 6 and 7). A lava flow followed the fissure on the SE flank of the SEC, which had opened during November 2006. Another flow moved E within the Valle del Bove.

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

Information Contacts: *Sonia Calvari*, Istituto Nazionale di Geofisica e Vulcanologia, Sezione di Catania, Piazza Roma 2, 95123 Catania, Italy (URL: http://www.ct.ingv.it/).

Figure 6. Activity at Etna's South-East Crater at 1834 on 29 April 2007, seen from the S at Torre del Filosofo. Courtesy of INGV.

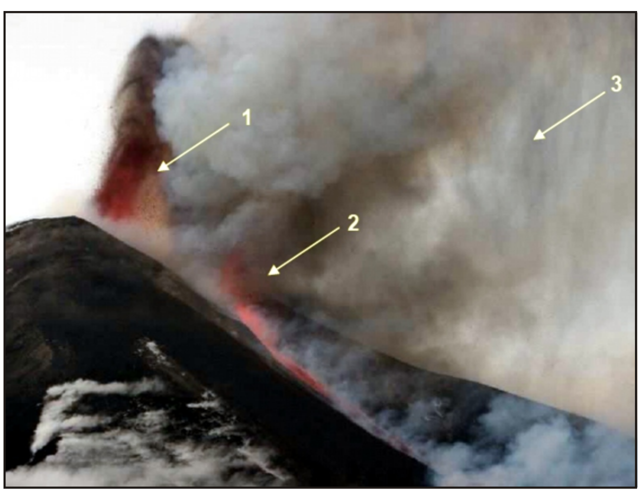

Figure 7. Etna in eruption on 29 April 2007. Arrows denote strong explosive Strombolian activity (1), spattering (2), and lapilli and ashfall (3). The spattering and related extrusions fed a lava flow descending as an incandescent ribbon. Courtesy of INGV.

Dukono

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

Our last Dukono report discussed an ash plume on 5 December 2006 (*BGVN* 32:01). During the time period of this report, 1 January through mid-April 2007, the Darwin Volcanic Ash Advisory Centre (VAAC) detected a small plume on satellite imagery on 16 January 2007 that lacked clear ash content.

The 16 January plume was imaged using data from two satellites (DMSP and MTSAT-1R). The Darwin VAAC's ash advisory noted a low-level plume blowing to the SSE on an image taken at 2233 on 15 January (time and date in terms of UTC; 0733 on 16 January local time).

Table 1 contains a list of thermal anomalies detected from MODIS satellites by the Hawai'i Institute of Geophysics and Planetology (HIGP) Thermal Alerts System during the first four months of 2007. There were two alerts on 13 February followed by one alert on the respective days 15, 18, and 24 February and 8 March.

Date (UTC)	Time (UTC)	Pixels	Satellite
13 Feb 2007	1405	1	Terra
13 Feb 2007	1700	1	Aqua
15 Feb 2007	1350	1	Terra
18 Feb 2007	1715	1	Aqua
24 Feb 2007	1345	1	Terra
08 Mar 2007	1410	1	Terra

Table 1. Thermal anomalies at Dukono based on MODIS-MODVOLC retrievals and processing for the interval 1 January through April 2007. Courtesy of Hawai'i Institute of Geophysics and Planetology (HIGP) Thermal Alerts System.

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 N 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 historically active.

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 (http://hotspot.higp.hawaii.edu/).

Semeru

Java, Indonesia
8.108°S, 112.92°E; summit elev. 3,676 m
All times are local (= UTC + 7 hours)

Our previous report (*BGVN* 29:06) covered activity at Semeru through 4 July 2004. This report, compiled chiefly from reports from the Center of Volcanology and Geological Hazard Management (CVGHM) and the Darwin Volcanic Ash Advisory Centre (Darwin VAAC), discusses subsequent activity into early 2007. Minor eruptions with the highest reported plumes reaching 7.6 km altitude continued from mid-2006 through April 2007. During mid-2006 to May 2007 there were also numerous thermal anomalies. The thermal data were captured by MODIS satellite sensors and presented on the MODVOLC system.

On 9 March 2006, the CVGHM reported "ash rain" fell in the vicinity of Semeru. An eruption associated with earthquakes was photographed on 31 October 2006 (figure 8). On April 22, based on information from a significant meteorological notice and satellite observations the Darwin VAAC reported the first of a series of eruptions. Plumes rose to an altitude of ~ 4 km. Table 2 summarizes reported ash plume eruptions at Semeru through February 2007.

Geologic Summary. Semeru, the highest volcano on Java, and one of its most active, lies at the southern end of a volcanic massif extending north to the Tengger caldera. The steep-sided volcano, also referred to as Mahameru (Great Mountain), rises abruptly to 3676 m above coastal plains to the S. Gunung Semeru was constructed S of the overlapping Ajek-ajek and Jambangan calderas. A line of lake-filled maars was constructed along a N-S trend cutting through the summit, and cinder cones and lava domes occupy the E and NE flanks. Summit topography is complicated by the shifting of craters from NW to SE. Frequent 19th and 20th cen-

Date	Plume Height (km)	Plume Drift	Comments
18 Jul 2004	3	NW	pilot report
5-10 Aug 2004	7.6 max		pilots' reports of ash clouds
10 Aug 2004	6.1		ash plume
24 Aug 2004		WSW	thin plume
25 Aug 2004		WSW	thin plume, no ash visible
21 May 2005	4.6	S, then SSE	
25 May 2005			small plume reported by Darwin VAAC
08-14 Mar 2006			"ash rain" reported by CVGHM
22 Apr 2006	4		based on significant meteorological notice, Darwin VAAC reported an eruption that generated plume (not visible on satellite imagery)
10-16 May 2006	6.1		
04 Jun 2006			pilot reported multiple minor eruptions
05-06 Jun 2006			small ash plumes
06, 12 Jun 2006			small ash plumes
11, 13 Jun 2006			minor ash/steam plumes
14 Jun 2006	6.1		pilot observation
15, 17, 18 Jun 2006			small ash plumes
25 Jun 2006	5.5		
29 Jun 2006	?	SE	
10 Jul 2006	5.5		
14 Jul 2006	?	SE	
17 Jul 2006	4.3		
18, 21, 24 Jul 2006	4.3 (max)		
24-25, 31 Jul 2006	?		small plumes visible
02 Aug 2006	5.2		
25 Aug 2006			ash plumes visible
15 Sep 2006	4.3	W	
20-21 Sep 2006	11; 4.9	SW; 90 km W	
18 Oct 2006	4.6		
25-26 Oct 2006	7.6	W	
30 Oct 2006			ash/steam emissions
22 Nov 2006	7.6	S	incandescent material fell in all directions within 200 m of plume
24 Nov 2006	4.4		
21 Dec 2006	4.3		
10-11 Feb 2007			ashfall 35 km E

Table 2. Summary of reported ash plumes emitted from Semeru, July 2004 to February 2007. Courtesy of CVGHM and the Darwin VAAC.

Figure 8. Photograph showing a Semeru ash explosion on 31 October 2006. Courtesy CVGHM.

tury eruptions were dominated by small-to-moderate explosions from the summit crater, with occasional lava flows and larger explosive eruptions accompanied by pyroclastic flows that have reached the lower flanks of the volcano. Semeru has been in almost continuous eruption since 1967.

Information Contacts: *Dali Ahmad*, *Hetty Triastuty*, *Nia Haerani*, and *Suswati*, Center of Volcanology and Geological Hazard Mitigation (CVGHM), Jalan Diponegoro No. 57, Bandung 40122, Indonesia (Email: dali@vsi.esdm.go.id; URL: http://www.vsi.esdm.go.id/); *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 (http://hotspot.higp.hawaii.edu/); *Agence France-Presse. (AFP)* (http://www.afp.com/english/home/).

Ritter Island

Northeast of New Guinea, Papua New Guinea
5.52°S, 148.121°E; summit elev. 140 m

Submarine eruptions occurred at Ritter Island in 1972 and 1974 (*CSLP* 146-74). More recently, small eruptions were reported during 2002 and 2006. The island, which sits off the W end of New Britain Island (figure 9), is composed of a ~ 1.9-km-long arc-shaped segment of the caldera rim. The inner, concave side of the island faces W. In clear weather villagers in Kampalap village, ~ 13.5 km SSW on Umboi Island, can see and monitor Ritter Island.

On 2 August 2002, an advisory was issued by the Darwin VAAC based on a pilot observation indicating an ash cloud to ~ 3 km altitude, although satellite data was unable to confirm the presence of ash.

In what began as an ambiguous case, the Darwin VAAC issued an advisory for a 17 October 2006 eruption at Ritter Island. The initial report was confusing because a pilot had reported the eruption to the Rabaul Volcano Observatory (RVO) as being from Langila. The VAAC report noted that there was no plume at Langila in satellite imagery, but instead could see one farther W at Ritter Island. The plume was low and seen on MTSAT imagery (at 0133 UTC on 17 October); the presence of ash was not mentioned.

A report to RVO from Kampalap village, passed through the Langila observer, confirmed unusual activity on 17 October. RVO reported occasional small earthquakes followed by white vapor and diffuse ash clouds. The Kampalap observer saw occasional rock slides from the inner crater wall. Fine ash fell at Kampalap that the reporter indicated was not from Langila. No similar eruptive episodes were recorded through 1 November. Throughout this interval the RVO relied on seismic instrumentation in West New Britain, but an instrument was being prepared for possible deployment at Ritter Island.

Geologic Summary. Prior to 1888, Ritter Island was a steep-sided, nearly circular island about 780 m high. The current small, 140-m-high island is a topographically insignificant, 1900-m-long arcuate feature between Umboi and Sakar Islands. Several historical explosive eruptions had been recorded prior to 1888, when large-scale slope failure destroyed the summit of the conical basaltic-andesitic volcano, leaving the arcuate 140-m-high island remnant with a steep W-facing scarp that descends below sea level. Devastating tsunamis were produced by the collapse and swept the coast of Papua New Guinea and offshore islands. Two minor post-collapse explosive eruptions, during 1972 and 1974, occurred offshore within the largely submarine 3.5 x 4.5 km breached depression formed by the collapse.

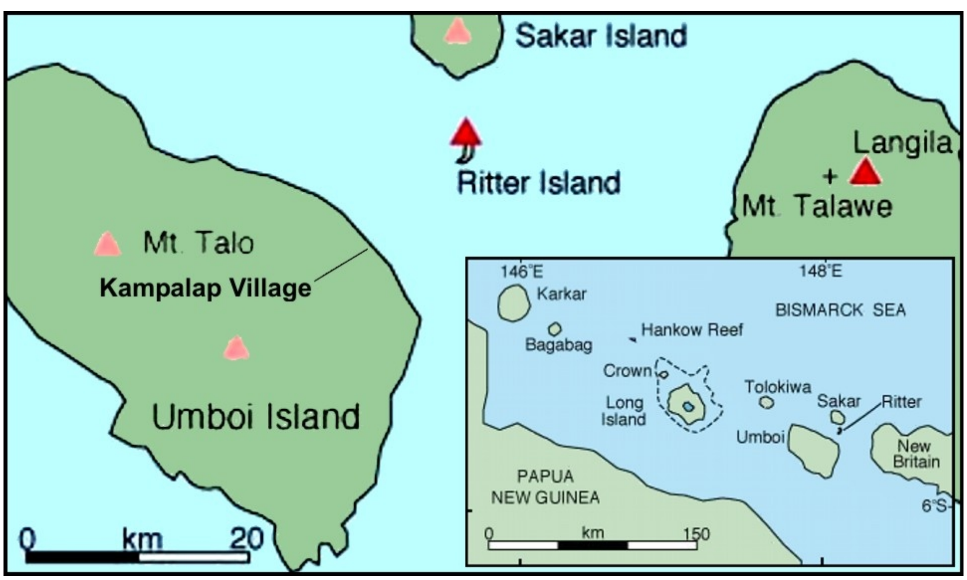

Figure 9. Location sketch maps showing the context of Ritter Island, which sits just E of New Britain Island and N of the main island. Many of the islands shown contain Holocene volcanoes along the same arc as New Britain Island. Courtesy of VolcanoWorld.

Information Contacts: *Herman Patia*, Rabaul Volcanological Observatory (RVO), Department of Mining, Private Mail Bag, Port Moresby Post Office, National Capitol District, Papua New Guinea (Email: hguria@global.net.pg); *VolcanoWorld* (URL: http://volcano.und.edu/).

Tinakula

Santa Cruz Islands, SW Pacific
10.38°S, 165.80°E; summit elev. 851 m
All times are local (= UTC +11 hours)

No thermal anomalies at Tinakula were detected by MODIS satellite systems between 9 May 2001 and 11 February 2006, but anomalies were then detected through mid-April 2006 (*BGVN* 31:03). Thermal anomalies continued at about the same pace and intensity (in pixels) through 1 June 2006 (table 3). From 4 August 2006 through March 2007, on 19 different days there were 1- or 2-pixel thermal anomalies measured by MODIS.

Date (UTC)	Time (UTC)	Pixels	Satellite
14 Apr 2006	1135	1	Terra
16 Apr 2006	1125	2	Terra
	1425	1	Aqua
18 Apr 2006	1410	3	Aqua
19 Apr 2006	1155	3	Terra
	1455	1	Aqua
21 Apr 2006	1145	1	Terra
	1445	2	Aqua
23 Apr 2006	1130	1	Terra
25 Apr 2006	1420	2	Aqua
28 Apr 2006	1150	3	Terra
02 May 2006	1125	3	Terra
04 May 2006	1110	2	Terra
06 May 2006	1400	1	Terra
16 May 2006	1135	2	Terra
01 Jun 2006	1135	2	Terra
01 Jun 2006	1435	3	Aqua
04 Aug 2006	1135	1	Terra
30 Oct 2006	1145	1	Terra
08 Nov 2006	1135	2	Terra
08 Dec 2006	1450	1	Aqua
12 Dec 2006	1425	1	Aqua
19 Dec 2006	1435	1	Aqua
04 Jan 2007	1130	1	Terra
11 Jan 2007	1135	1	Terra
20 Jan 2007	1130	1	Terra
27 Jan 2007	1135	1	Terra
05 Feb 2007	1130	2	Terra
17 Feb 2007	1155	1	Terra
26 Feb 2007	1150	1	Terra
28 Feb 2007	1140	1	Terra
09 Mar 2007	1130	1	Terra
16 Mar 2007	1140	2	Terra
18 Mar 2007	1125	1	Terra
	1425	1	Aqua
20 Mar 2007	1415	1	Aqua
30 Mar 2007	1150	2	Terra

Table 3. MODIS/MODVOLC thermal anomalies at Tinakula for mid-April 2006 through mid-April 2007 (continued from table in *BGVN* 31:03). Courtesy of the University of Hawai'i Institute of Geophysics and Planetology (HIGP) MODIS Hotspot Alert System.

According to a 1994 summary by the Solomon Island observatory (World Organization of Volcanic Observatories, 1997), "The last reported large eruption was in 1985. Tinakula is highly active [and] erupts andesitic ash almost every week." No recent field observations have been made by scientists.

Reference: World Organization of Volcanic Observatories (WOVO), 1997, Volcanoes of the Solomon Islands. 1. Tinakula, (section 0505-07), *in* Netter, C., and Cheminée, J-L. (eds.), Directory of Volcano Observatories, 1996-1997: WOVO/IAVCEI/UNESCO, Paris, 50 p.

Geologic Summary. The small 3.5-km-wide island of Tinakula is the exposed summit of a massive stratovolcano that rises 3-4 km from the sea floor at the NW end of the Santa Cruz islands. Tinakula resembles Stromboli volcano in containing a breached summit crater that extends from the 851-m-high summit to below sea level. Landslides enlarged this scarp in 1965, creating an embayment on the NW coast. The satellitic cone of Mendana is located on the SE side. The dominantly andesitic Tinakula volcano has frequently been observed in eruption since the era of Spanish exploration began in 1595. In about 1840, an explosive eruption apparently produced pyroclastic flows that swept all sides of the island, killing its inhabitants. Frequent historical eruptions have originated from a cone constructed within the large breached crater. These eruptions have left the upper flanks of the volcano unvegetated.

Information Contacts: *Hawai'i Institute of Geophysics and Planetology*, MODIS Thermal Alert System, School of Ocean and Earth Sciences and Technology (SOEST), University of Hawai'i, 2525 Correa Road, Honolulu, HI, USA (URL: http://hotspot.higp.hawaii.edu); *Solomon Island Observatory*, Water and Mineral Resources Division, Honiara, Solomon Islands (URL: http://www.wovo.org/0505_07.htm).

Heard

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

An ASTER image over Heard for 29 February 2007 (figure 10) was found by Matt Patrick in which two thermal anomalies are shown, separated by ~ 300 m. The anomaly to the SE appeared to be a new feature, representing either a distinct vent or a hot distal portion of an active flow from the main vent. There are no anomalous shortwave pixels between the two anomalies as one might expect for an active lava surface, but the flow may be channeled underground between the anomalies. The total lack of anomalous pixels in the region between the two anomalies, however, caused Patrick to suspect that this is a distinct vent. If this is a distinct vent, it would be the first clear illustration of multiple vents at Heard. None of the previous images Patrick has studied covering the last 6 years (including the 8 December 2006 image, also using Band 9-3-1 color mapping, shown in figure 11) showed indications of a secondary anomaly.

MODIS satellite data also revealed thermal anomalies on 24 different days between 27 December 2006 and 6 April 2007 (table 4).

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

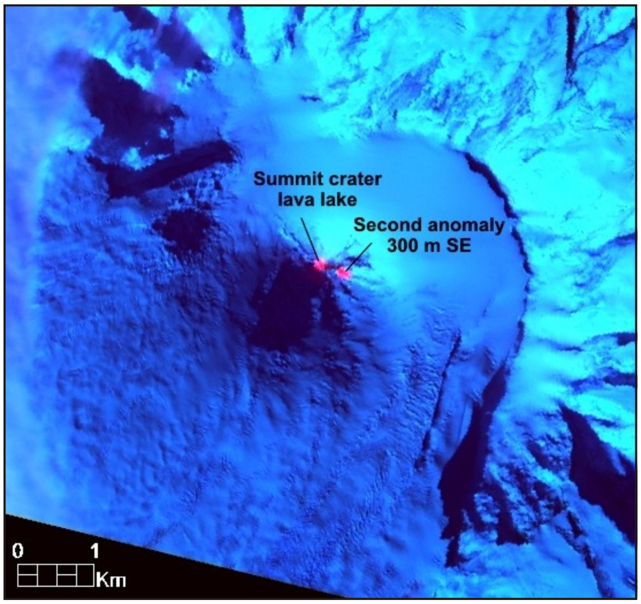

Figure 10. An ASTER Band 9-3-1 RGB composite image of Heard for 29 February 2007, with the shortwave infrared band 9 mapped to red, indicating high temperatures. Two distinct anomalies near the summit of Mawson Peak are shown. The W-most anomaly is at the location of previous anomalies, which appear to be the summit crater (lava lake), while the anomaly 300 m SE is a new feature. Courtesy Matt Patrick.

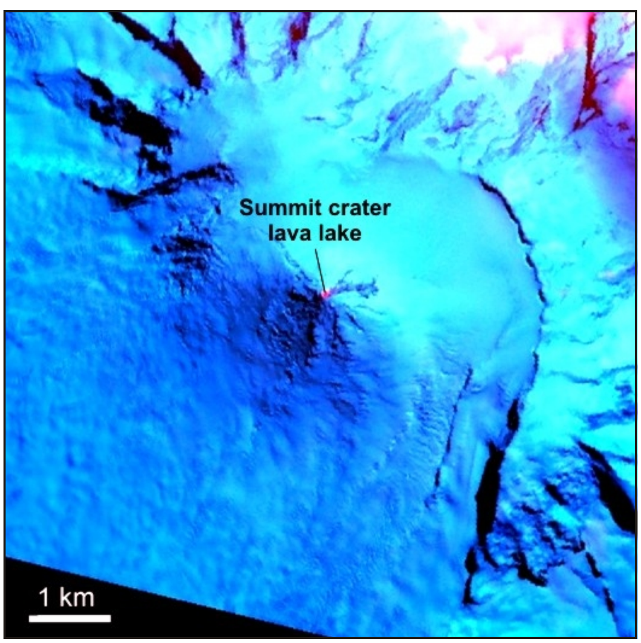

Figure 11. An ASTER Band 9-3-1 RGB composite image of Heard for 8 December 2006, with the shortwave infrared band 9 mapped to red, indicating high temperatures. One distinct anomaly near the summit of Mawson Peak is shown. Courtesy Matt Patrick.

Date (UTC)	Time (UTC)	Pixels	Satellite
27 Dec 2006	1845	1	Terra
29 Dec 2006	1830	1	Terra
31 Dec 2006	1820	2	Terra
	2005	1	Aqua
09 Jan 2007	1815	2	Terra
19 Jan 2007	1850	1	Terra
04 Feb 2007	1900	1	Aqua
05 Feb 2007	1940	1	Aqua
07 Feb 2007	1930	2	Aqua
16 Feb 2007	1925	1	Aqua
21 Feb 2007	1940	1	Aqua
26 Feb 2007	0445	1	Terra
05 Mar 2007	1820	2	Terra
07 Mar 2007	1810	1	Terra
11 Mar 2007	1745	1	Terra
12 Mar 2007	1825	2	Terra
	2015	1	Aqua
14 Mar 2007	1815	1	Terra
	2000	2	Aqua
18 Mar 2007	1935	1	Aqua
20 Mar 2007	1925	1	Aqua
24 Mar 2007	1850	1	Terra
26 Mar 2007	0505	1	Terra
27 Mar 2007	1745	2	Terra
28 Mar 2007	2015	2	Aqua
29 Mar 2007	1920	1	Aqua
06 Apr 2007	0450	1	Terra

Table 4. Thermal anomalies at Heard from mid-December 2006 to early April 2007 from MODIS satellites. Continued from table in *BGVN* 31:05. Courtesy of Hawai'i Institute of Geophysics and Planetology (HIGP) Hot Spots System.

Information Contacts: *Hawai'i Institute of Geophysics and Planetology (HIGP) Hot Spots System,* University of Hawai'i, 2525 Correa Road, Honolulu, HI 96822, USA (URL: http://hotspot.higp.hawaii.edu); *Matthew Patrick*, Dept. of Geological and Mining Engineering and Sciences, Michigan Technological University, 1400 Townsend Drive, Houghton, MI 49931, USA (Email: mpatrick@mtu.edu; URL: http://www.geo.mtu.edu/~mpatrick).

Ruapehu

New Zealand
39.28°S, 175.57°E; summit elev. 2,797 m
All times are local (= UTC +12 hours)

A moderate hydrothermal eruption at Ruapehu on 4 October 2006 (*BGVN* 32:02) renewed concerns about a lahar that could be generated from breakout of the summit crater lake through a weak dam composed of tephra. The dam, ~ 8 m high, was formed during eruptions in 1995 and 1996. In 1953, a similar dam failed and 15 lives were lost when the resulting lahar destroyed a rail bridge at Tangiwai. As reported by the New Zealand Institute of Geological & Nuclear Sciences (GNS Science), on 18 March 2007 at about 1100 the tephra dam failed and such a lahar was initiated. The resulting discolored region of sediment deposit was visible from space (figure 12).

GNS Science reported that on 18 March 2007 step-wise failure of the dam by headward scarp retreat above seeps in its downstream face was initiated at 1055, followed by catastrophic failure and breaching at 1122. Heavy rain likely played a role in triggering the lahar by raising the surface of Ruapehu's Crater Lake above a critical level. The lake was ~ 1.2 m below the crest of the dam when it failed. A GNS Science fixed camera recorded a time-lapse sequence of images of the dam collapse and the outflow through a 40-m breach in the dam (figure 13). The outflow entered the steep rocky gorge of the upper Whangahu River where it rapidly entrained silt- to boulder-sized particles to become a non-cohesive debris flow within a few kilometers of the lake. The resultant flood (lahar) reached variable stage heights depending on the topography of the 155-km long river system, often exceeding 6-8 m and overtopping the banks. At one point the lahar topped a bridge across the river about 49 km downstream.

Lahar chronology. News releases from GNS Science and other agencies were issued on 18 March 2007. Some preliminary derivative reports were sent to us by Roger Matthews. These items provided a chronological series of observations indicating that the dam's failure was initiated at 1045 and climaxed at 1122 on 18 March.

Figure 13. Comparative photos of the 6.2-m high OnTrack (New Zealand Railway Corporation) lahar warning tower, located in the Whangaehu river 28 km downstream from Crater Lake. The tower was installed following the 1953 Tangiwai disaster to provide 15-min warning for the railway bridge 11 km downstream. The arm on the tower supports a radar stage gauge to measure flow depth. Images were captured by a Horizon Regional Council web cam. (top) Tower in the path of the lahar flow at 1255 on 18 March 2007. (bottom) Examining lahar deposits on 21 March 2007, with researchers providing scale of the tower and its inscribed scale marks. Courtesy of GNS Science and Vern Manville.

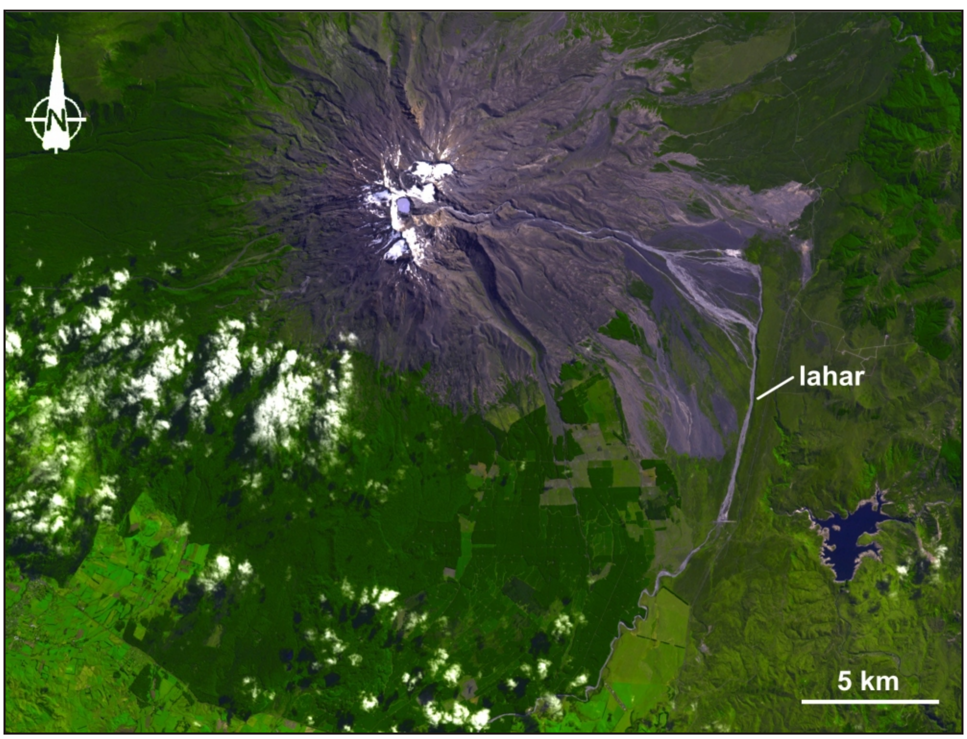

Figure 12. The Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) on NASA's Terra satellite captured this image of Mount Ruapehu and the path of its recent lahar on 25 March 2007. In the colored image, green indicates vegetation, dark blue indicates water, and purplish-gray indicates bare rock. The splotches of white at the summit show snow cover, and the billowy white balls nearby are clouds. S of the volcano, straight lines and sharp angles outlining patches of green indicate cultivated crops. The lahar appears as a rivulet of pale grayish-lavender that flows from the summit toward the E, then turns S. Near the base of the volcano, the lahar path separates briefly into two streams. Courtesy of NASA Earth Observatory.

News released at 1203 stated that, prior to the burst, police received indications that the tephra dam confining the Crater Lake was close to overflowing. Alarms from acoustic flow monitors (vibration sensors) installed in the dam at the Crater Lake outlet went off a number of times before the primary dam failure. The three monitoring sites on the crater rim, all activated with the dam failure.

A lahar [called 'moderate' by the New Zealand Department of Conservation (DOC)] was making its way down Mount Ruapehu after Crater Lake dam burst at about 1100 (figure 14). Ruapehu District Council said the lahar was expected to arrive at the Tangiwai road and rail bridges at about 1405 on 18 March. Spokesperson Paul Weetcroft said that the lahar's travel down the Whangaehu River was being monitored, and that the emergency management plan was working well; there were no reports of anyone in danger. He said that at this stage the lahar was expected to travel down the Whangeahu valley and out to sea. Roads were closed in the immediate area and rail transport was stopped. The Minister of Civil Defense, Rick Barker, says the systems set up to warn people about the lahar seem to have worked very well.

The Minister of Conservation stated that the lahar traveled down the predicted path, and the early warning response system worked as planned. An earthen dam (bund, or levee) built to divert the lahar's path toward the S withstood the lahar. As a result, the lahar continued down the Whangaehu valley away from the Tongariro catchment (which drains to the N into Lake Taupo). The lahar also continued safely down the valley and underneath the Tangiwai bridge.

The New Zealand Department of Conservation (DOC) reported at 1545 that the major peak of the lahar had passed. DOC believed the moderate-sized mudflow began when Mt Ruapehu's Crater Lake dam started to collapse between 11 and noon today, releasing the water over a 45-minute period. DOC's Dave Wakelin noted that the water kept within the channels and over the next couple of hours traveled safely down the Whangaehu River and under the Tangiwai bridges. The lahar was almost over by this time (1545), but some material was still moving down the river. No major infrastructure was damaged except for a small DOC footbridge between Tukino Mountain road and Rangipo. The tephra dam which was impounding the new crater lake was fully broken.

Aftermath observations. On 19 March 2007, GNS issued a Science Alert Bulletin concerning increased hydrothermal activity possible at Ruapehu's Crater Lake. Volcanologist Brad Scott of GNS Science said there had been an increase in volcanic earthquakes up to M 1 at the summit following the 18 March partial emptying of Crater Lake. Lowering of the lake could destabilize that hydrothermal system and lead to increased heating and steam-driven eruptions.

Scientists from the Department of Conservation (DOC) and GNS Science visited Mt. Ruapehu's crater lake on 19 March 2007 and confirmed that the tephra dam had eroded back down to the hard rim that formed the pre-1995 lake outlet. Water cascaded across a hard rock rim where once there was a 7.6-m-high dam. Prior to the previous day's collapse, the dam itself was 80-m long. Harry Keys of DOC stated in a press release that the breach was about 50- to 60-m wide at the top and 40-m wide at the hard rock rim, wider than scientists initially thought. The post-lahar lake level was 2,529.4 m elevation, a drop of 6.3 m from the pre-lahar level. The outlet continued to drain and the 'river' was about knee deep. The volume of water lost from the lake was is believed to be in the order of 1.3×10^6 m^3. Keys commented further that "One misconception we have heard is that now the lahar has happened there is no longer a Crater Lake! We have now reverted back to pre-1995 conditions with a Crater Lake of about 10×10^6 m^3 that is emptying over its natural outlet on the crater rim into the Whangaehu river." DOC emphasized that conditions either near or on the remains of the tephra dam were unstable and therefore hazardous.

Multi-agency Efforts. The Ruapehu Lahar Emergency Management Plan (Southern) was developed under the leadership of the Ruapehu District Council. Participants included officials from the Southern Ruapehu Lahar Planning Group, New Zealand Department of Conservation, New Zealand Ministry of Civil Defence and Emergency Management, police, and Horizons Regional Council, along with other key agencies including the Army, the New Zealand Fire Service, and GNS Science.

Reference: Keys, H.J.R., (date unknown), Lahars from Mount Ruapehu—mitigation and management; NZ Dept.

Figure 14. A camera installed by GNS Science near the summit of Ruapehu captured the failure of the tephra dam holding back Crater Lake and the lahar's onset. The fixed, digital still camera was installed overlooking the downstream side of the tephra dam in early January 2006. It had been taking pictures at 1-min intervals during daylight. Erosion scarps developed in the downstream face of the dam as a result of seepage through porous tephra layers in early 2007. Growth of these features culminated in dam failure on 18 March 2007. (top) Intact tephra dam at 1101. (middle) Crater Lake waters starting to flood through the breached dam at 1122. (bottom) Crater Lake waters pouring out through the extensive breach in the tephra dam at 1203. Courtesy of GNS Science lahar project, led by Vern Manville.

of Conservation website (a poster conveyed as a PDF file; creation/publication date unknown) (URL: http://www.doc.govt.nz/templates/summary.aspx?id=42442).

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 cu km dominantly andesitic volcanic massif is elongated in a NNE-SSW direction and is surrounded by another 100 cu km 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 at an altitude of 2,530 m, 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: *Institute of Geological & Nuclear Sciences* (GNS), Private Bag 2000, Wairakei, New Zealand (URL: http://www.gns/cri.nz/; http://data.geonet.org.nz/geonews/index.html); *Brad Scott,* Institute of Geological & Nuclear Sciences (GNS) (Email: B.Scott@gns.cri.nz); *New Zealand Department of Conservation,* Private Bag, Turangi, New Zealand (URL: http://www.doc.govt.nz/); *Roger Matthews,* North Shore City Council, Private Bag 93500 Takapuna, North Shore City 1331, New Zealand (URL: http://www.northshorecity.govt.nz); *The Press* (URL: http://www.stuff.co.nz/thepress); *National Aeronautics and Space Administration (NASA),* Earth Observatory (URL: http://earthobservatory.nasa.gov/).

Unnamed

East Pacific Rise near 9°50'N
Eastern Pacific Ocean
9.83°N, 104.30°W; summit elev. -2500? m

Along the fast spreading East Pacific Rise (EPR) crest near 9°50'N, Cowen and others (2007) reported on additional evidence regarding recent volcanic eruptions spanning about 4-5 months of activity discovered in April and May 2006. In April 2006, during routine recovery and redeployment of ocean-bottom seismometers (OBS) at the EPR R2K Integrated Study Site (ISS) near 9°50'N, eight of 12 OBS could not be recovered (*BGVN* 31:11). Anomalous turbidity and temperature in the water column along the ridge axis confirmed scientists' suspicions that the OBS were trapped by a new lava flow. A resurgence in magmatism had been postulated recently, based on temporal changes observed over the past few years in hydrothermal vent fluid chemistry and temperatures (Von Damm, 2004) and increasing microseismicity (Tolstoy and others, 2006).

According to Cowen and others (2007), within a week of the initial bottom-water surveys in late April, scientists mounted a rapid response expedition on board the research vessel (R/V) *New Horizon*. The expedition surveys included conductivity-temperature-depth (CTD) observations, optical tow-yos (tows during which a package is alternately lowered and raised), hydrocasts, and towed digital-imaging along the EPR axis between ~ 9°46'N and 9°57'N.

These surveys confirmed the occurrence of recent seafloor eruptions along more than 15 km of the ridge axis and up to ~ 1 km off axis. They documented widespread vigorous hydrothermal venting and a notable absence of vent megafauna (figure 15). Many of the hydrothermal vents studied over the past 15 years were disrupted. A prior eruption occurred in 1991-1992 (e.g., Haymon and others, 1993) along portions of the same segment of the EPR. This is the first repeat eruption documented at the same location along the mid-ocean ridge (MOR) crest.

Toomey and others (2007) discussed how mantle upwelling is essential to the generation of new oceanic crust at mid-ocean ridges, and concluded that such upwelling is asymmetric beneath active ridges. In their article, the authors used seismic imaging to show that the isotropic and anisotropic structure of the mantle is rotated beneath the East Pacific Rise. The isotropic structure defines the pattern of magma delivery from the mantle to the crust. They found that the segmentation of the rise crest between transform faults correlates well with the distribution of mantle melt. The azimuth of seismic anisotropy constrains the direction of mantle flow, which is rotated nearly 10° anticlockwise from the plate-spreading direction. The mismatch between the locus of mantle melt delivery and the morphologic ridge axis results in systematic differences between areas of on-axis and off-axis melt supply. The authors conclude that the skew of asthenospheric upwelling and transport governs segmentation of the East Pacific Rise and variations in the intensity of ridge crest processes.

References. Cowen, J.P., Fornari, D.J., Shank, T.M., Love, B., Glazer, B., Treusch, A.H., Holmes, R.C., Soule, S.A., Baker, E.T., Tolstoy, M., and Pomraning, K.R., 2007 (13 February), Volcanic Eruptions at East Pacific Rise Near 9°50'N: Eos, Transactions, American Geophysical Union, v. 88, no. 7, p. 81, 83.

Haymon, R.M., Fornari, D.J., Edwards, M.H., Carbotte, S., Wright, D., and Macdonald, K.C., 1991, Hydrothermal vent distribution along the East Pacific Rise crest (9 deg 9'-54' N) and its relationship to magmatic and tectonic processes on fast-spreading mid-ocean ridges: Earth and Planetary Science Letters, v. 104, p. 513-534.

Haymon, R.M., Fornari, D.J., Von Damm, K.L., Lilley, M.D., Perfit, M.R., Edmond, J.M., Shanks, W.C., III, Lutz, R.A., Grebmeir, J.M., Carbotte, S., Wright, D., McLaughlin, E., Smith, M. Beedle, N., and Olson, E., 1993, Volcanic eruption of the mid-ocean ridge along the East Pacific Rise crest at 9 deg 45-52 min N: direct submersible observations of seafloor phenomena associated with an eruption event in April 1991: Earth and Planetary Science Letters, v. 119, p. 85-101

Toomey, D.R., Jousselin, D., Dunn, R.A., Wilcock, W. S., and Detrick, R.S., 2007, Skew of mantle upwelling beneath the East Pacific Rise governs segmentation: Nature, v. 446, p. 409-414 (doi:10.1038/nature05679).

Tolstoy, M., J.P. Cowen, E.T. Baker, D.J. Fornari, K.H. Rubin, T.M. Shank, F. Waldhauser, D.R. Bohnenstiehl, D. W. Forsyth, R.C. Holmes, B. Love, M.R. Perfit, R.T.

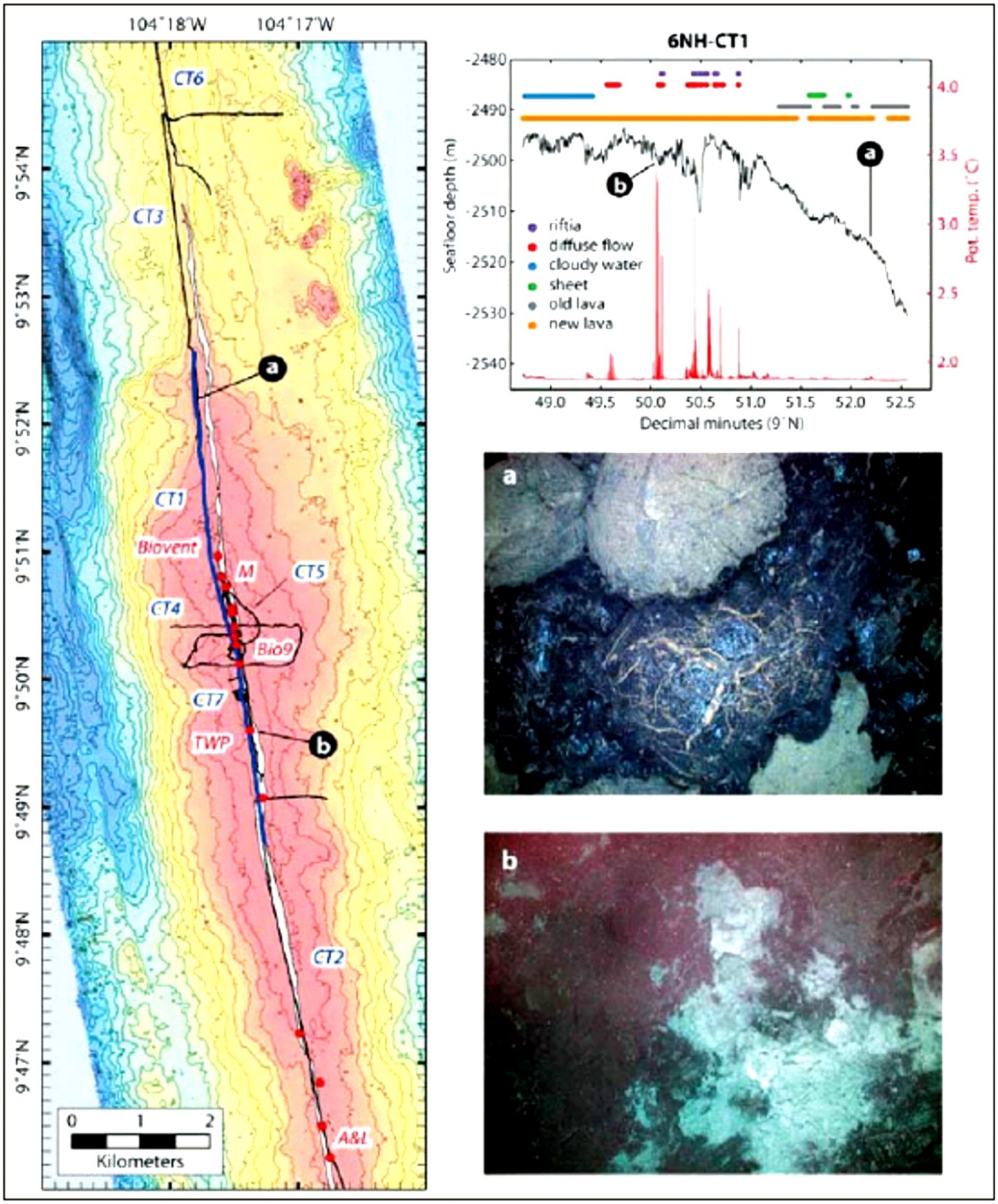

Figure 15. (Left) Location map of the track of the TowCam (Woods Hole Oceanographic Institution's digital deep-sea camera with rock and water sampling capabilities) which surveyed a distance of ~ 4 minutes of latitude (~ 7 km) along the ridge axis over the new eruptions. Red dots indicate old high-temperature hydrothermal vents. (Top right) An along-axis bathymetric profile of the EPR, ~ 7 km long, compiled from depth and altitude data from a TowCam. The profile is shown with geological and biological observations linked to symbols that appear in a key and on horizontal lines above the profile. The lowest trace, "new lava," is continuous over a broad expanse of the S end of the profile (on either side of "b" on the map), and areas without new lava appear at only a few spots near "a" (9 52'N). A plot of the potential temperature (the temperature of a water sample if lifted adiabatically, in effect, without thermal contact with surrounding water, to the surface) appears below the profile. TowCam photographs, keyed to their location along the track, include ("a" middle right) new pillow to lobate lava flow overlying older sediment-covered pillows and ("b." bottom right) diffuse hydrothermal venting through recently erupted lava, material possibly covered with microbial growth. Courtesy Cowen and others (2007).

Weekly, S.A. Soule, and B. Glazer, 2006, A sea-floor spreading event captured by seismometers: Science, v. 314, no. 5807, p. 1920-1922.

Von Damm, K. L., 2004, Evolution of the hydrothermal system at East Pacific Rise 9°50'N: Geochemical evidence for changes in the upper oceanic crust, *in* C. German and others (ed), Mid-Ocean Ridges: Hydrothermal Interactions Between the Lithosphere and Ocean: Geophys. Monogr. Ser., v. 148, p. 285-304.

Geologic Summary: Evidence for a very recent, possibly ongoing eruption was detected during a series of dives in the submersible vessel Alvin in 1991 on the East Pacific Rise at about 9°50'N (9.83°N). Hot-vent animal communities that had been documented during November to December 1989 imaging were observed to have been buried by fresh basaltic lava flows, and the scorched soft tissues of partially buried biota had not yet attracted bottom scavengers. Fresh black smoker chimneys were draped by new lava flows. This position was at a depth of ~ 2,500 m S of the Clipperton fracture zone, about 1000 km SW of Acapulco, México. It coincided with a location where fresh lava flows previously estimated as less than roughly 50 years in age had been found (Haymon et al., 1991). Later dating of very short half-life radionuclides from dredged samples confirmed the young age of the eruption and indicated that another eruptive event had taken place in late 1991 and early 1992. An eruption in 2005-2006 produced lava flows that entrapped previously emplaced seismometers.

Information Contacts: *RV New Horizon* and *Scripps Institution of Oceanography*, University of California - San Diego, 8602 La Jolla Shores Drive, La Jolla, CA 92037, USA (URL: http://sio.ucsd.edu/); *Woods Hole Oceanographic Institution*, Woods Hole, MA 02543, USA (URL: http://www.whoi.edu/).

Shiveluch

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

In December 2006 Shiveluch underwent heightened seismic and volcanic activity after more than a year of lesser activity (*BGVN* 31:11). After significant explosive activity during 26-27 December 2006 that caused the Kamchatkan Volcanic Eruption Response Team (KVERT) to briefly raise the hazard status, activity remained above background levels into January 2007.

The seismic network recorded 200 shallow earthquakes daily between 29 December and 12 January 2007, accompanied by fumarolic activity, avalanches, and gas-and-ash plumes that rose from 4.3 km to 13.7 km altitude, drifting E and SSW. A large thermal anomaly over the dome was noted.

Between 12 January to 16 February, this activity continued. The number of earthquakes dipped to as low as 120 per day before increasing to 200 again during 2-9 February. Plumes during this time rose to an altitude of 3.5-6.5 km and drifted in a variety of directions. The large thermal anomaly over the dome remained. An eruption occurred on 6 February that was not visible on satellite imagery.

Astronauts aboard the Space Shuttle noted a plume around 21 March (figure 16). On 29 March, an explosive event at Shiveluch produced an ash plume (figure 17) that, according to the Tokyo VAAC, reached an altitude of 11.9 km and drifted NE. The next day, an explosive event that lasted about 6 minutes produced a plume that reached altitudes of 10.1-12.2 km, and drifted NE. According to a news article, on 31 March, a mudflow covered an approximately 900-m-long section of road, in an area ~ 20 km from Shiveluch.

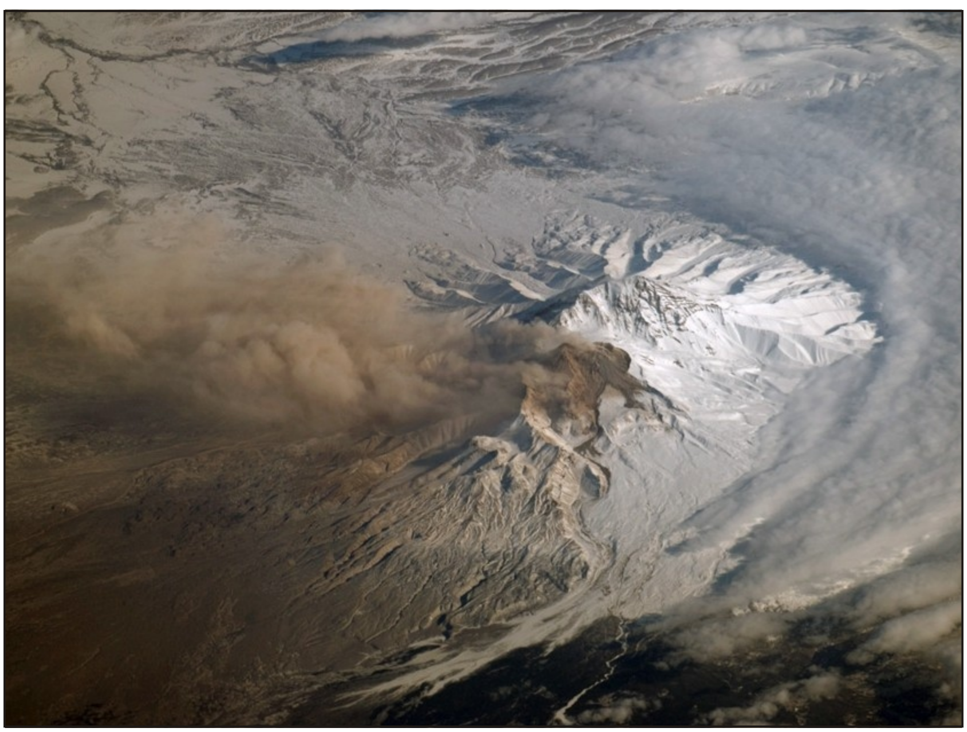

Figure 16. Plume from Shiveluch taken by astronauts aboard the International Space Station (ISS) around mid-morning on or around 21 March 2007. Photograph ISS014-E-17165. Courtesy of NASA.

In subsequent reports, KVERT indicated that seismic activity continued above background levels during 4-12 April. Based on seismic interpretation, observation, and video data, ash-and-steam plumes rose to altitudes of 4.5-7 km throughout this period. The large thermal anomaly was visible on satellite imagery during 1-10 April. As of 10 April, the Color Code at Shiveluch remained at Orange.

Geologic Summary. The high, isolated massif of Shiveluch volcano (also spelled Sheveluch) rises above the lowlands NNE of the Kliuchevskaya volcano group. The 1300 cu km Shiveluch is one of Kamchatka's largest and most active volcanic structures. The summit of roughly 65,000-year-old Stary Shiveluch is truncated by a broad 9-km-wide late-Pleistocene caldera breached to the south. Many lava domes dot its outer flanks. The Molodoy

Figure 17. Aqua satellite image of ash cloud discharged from Shiveluch. This image was taken on or about 29 March as the ash cloud, in the absence of significant wind, hovered directly over the summit. The cloud casts its shadow northward over the icy landscape. By using sun-angle computations and time of day, such shadows can be used to estimate plume-top altitudes. Courtesy of NASA (NASA/GSFC/MODIS Rapid Response Team).

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 Shiveluch. At least 60 large eruptions of Shiveluch have occurred during the Holocene, making it the most vigorous andesitic volcano of the Kuril-Kamchatka arc. Widespread tephra layers from these eruptions have provided valuable time markers for dating volcanic events in Kamchatka. Frequent collapses of dome complexes, most recently in 1964, have produced debris avalanches whose deposits cover much of the floor of the breached caldera.

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