

MARGINS Event Response: Anatahan Volcano

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In May 2003, participants on a MARGINS research cruise coincidentally encountered the first historic eruption of Anatahan, the southern-most subaerial volcano of the Mariana island arc.

In response to this unique event, the [Lamont] MARGINS Office organized the immediate dispatch of a team of volcanologists to sample the products of the ongoing eruption. Samples collected during the expedition were distributed to the MARGINS scientific community for analysis. As a result, MARGINS scientists contributed to a Special Session on the Anatahan eruption at the Fall 2003 AGU meeting, and a special issue of *Journal of Volcanology and Geothermal Research (JVGR)* on the eruption co-edited by representatives of the three main organizations working on Anatahan: Dr. David Hilton, MARGINS; Dr. John Pallister, USGS and Rudi Pua, EMO.

Active seismicity and dome building has continued since 2003, and from April to July 2004 Anatahan erupted for a second time. The third historical eruption began on January 5, 2005. Within two days, ash was rising to 10,000 feet and blowing 40 nautical miles downwind, and observers were witnessing bombs a meter across being ejected hundreds of meters above the crater walls.

According to an EMO report distributed in February 2005, "By January 20 explosions were occurring every 3 to 10 seconds and fresh ejecta and small lava flows had filled the innermost crater to nearly the level of the pre-2003 East Crater floor. The eruption peaked during January 26 and February 2, during which time the volcano sent ash as high as 15,000 to 20,000 feet locally and as far as 100 miles downwind, and vog nearly

600 miles downwind. Two weeks later the 2003 crater floor had essentially been entirely covered by fresh lava to a diameter of about one kilometer."

Event Response (March 2005)

In order to investigate these new developments, Dr. Tobias Fischer of the University of New Mexico, Albuquerque, petitioned MARGINS to fund a second Anatahan event response. NSF approved the response via a small supplement to the MARGINS Office grant, allowing Dr. Fischer and Dr. David Hilton (Scripps) to travel to Anatahan in order to collect rock samples from the 2005 eruption, measure SO₂ flux from the volcano, and

help EMO and USGS with servicing of seismic stations.

Drs. Fischer and Hilton, accompanied by Juan T Camacho (EMO) and Mike Cunningham (Americopters), arrived at Anatahan by helicopter on the morning of March 14, 2005. While there, they sampled a 3mm layer of ash deposited by the January 2005 eruption on the volcano's southeast flank in the vicinity of Frank Truesdell's section named FTM-03-21 (Truesdell *et al.*, *JVGR Anatahan special issue*, in press). The fresh deposit was scoria poor and contained rare lithics. Inside the main crater, they sampled scoriaceous material in the vicinity of bomb impact craters and bomb fragments. From a 15mm covering on the box



Anatahan's East Crater looking from the west. The crater rim is in the foreground. The East Crater is nearly filled with lava flows or dome material. Photograph: David Hilton, March 14, 2005

Account compiled in part by Paul Wyer, MARGINS Office Coordinator, based on:

- T. Fischer and D. Hilton (2005), *NSF-MARGINS Expedition to Anatahan Volcano March 2005*, www.margins.wustl.edu/Research/AnatahanReport2005.html
- R. A. White (2005), *Summary of the 5 April 2005 Anatahan Eruption to 50,000 ft.*, www.margins.wustl.edu/Research/AnatahanReport_3_7_2005.html

containing the East Meadow USGS seismic station – which they cleaned and returned to functionality — they collected scoria poor ash. Sites on the northeast part of the main crater and the abandoned village buried in the May 2003 eruption had no deposits from the 2005 eruption.

Mini-DOAS (differential optical absorption spectrometry) SO₂ flux measurements were obtained by traversing over the ocean beneath the plume on March 14 and March 16. The plume appeared larger on the 16th than the 14th, and contained a significantly higher average SO₂ concentration (340 ppm m versus 130 ppm m). Based on the measured wind speeds on East Meadow (3.0 m/s vs. 2.5 m/s) and width of the plume at the time and location of the measurement (~3.2 km vs. ~10 km), the SO₂ flux was ~800 metric tons per day on the 16th and ~1000 metric tons per day on the 14th respectively. On the basis of these preliminary results, the SO₂ flux was about half that of the May 2003 event. However, a detailed evaluation of all traverses under the plume will be performed to validate the results.

Fischer and Hilton also made use of the helicopter transfers to, from, and around the island to observe changes in the volcano morphology since April 2004. The previously deep East Crater area was now filled with a dome or lava flow. Vigorously discharging fumaroles and abundant sulfur deposits cover the surface of the dome. The site of the abandoned village is now grown over by vegetation.

Sample Distribution

Samples collected during the March 2005 Anatahan event response will be

distributed to the MARGINS community for analysis:

- **Scoria poor southeast flank sample, Anat 05-01: N16°20.057'; E145°39.729'; 49 m.**
- **Main crater scoracious sample, Anat 05-02: N16°20.409'; E145°41.748'; 433 m.**
- **Scoria poor East Meadow sample, Anat 05-03: N16°20.573'; E145°43.028'; 82 m.**

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Eruption to 50,000 Ft. (April 2005)

Around the time of the MARGINS event response (March 14) the seismicity and eruption of Anatahan started ramping up again. Activity from that date on was marked by periods of seismic quiescence (March 17–21 and March 25–28) and explosive activity (March 21–25 and March 28–April 5, peaking on April 3). Each phase of explosive activity probably corresponded to reopening of the volcano vent. However, the decline in seismic activity from April 3 to April 5 was followed by a slow increase in tremor amplitudes starting at about 1000 UT on the morning of April 5. There were no precursory seismic signals, but at around 1600UT the Guam Meteorological Weather Office observed ash rising to around 30,000 ft. on their radar, which Jennifer Piatt at the Air Force Weather Agency verified with satellite imagery. Shortly after 1700 UT the Air Force Weather Agency advised that the ash had reached 50,000 ft.

The peak of the eruption lasted little over an hour, but John Ewert of the USGS later estimated that ~50,000 m³ of ash was erupted during this interval. This

equates to a large VEI 3. Over another hour, the eruption dropped off rapidly to near background level, at which it largely remained. On the basis of observations and computer models, Randall White and John Ewert of the USGS were able to advise the EMO Director that Saipan would receive only a light (< 2 mm) dusting of ash.

The late March-early April eruption disabled two seismometers and two microphones on Anatahan island, and left the remaining short-period seismometer, ANA2, only partially operational. Frequent transmission dropouts owing to ash obscuring transmission paths and solar panels led to a few false alarms but Andy Lockart (USGS) has modified the alarm system triggering mechanism to cope with the new circumstances. Lockhart arrived in Saipan on May 10 to attempt repairs to the seismic and acoustic stations on Anatahan.

References:

- de Moor, J.M., Fischer, T.P., Hilton, D.R., E. Hauri, L.A. Jaffe, Camacho, J.T. (in press) Degassing at Anatahan volcano during the May 2003 eruption: Implications from petrology, ash leachates, and SO₂ emissions. *J. Volcanol. Geotherm. Res.*
- Fischer, T.P., Hilton, D.R., de Moor, J.M.F., Jaffe, L.A., Spilde, M.N., Counce, D., and Camacho, J.T., 2003. The first historical eruption of Anatahan volcano, Mariana islands. *Eos Trans. AGU* 84, (46), V32B-1009.
- Truesdell, F.A., Moore, R.E., Sako, M., White, R.A., Koyanagi, S.K., Chong, R., Camacho, J.T. (in press) The 2003 eruption of Anatahan volcano, Commonwealth of the Northern Mariana Islands: chronology, volcanology, and deformation. *J. Volcanol. Geotherm. Res.*



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