MONITORING THE SOUFRIERE HILLS VOLCANO ON MONTSERRAT WITH CALIPSO

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Introduction: Instruments were placed around the Soufriere Hills Volcano (SHV) in Montserrat located in the Lesser Antilles during the month of January 2003. These instruments included Sacks-Evertson strainmeter, borehole tiltmeter, borehole seismometers and continuous GPS at a total of four sites. This installation is referred to as the CALIPSO project (Caribbean Andesite Lave Island Precise-Geodetic Seismic Observatory). The CALIPSO instruments complement the existing University of Arkansas-Montserrat Volcano Observatory (MVO) network of six sites, which are comprised of CGPS and surface seismometers. We returned in July of 2003 to update the instrument package with the addition of a data telemetry system, which allows the information collected on site to be relayed via Freewave antennae to the MVO where it is distributed through the internet. The instrument package was revamped with the addition of the Quantera 330 six channel analog to digital converter, a Quantera Packet Baler used to store the data in case of system failure, the UDP-10 serial to IP delivery system, a five port ethernet switch and the equipment necessary to use Freewave telemetry. We had 2.5 sites taking data during the July 12th SHV eruption. Unfortunately two CGPS sites at Whites Yard and Heritage Estate were destroyed during the July 12th eruption, and will need to be replaced with new equipment at a later date.

Methods: The new instrument package was put in place to aid in the data collection process. All instrumentation was placed in a concrete crypt, which was designed to shield the equipment, allowing it to remain in the field continuously for a planned lifespan of 30 years. The instruments were powered either by AC, or a battery array of 12 volt lead acid batteries supplemented with solar panels. The Quantera 330 was connected to both the Sacks-Evertson strainmeter and the borehole seismometer. The Q330 converts the analog instrument signals into packets of digital information. From the Q330, the packets were sent through the five port switch and the Freewave at 24bits per sample to the MVO. The strainmeter is sampled at 50 Hz while the seismometer is sampled at 200 Hz. The Q330 also sends the packets of information to the Packet Baler, where the packets are saved in case of failure of the telemetry system. The Ashtech antenna and receiver, as well as the borehole tilt, were connected to the UDP-10 serial to IP device servers, which then went through the five port switch to the telemetry system, which includes a Freewave DGR-115RE ethernet bridge radio modem connected to a 6 dB or 10 dB yagi antenna. All of the data packets are sent using this telemetry package to the MVO, where they are received by a mirror package connected to a 16 port switch, which puts the packets on the MVO LAN. There were 2.5 sites taking data prior to, and throughout, the July 12th eruption. The sites were able to record the hybrid swarms that lead up to the eruption, as they grew into a continuous tremor directly before the eruption took place. Unfortunately these sites did not yet have a fully setup telemetry package.

Discussion: Hybrid swarms began one week prior to the eruption and slowly intensified through July 11th as the seismic events gradually became larger and more closely spaced. By the morning of July 12th the swarms had merged into a continuous tremor signal. By 9 AM local time, the >230 million m^3 dome, which last had a significant collapse in July 2001, began to generate pyroclastic flows that were directed primarily towards the Tar River Valley and White's Ghaut. The dome collapse was further aided by a steady rainfall, which occurred throughout the morning hours of July 12th and several days prior to the dome collapse. By the afternoon the pyroclastic flows became more frequent, with many reaching the sea, and by evening they were continuous. One flow traveled 2 kilometers over the surface of the sea at Tar River Valley. The island wide accumulation of ash and accretionary lapilli were direct results of the pyroclastic flow and explosive activity. The main explosive event occurred between 23:00 and midnight of the 12th, with dense rock fragments of several mm to 2cm falling island wide. The Washington Volcanic Ash Advisory Center (VAAC) recorded a column height of 48-50,000 ft for the event. Activity remained at a high level until 2:00 AM on July 13th, and continued to decline until a second major explosion occurred at 9:10 AM. Two more explosions occurred throughout the following two days with pumices reaching between 30cm at Spring Hill and 6cm at Olveston. These events were recorded by our instruments. The data are due to be processed and future work will involve modeling in an attempt to better understand the mechanism of eruption.

Conclusion: The data gathered relating to the July 12th dome collapse can be used to model the collapse, deriving a mechanism for the cause of the eruption. Once each site is completed it will be possible to monitor the period of dome growth leading to dome collapse, with the added convenience of having the data available via the internet. This data set will allow for a model of the dome collapse to be created, adding to the understanding of the internal processes of andesitic volcanoes.

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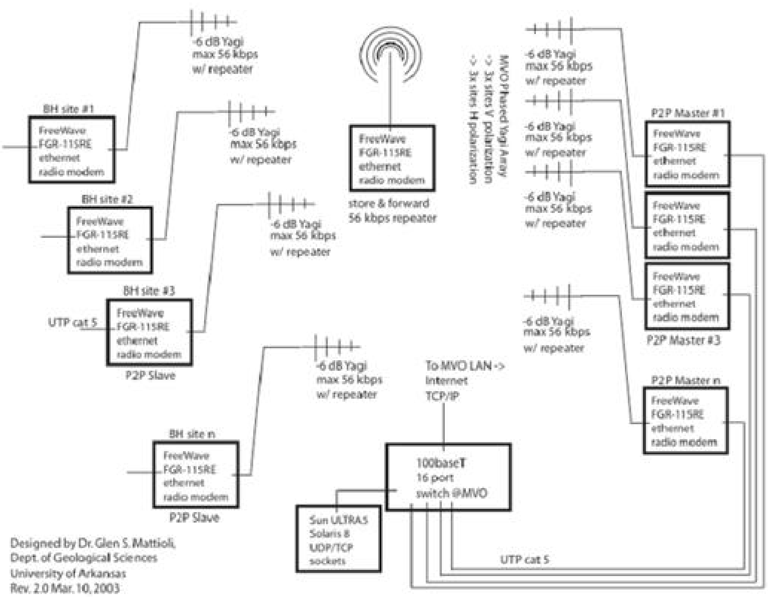

Fig. 1

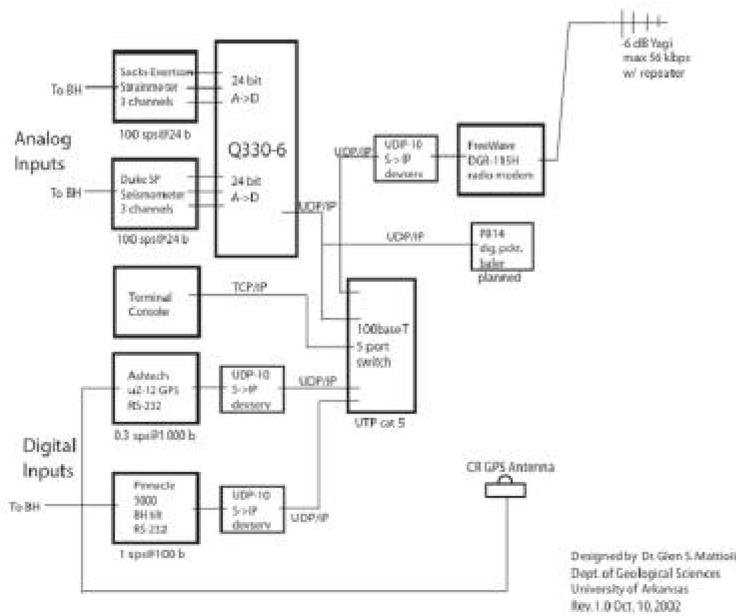

Fig. 2

Figure 1: Schematic of the Freewave telemetry system
Figure 2: Schematic of the CALIPSO instrument package, including telemetry connection
Figure 3: Trants borehole seismic and strain records for the July 12th sub-plinian to plinian event that occurred near 11:00 PM local time (AST)

Fig. 3