NSF-MARGINS Expedition to Anatahan Volcano — March 2005

According to the Emergency Management Office (EMO) report distributed in February 2005, the third historical eruption of Anatahan began on January 5, after three days of precursory seismicity. On January 6 frequent strombolian explosion signals began and by the next day ash was rising to 10,000 feet and blowing 40 nautical miles downwind. Bombs a meter in diameter were being thrown hundreds of feet in the air. 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 (volcanic smog) 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.

NSF-MARGINS supported a response to this eruption. Tobias Fischer (University of New Mexico) and David Hilton (Scripps Institution of Oceanography) traveled to Anatahan to collect rock samples, help EMO and USGS with servicing of seismic stations and measure SO$_2$ flux from the volcano. This report summarizes the activities of the response team. Samples collected will be distributed to the MARGINS community and USGS for analyses.

On March 14, Tobias Fischer, David Hilton, Juan T Camacho (EMO), Mike Cunningham (Americopters) arrived at Anatahan by helicopter at 8:36 am, local time. The East Crater was obscured by clouds and we were not able to fly over the east crater wall to make visual observations of the crater area. While on Anatahan we

a) landed on the south east side of the volcano and sampled the deposit of the January 2005 eruption. The 2005 deposit was clearly visible on top of the 2003 gray ash unit with a thickness of 3 mm. The deposit consisted of ash containing dense dark colored material. It is scoria poor and contained rare lithics.
Figure 1. The 2005 deposit is ~3mm thick and overlies units RA (reddish brown) S and GA (gray) of the 2003 eruption.

Figure 2. Close up of section seen in Figure 1.
b) landed inside the main crater to the north of Mugabe EDM station. Abundant bomb impact craters were visible in this area (Figures 3-5). We sampled the scoriaceous material in the vicinity of the bomb impact craters and fragments of the bombs.

Figure 3. Bombs from the 2005 eruption in main crater. Bomb in top and center of picture is approximately 1 m in diameter.
Figure 4. Bomb craters (and bomb – center of picture) from the 2005 eruption. Bomb crater on right is approximately 1.5 m in diameter

Figure 5. Camacho (left) and Fischer sampling 2004 tephra and bomb fragments from 2005 eruption.
c) landed on the north east part of the main crater but outside the East Crater wall. In this area the ground was hard and we did not observe any 2005 deposits.

d) flew towards the East Cater to make visual observations. The East Crater area looks different from the previous year (April 2004). We did not see a deep explosion crater. The crater is now filled with a dome or lava flow. Fumaroles vigorously discharge gases and abundant sulfur deposits cover the surface of the dome. There were no ash emissions and white plume of gas and steam was discharging from the crater area.

Figure 6. The East Crater looking from the west. In foreground is the crater rim of East Crater. The East Crater is nearly filled with lava flows or dome material.
Figure 7. Looking into the East Crater from the west. Abundant fumaroles discharge steam and gases; abundant sulfur deposits are visible.

e) landed on the East Meadow and cleaned the solar panel of the USGS seismic station. The panel was covered with 2005 ash and the station had not been working for several weeks. After cleaning of the panel the station is now functioning again, recording data. We sampled the 2005 ash deposit on top of the box containing the seismic station (Fig. 8). The deposit consists of ash containing dense dark colored material. As at site 1, the ash was scoria poor. Thickness is 15 mm.
f) landed on the site of the abandoned village where we had collected the deposits of the May 2003 eruption. The site is now grown over by vegetation, the remaining buildings have completely collapsed. No deposit of the 2005 eruption was found.
g) performed mini DOAS SO₂ flux measurements by traversing over the ocean to the west of Anatahan. The sky was cloudy but plume was visible. Starting at 12:50 local time, we performed several traverses under the plume, The plume did not contain visible ash.

On March 16, Tobias Fischer, David Hilton and Mike Cunningham (Americopters) returned to Anatahan to make additional mini DOAS SO₂ flux measurements.

As on March 16, the plume of Anatahan did not contain visible ash and consists of water vapor and gases.
Figure 11. Anatahan on March 16, 2005 looking to the north east.

Starting at 14:50 local time, we again measured SO$_2$ flux by mini DOAS. We traversed under the plume to the west of the volcano. On this day the plume appeared larger than on March 14. The wind speed measured on the east meadow on this day was 3.0 to 3.2 m/s.

Preliminary evaluation of the mini DOAS data

March 14, 2005. The average SO$_2$ concentration of the plume was approximately 130 ppm m. The width of the plume at the time and location of the measurement was approximately 10 km. Using a measured wind speed (East Meadow) of 2.5 m/s, the SO$_2$ flux was approximately 1000 metric tons per day.

March 16, 2005. The average SO$_2$ concentration of the plume was approximately 340 ppm m. The width of the plume at the time and location of the measurement was approximately 3.2 km. Using a measured wind speed (East Meadow) of 3.0 m/s, the SO$_2$ flux was approximately 800 metric tons per day.

NB: a detailed evaluation of all traverses under the plume will be performed to validate these preliminary SO$_2$ flux results.
Compared to the measurements performed in May 2003, immediately after the first historical eruption of Anatahan (approximately 3500 metric tons per day, de Moor et al., in press) and the measurements performed in April 2004 (approximately 2000 metric tons per day, Fischer et al., 2004), the current SO$_2$ flux of Anatahan is about a factor of two lower than last year.

Report prepared by:

Tobias Fischer, Department of Earth and Planetary Sciences, University of New Mexico (fischer@unm.edu)

David Hilton, Geoscience Division, Scripps Institution of Oceanography (drhilton@ucsd.edu)