

Annual Report for Period:04/2003 - 04/2004**Submitted on:** 09/30/2003**Principal Investigator:** Jansma, Pamela E.**Award ID:** 0116485**Organization:** U of Arkansas**Title:**

Collaborative research: magma reservoir-conduit dynamics as revealed by a borehole geophysical observatory and continuous GPS

Project Participants**Senior Personnel****Name:** Jansma, Pamela**Worked for more than 160 Hours:** No**Contribution to Project:**

Dr. Jansma acted as a substitute PI for Dr. Glen S. Mattioli while he was an IPA to the National Science Foundation, where he was the Program Director for Petrology and Geochemistry in the Division of Earth Sciences. Dr. Mattioli returned to his normal duties as an Associate Professor in the Department of Geosciences at the University of Arkansas in August 2003. He is now responsible for all scientific and technical issues for this award. A formal request for a change of PI will be submitted as soon as possible. Dr. Jansma will remain a co-PI, although she will not accept any salary from this award. She will provide technical guidance and scientific coordination with other ongoing GPS geodetic projects in the Lesser Antilles arc.

Name: Mattioli, Glen**Worked for more than 160 Hours:** Yes**Contribution to Project:**

Dr. Mattioli was the original PI when this grant was submitted to the NSF in February 2001. Dr. Mattioli was the Program Director for the Petrology and Geochemistry program in the Division of Earth Sciences from July 2001 until August 2002. Dr. Jansma acted as a substitute PI for Dr. Mattioli during his NSF tenure and for 1 year beyond. A formal change of PI is being submitted. Dr. Mattioli has been fully responsible for all scientific, technical, and administrative aspects of this award since his return to full time teaching at the University of Arkansas in late August 2002. He spent a combined two months in the field in Montserrat in November/December 2002, January 2003, and July/August 2003. His activities included supervision of drilling operations, maintenance of drilling and financial records for the project, participation in site selection, design and supervision of the instrument crypts and CGPS monuments, data archival and analysis, and installation of the new Quanterra and FreeWave data acquisition systems. In addition, he supervised all the other participants from UARK during the course of the year. He accepted two months of summer salary from the first CGI during the summer of 2003.

Post-doc**Graduate Student****Name:** Turner, Henry**Worked for more than 160 Hours:** No**Contribution to Project:**

Mr. Turner completed his M.S. degree in August 2003 and now is enrolled in the Environmental Dynamics Ph.D. program at the University of Arkansas. He was awarded a prestigious Walton Distinguished Doctoral Fellowship by the Graduate School at UARK. His primary focus is the fore-arc kinematics of the

modeling. His support is from another NSF award to PI P. Jansma. Mr. Turner did not actively participate in the CALIPSO project during this reporting period.

Name: Van Boskirk, Elizabeth

Worked for more than 160 Hours: Yes

Contribution to Project:

Ms. Van Boskirk assisted during the installation of three of the four CGPS sites associated with the borehole observatory in July 03. She was primarily responsible for organizing all the components for each site into separate kits for deployment in the field. In addition, she was responsible for helping to train other UARK undergraduate students in GPS field procedures prior to the Montserrat deployment in July. She assisted in the cleanup and reorganization of the CALIPSO lab space in Montserrat after the July 12th eruption.

Undergraduate Student

Technician, Programmer

Name: Jones, Neil

Worked for more than 160 Hours: No

Contribution to Project:

Mr. Jones assisted with the setup of the computer network at each remote borehole site during the July 03 field campaign. He maintained a digital database of all the electronic component serial numbers, IDs, and IP addresses. He also assisted CIW personnel in preparing various cables and connectors required for the RF telemetry system. He assisted in the cleanup and reorganization of the CALIPSO lab space in Montserrat after the July 12th eruption.

Name: Johnston, William

Worked for more than 160 Hours: No

Contribution to Project:

Dr. Johnston is a Research Associate in the Center for Advanced Spatial Technologies within the University of Arkansas and only works with the CALIPSO project part-time on an hourly basis. To date, he has only billed our project for 36 hr. His Ph.D. is in Electrical Engineering and Computer Science and his expertise is in high level programming and web-based database query system development. He was primarily responsible for testing and configuration of the new Quanterra Q330, PB-14 digital packet balers, and the FreeWave ethernet bridge radio modems. He has also assisted in the design, testing, and implementation of the IPsec Virtual Private Network between the UARK and the MVO for secure communications with the CALIPSO instruments in Montserrat.

Other Participant

Name: Russell, Orion

Worked for more than 160 Hours: Yes

Contribution to Project:

Mr. Russell helped in the field during drilling operations in Jan. and Feb. 03. He logged core along with the other junior geologists and assisted the PI's with logistical issues. He was responsible for moving and storing all the cores obtained from the boreholes from their temporary storage facility to a more permanent one. He also shot video and digital still photography of drilling operations that is included on the CALIPSO web site.

Research Experience for Undergraduates

Name: Mischler, John

Worked for more than 160 Hours: Yes

Contribution to Project:

Mr. Mischler was a REU participant in the Arkansas-Oklahoma Space Center REU for Summer 2003. He assisted in the installation of the CGPS mounts and RF telemetry antennae at 2 of the 4 borehole sites. Working together with

storage facility and cleaned up at several of the sites after the July 12th eruption. His primary REU research focus was not with the CALIPSO project, but rather with the collection and interpretation of campaign GPS data in Dominica. As per his REU requirements, Mr. Mischler presented his results to the rest of the REU participants and faculty in a poster and talk.

Years of schooling completed: Junior

Home Institution: Other than Research Site

Home Institution if Other: Augustana College, IL

Home Institution Highest Degree Granted(in fields supported by NSF): Bachelor's Degree

Fiscal year(s) REU Participant supported: 2003

REU Funding: REU site award

Name: McBee, Jonathan

Worked for more than 160 Hours: Yes

Contribution to Project:

Mr. McBee was a REU participant in the Arkansas-Oklahoma Space Center REU for Summer 2003. He assisted in the installation of the battery array at the Trants borehole site and the RF telemetry antennae at 2 of the 4 borehole sites. Working together with Mr. Mischler, he completely reorganized the Olveston equipment and core storage facility and cleaned up at several of the sites after the July 12th eruption. His primary REU research focus was with the CALIPSO project. He assisted Dr. W. Johnston with testing and configuring the new data acquisition systems (Quanterra 330's and FreeWaves) prior to deployment in Montserrat. As per his REU requirements, Mr. McBee presented his results to the rest of the REU participants and faculty in a poster and talk.

Years of schooling completed: Junior

Home Institution: Other than Research Site

Home Institution if Other: Wheaton College, MA

Home Institution Highest Degree Granted(in fields supported by NSF): Bachelor's Degree

Fiscal year(s) REU Participant supported: 2003

REU Funding: REU site award

Organizational Partners

The Pennsylvania State University

Carnegie Institution Washington

Duke University

Bristol University

Bristol and Leeds Universities have obtained additional financial support for this NSF project through a NERC grant. The funding was transferred to Penn State and after currency conversion, wire fees, etc. amounts to \$190K, which will be used to partially support drilling costs incurred by DOSECC.

Montserrat Volcano Observatory

The Montserrat Volcano Observatory will provide space for computers and electronics related to the borehole observatory. In addition, they will allow the borehole observatory research team access to existing and future geophysical observations including ground deformation (currently there are 3 CGPS sites), electronic tilt, and short period and broadband seismic data. It is

anticipated that MVO personnel will provide routine maintenance for all new and integrated instrumentation related to the borehole and CGPS observatory.

The University of Puerto Rico, Mayaguez

UPRM has an existing CGPS network (3 sites) and RF telemetry infrastructure on the Soufriere Hills volcano. The CGPS and RF networks are fully integrated with their MVO equivalents. Dr. Mattioli was the PI on two NASA awards to the University of Puerto Rico that resulted in the purchase, installation, and maintenance of this infrastructure from 1995-2002. The equipment is on long term loan to the MVO from UPRM and will remain in place until it either fails or the MVO is closed.

Other Collaborators or Contacts

Activities and Findings

Research and Education Activities:

The following summary was co-written by the Project Leader, Dr. Barry Voight, and Senior Investigator, Dr. Glen Mattioli, and thus both Penn State and UARK submissions are essentially the same.

The project has been designated by us as δCaribbean Andesite Lava Island Precision Seismo-geodetic Observatoryö, with the acronym CALIPSO. The project has greatly enhanced the monitoring and scientific infrastructure at the Soufriere Hills Volcano, Montserrat with our recent installation of an integrated array of borehole and surface geophysical instrumentation at four sites.

Drilling by DOSECC commenced in November and continued through March, with all senior staff participating. Cores were logged by student öjunior geologistsö supervised by senior staff, comprising a major on-site educational effort by CALIPSO; the students came from Penn State, U Arkansas, Bristol University (UK), and the University of the West Indies. The students gained important experience in drilling, logging and equipment installations. Drilling was conducted generally by two-man crews on two 12-hour shifts, giving 24-hour continuous drilling. The time and costs required for drilling were considerably larger than initially estimated by DOSECC, due largely to a combination of very permeable volcanic rock formations and a relatively small drill rig, with some time lost also due to volcanic hazard alerts. Four holes were completed satisfactorily to design depth of about 200 m, and deep instruments were installed. The strainmeter sonde was installed while the rig was on site and other instruments were added later, with one exception (Olveston site) where seismometer and strainmeter were linked together. Each site contained a concrete crypt for protection of electronics, data acquisition and telemetry hardware, and in one case for top-of-borehole wellhead protection (Olveston site). Crypts also house large battery arrays for backup power. The sites were designed and built to be sufficiently hardened to withstand extreme meteorological events (e.g. hurricanes) and only require minimum routine maintenance over an expected observatory lifespan of >30 y.

The sensor package at each site includes: a single-component, very broad

band, Sacks-Evertson strainmeter, a three-component seismometer designed by Duke/CIW (~Hz to 1 kHz), a Pinnacle Technologies series 5000 tiltmeter, and a surface Ashtech u-Z CGPS station with choke ring antenna, SCIGN mount and radome. This instrument package is similar to that envisioned by the Plate Boundary Observatory for deployment on EarthScope target volcanoes in western North America and thus the CALIPSO Project may be considered a prototype PBO installation with real field testing on a very active and dangerous volcano.

Borehole sites were installed in series and data acquisition began immediately after the sensors were grouted into position at 200 m depth, with the first completed at Trants (5.8 km from dome) in Dec 2002, then Air Studios (5.2 km), Geralds (9.4 km), and finally Olveston (7.0 km) in March 2003. Analog data from the strainmeter (50 Hz sync) and seismometer (200 Hz) were initially digitized and locally archived using RefTek 72A-07 data acquisition systems (DAS) on loan from the PASSCAL instrument pool. Data were downloaded manually to a laptop approximately every month from initial installation until August 2003, when new systems were installed. Approximately 0.2 Tb of raw data in SEG-Y format have already been acquired and are currently archived at UARK for analysis by the CALIPSO science team. The very large July 12 2003 dome collapse (~100 million cubic meters) and vulcanian explosion events were recorded by strainmeter at 3 of the 4 sites, and by seismometer at 2 sites. The CALIPSO teams are currently researching this data.

Steel reinforced, poured concrete crypts were constructed to house the surface instruments, data acquisition, telemetry components, and backup battery array with sufficient power to last 10 d without recharging. The central, cross-braced column of the crypt also functions as the monument for the CGPS antenna, which is coupled to a bedrock-grouted 1.5ö steel pipe using a precision SCIGN level. In August 2003, the original temporary 16 bit data acquisition systems (RefTek 72A-07) were replaced with Quanterra Q330 six channel 24 bit systems equipped with PB14 digital packet balers, which can locally buffer up to 20 Gb of strain and seismic data in MSEED packets. All instruments are linked together via a cat 5 IP LAN and data are telemetered from each remote using a single FreeWave FGR-115RE ethernet radio bridge, and where necessary repeater, to the Montserrat Volcano Observatory (MVO). Here they are to be cached prior to transmission via an IPsec VPN to UARK for final archival.

Current work (last 2 months) has focused on finalizing the telemetry connections to and through MVO. Several important issues have emerged as we have now are beginning to telemeter data from the remote sites to the MVO and then onto to UARK for archival and analysis. Current internet links between the MVO and world beyond are far less robust than originally anticipated. Bandwidth is far more limited than the original design specifications for the MVO, and all links critically depend on one repeater site, which currently does not have UPS and generator power backup. This has caused frequent data stream interruptions. We anticipate that the appropriate power backup modifications will be put in place in the next month or so by the MVO. Because the telemetry links are not yet fully operational, data has accumulated on the packet balers since late August 2003. One additional trip by UARK personnel will be required to finalize all telemetry issues and to download data acquired at each site between August and October 2003. In addition, scripts to monitor each remote site and övacuumö the data from each of the sensors is currently being designed. Initial coding and testing has begun and will be completed by the end of 2003. All data are also made

available to MVO for hazards mitigation purposes.

Finally, we have organized a meeting to be held during AGU in December for all CALIPSO participants, including UK colleagues, for discussions on data, preliminary research findings, and future planning.

Findings:

The following summary was co-written by the Project Leader, Dr. Barry Voight, and Senior Investigator, Dr. Glen Mattioli, and thus both Penn State and UARK submissions are essentially the same.

Most of the substantial work over the last year has gone into the drilling and instrumentation efforts. Findings in that period revolved about the decisions required on instrumentation, hole siting, drilling, instrument installations, data acquisition and management, and budget issues.

Data were also collected in batches, and only now are we coming to the point where data streams may be transmitted via VPN for archival. We are thus ending the drill-instrumentation phase of the project, and are entering the phase where the data can be examined by the collaborative CALIPSO teams.

Our current research efforts mainly focus on data obtained for the July 12-15 (LT) 2003 eruption of Soufriere Hills Volcano. Data were recorded by the 3 operating borehole stations of the CALIPSO project (unfortunately at time of eruption, the Olveston site had been disconnected to permit final construction work on the surface housing structure). Each of these stations was instrumented with a three-component seismometer, a Sacks-Evertson strainmeter, a tiltmeter, and a CGPS, although the seismometer electronics were unconnected at one site.

The andesitic lava dome on SHV had been growing without major collapse since July 2001. About three days before the eruption a large number of small seismic events occurred with changing time interval between them, until they blended together to form a volcanic tremor. Pyroclastic flows from early partial dome collapses started about 18 hours before a significant explosion, and grew in size throughout the day and evening. The explosion occurred just before midnight on July 12 (LT), causing a 50,000 foot ash column. Its signals were recorded by two seismometers and three strainmeters, with ultra-long period (ULP) signals dominating the strainmeter records. Further, smaller explosions occurred on the next few days. This dataset is unprecedented as no strainmeter nor deep seismometer has recorded such events previously, and the research results promise to be of major significance. The data are currently being investigated.

Training and Development:

This summary was co-written by Project Director, Dr. Barry Voight, and Senior Investigator, Dr. Glen Mattioli. Penn State and UARK submissions are identical.

The information developed in this project to date has added considerably to the experience of all PIs. PI B. Voight served as Project Director but of course substantial and essential contributions were made D Elsworth as Co-PI and indeed by all PIs and their respective teams. Drs Linde and Sacks, and N. McWhorter led the strainmeter construction and installations, Drs Shalev and Malin the seismometer installations, and Dr Mattioli the CGPS work. Mattioli also designed the crypts, the acquisition and telemetry systems, and archival system. Logistics and contractor coordination during the drilling process was led by PSU Research Associate S. Young. PSU PhD Student D Hidayat

assisted in various important ways during instrument installation, electronics and telemetry. Post-doc scientists, Christina Widiwidjayanti and Amanda Clarke have contributed to instrumentation and modeling aspects. A new PhD candidate at PSU, V Miller, assisted with electronics installation (and basic manual labor, joining several PIs in the latter task). In addition, four students from the UARK participated in the installation of the new data acquisition systems in July 2003. These include Elizabeth Van Boskirk (M.S. candidate), Neil Jones (B.S. AE03), and two NSF-REU students from the Arkansas-Oklahoma Space Center, John Mischler (a senior undergraduate at Augustana College, IL) and Jon McBee (a senior undergraduate at Wheaton College, MA).

A host of other undergraduate and graduate students assisted our effort in a very important manner, as on-site Assistant Geologists during the drilling and instrumentation program: Eliana Arias, Javed Ali, Brianne Alleyn, Kim Berlo, Dannie Hidayat, Madeleine Humphreys, Sabrina Innocenti, Kelly Knight, Kelsey Johnson, Lara Owens, John Simmons, Rob Watts, Orion Russell. These individuals (from Caribbean area, US and UK universities) helped CALIPSO but at the same time gained important experience in drilling, sophisticated instruments, and monitoring.

Likewise, we were assisted at various times by MVO staff, who have benefited from installation experience and from information helpful to their hazards management and hazards assessment duties.

Outreach Activities:

The information acquired in this research is being transferred to undergraduate and graduate students at Penn State (and collaborating institutions), as well as to colleagues. At this early stage a handful of abstracts have been prepared on our work, and a number of presentations are being made at the AGU Meeting in San Francisco in December.

Other CALIPSO presentations have been at the national and local level, including: the NSF EarthScope Workshop, the NSF Infrasonics Workshop, and the NSF Long Valley Caldera Workshop, UARK Dept. of Geosciences Colloquium. We anticipate that many publications and presentations of this research, and press releases, will be forthcoming following further data analysis.

An article in the Volcanology Special Issue of SCIENCE featured the CALIPSO Project: Richard Stone, Bracing for the Big One on Montserrat, SCIENCE, 28 March 2003.

Several articles were published in the popular local media and on the web related to the experiences of the CALIPSO team during the July 12, 2003 eruption. These include:

• Students get explosive view of research at volcano site, M. Blouin, published electronically by the Office of Science and Research Communication at the University of Arkansas on July 31, 2003.

(http://advancement.uark.edu/news/NEWS_ARCHIVES/JUL03/mattioli03.html)

Information based on personal interview with G. Mattioli and four UARK students who participated in the fieldwork in July, 2003. Digital photographs for the article provided by G. Mattioli.

• Up through the cracks: UA students watch eruption, J. Dunn, published in

The Arkansas Traveler on September 3, 2003. Information for the article based on a phone interview with G. Mattioli. Courtesy photograph provided by G. Mattioli.

UA researchers work interrupted by volcano, D. Terry, published in the Northwest Arkansas Times on September 7, 2003. Information based on a personal interview with G. Mattioli. Courtesy photographs provided by G. Mattioli.

G. Mattioli taught two classes to the 4th and 5th grade Fayetteville Public Schools Gifted and Talented Summer Program in Earth Sciences. He discussed the origin of volcanoes, where we find them on Earth, how they erupt, and described methods we can use to study them, including the new instrumentation of the CALIPSO project. B Voight gave a video interview for a 5th grade student project at the State College Public School, discussing the origin of volcanoes, volcano monitoring, and hazards management.

CALIPSO also assisted in the development of a computer lab at Lookout School in Montserrat, and Susan Wheeler developed an innovative GIS training module and coordinated its use within the public school system of Montserrat, involving 4 primary schools and a middle school. The module included various map products, DEMs plus geographical and infrastructure overlays.

Journal Publications

Mattioli, G., Herd, R., Aponte, M., Dixon, T., Jansma, P., and A. Smith, "The Dynamics of an Ongoing Andesitic Eruption: What We Have Learned From Surface Deformation at Soufriere Hills Volcano, Montserrat, BWI", *Eos Trans. AGU, Spring Meet. Suppl.*, Abstract T31A-06, 2002, p. 35, vol. 83(19), (2002). Published

Glen S. Mattioli, Richard Herd, Pamela E. Jansma, "Modeling of surface deformation cycles at Soufriere Hills, Montserrat from October 1995 to December 2001", *Eos Trans. AGU, Fall Meet. Suppl.*, Abstract T12A-1309, 2002, p. S358, vol. 83 (47), (2002). Published

Mattioli, G., D. Elsworth, A. Linde, P. Malin, N. McWhorter, D. Nielson, S. Sacks, E. Shalev, B. Voight, and S. Young, "Magma reservoir and conduit dynamics as revealed by a borehole geophysical observatory and continuous GPS: The CALIPSO Project plan and goals", *EarthScope Workshop on Active Magmatic Systems (Nov. 2002)*, Heathman, WA, p. xx, vol. 1, (2002). Published

Mattioli, G.S., D. Elsworth, A. Linde, P. Malin, N. McWhorter, D. Nielson, S. Sacks, E. Shalev, B. Voight, and S. Young, "Instrumentation, integration, and progress on the CALIPSO borehole project at Soufriere Hills volcano, Montserrat", *Seismological Research Letters*, p. 230, vol. 74 (2), (2003). Published

Mattioli, G.S. and R. Herd, "Correlation of cyclic surface deformation recorded by GPS geodesy with surface magma flux at Soufriere Hills volcano, Montserrat", *Seismological Research Letters*, p. 213, vol. 74 (2), (2003). Published

Wadge, G. Mattioli, G.S., and R. Herd, "Ground deformation at Soufriere Hills, Montserrat during 1998-2000 measured by radar interferometry and GPS", *J. Volc. and Geotherm. Res.*, p. , vol. , (). In revision by co-authors

Young, S., D. Elsworth, A. Linde, P. Malin, G. Mattioli, N. McWhorter, D. Nielson, S. Sacks, E. Shalev, and B. Voight, "The CALIPSO borehole project, Montserrat", *Seismological Research Letters*, p. 198, vol. 74 (2), (2003). Published

Young, S., B. Voight, G. Mattioli, S. Sacks, A. Linde, E. Shalev, P. Malin and D. Elsworth, "Geophysical investigation of conduit and storage region processes: the

CALIPSO borehole observatory project at Soufriere Hills volcano, Montserrat, Lesser Antilles", Proc. IUGG General Assembly, Sapporo, Japan, (V10/02A/A01-006), p. 542, vol. A, (2003). Published

Young, S., B. Voight, M. Edmonds, R. Herd, G. Thompson and G. Mattioli, "Investigation of cyclic activity at Soufriere Hills volcano, Montserrat, through multiple monitoring techniques", Proc. IUGG Gen. Assembly, Sapporo, Japan (V11/03A/A02-001), p. 543, vol. A, (2003). Published

B Voight, G Mattioli; S Sacks, A Linde, N McWhorter, B Schleigh; E Shalev, P Malin; D Elsworth, S Young, D Hidayat, C Widiwidjayanti, V Miller; S Sparks, J Neuberg; Staff, Montserrat Volcano Observatory, "The magmatic system at Soufriere Hills Volcano, Montserrat, and the CALIPSO Project", NSF Long Valley Caldera Workshop, Mammoth CA, Oct 8-12, 2003., p. , vol. 1, (2003). Accepted

B Voight, GS Mattioli, SR Young, AT Linde, IS Sacks, PE Malin, E Shalev, D Hidayat, D Elsworth, C Widiwijayanti, V Miller, RSJ Sparks, J Neuberg, V Bass, P Dunkley, M Edmonds, R Herd, A Jolly, G Norton, G Thompson, "CALIPSO Borehole Instrumentation Project at Soufriere Hills Volcano, Montserrat, BWI: Overview and Prospects", EOS AGU Trans. (in press, Dec 2003 AGU Mtg)., p. , vol. , (). Accepted

S Young, B Voight, G Mattioli, A Linde, S Sacks, P Malin, E Shalev, D Hidayat, D Elsworth, S Sparks, J Neuberg, P Dunkley, G Norton, R Herd, M Edmonds, G Thompson, A Jolly and V Bass, "Linking surface activity to the deep volcanic plumbing system: the CALIPSO borehole observatory project on Montserrat", EOS AGU Trans. (in press, Dec 2003 AGU Mtg)., p. , vol. , (). Accepted

GS Mattioli, AT Linde, IS Sacks, PE Malin, E Shalev, D Elsworth, D Hidayat, B Voight, SR Young, PN Dunkley, G Norton, R Herd, "CALIPSO Borehole Instrumentation Project at Soufriere Hills Volcano, Montserrat, BWI: Data acquisition, telemetry, integration, archival, and analysis systems", EOS AGU Trans. (in press, Dec 2003 AGU Mtg)., p. , vol. , (). Accepted

E Shalev, PE Malin, IS Sacks, AT Linde, B Voight, GS Mattioli, SR Young, D Elsworth, D Hidayat, "CALIPSO Borehole Station Observations Before and During the July 2003 Montserrat Eruption", EOS AGU Trans. (in press, Dec 2003 AGU Mtg)., p. , vol. , (). Accepted

Books or Other One-time Publications

Web/Internet Site

URL(s):

<http://www.geoee.psu.edu/calipso>

<http://comp.uark.edu/~mattioli/research/CALIPSO/Intro.html>

Description:

Two websites for the CALIPSO project have been developed, at PSU and UARK:

<http://www.ems.psu.edu/%7Eelsworth/projects/calipso/>

<http://comp.uark.edu/~mattioli/research/CALIPSO/Intro.html>

These sites include extensive archives of digital photographs at all stages of the CALIPSO project. Recently submitted AGU abstracts, PowerPoint presentations related the project, detailed design schematics, and background information.

Other Specific Products

Contributions

Contributions within Discipline:

Contributions to Other Disciplines:

Our results are expected to provide basic data and considerations of interest to theoretical modelers, geodesists, tectonic seismologists, and specialists in hazards assessments and disaster prevention.

Contributions to Human Resource Development:

Undergraduate, graduate, and post-graduate students and researchers have been involved in nearly every phase of the CALIPSO project. We expect that there will be senior honors theses, M.S. theses, and Ph.D. dissertations completed by the end of the project.

Contributions to Resources for Research and Education:

PI's at the various institutions have incorporated CALIPSO data and findings into the formal teaching. The official web page for the McGraw-Hill Physical Geology (9ed) text will have a link pointing to the CALIPSO web resources. This will expose a broad spectrum of undergraduate geology students at diverse institutions to the modern geophysical study of an active and dynamic volcanic system.

Contributions Beyond Science and Engineering:

This project is expected to contribute directly and fundamentally to hazards and risk assessments on Montserrat, in addition to hazards responses, Government decisions on development and access/zoning. The outreach activities will affect many persons outside the technical field.

Special Requirements**Special reporting requirements:**

Unobligated funds: Less than 10 percent of current funds

Change in Objectives or Scope: None

Unobligated funds: less than 20 percent of current funds

Animal, Human Subjects, Biohazards: None

Categories for which nothing is reported:

Any Book

Any Product

Contributions: To Any within Discipline