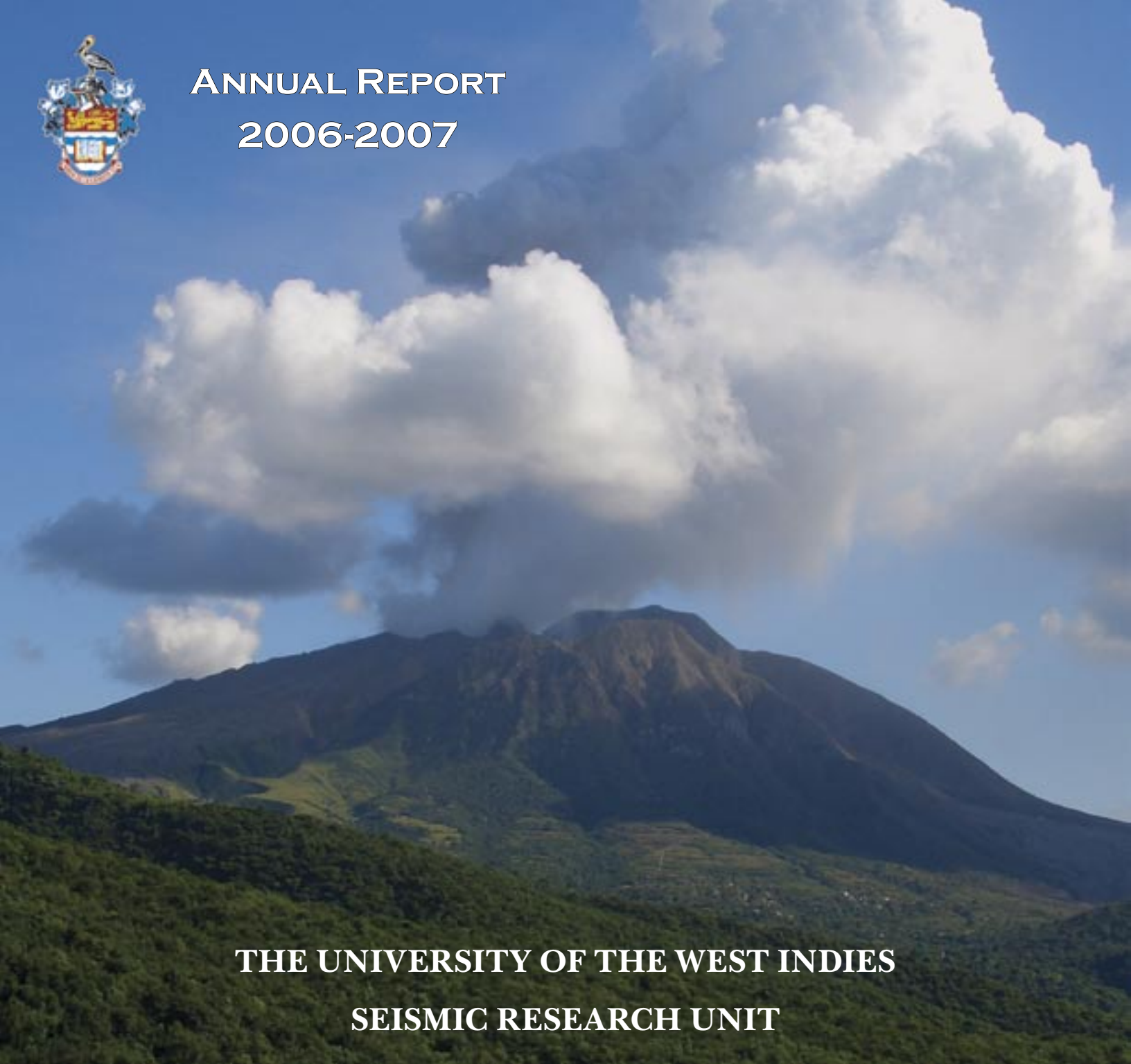


Annual Report
2006-2007

THE UNIVERSITY OF THE WEST INDIES

SEISMIC RESEARCH UNIT

Cover photo: Soufriere Hills Volcano, Montserrat, 2007

The main objectives of the Seismic Research Unit are to provide contributing governments with accurate and up-to-date information about earthquake and volcanic activity in the Eastern Caribbean.

Contents

Director's message

Richard E. A. Robertson, Geologist & Director

The past year has been an extremely busy and productive one for the Seismic Research Unit. Two notable accomplishments were our success in securing major grants from the United States Agency for International Development/Office for Foreign Disaster Assistance (USAID/OFDA) and the Government of Trinidad and Tobago as well as our hosting of an international training course in tsunami warning systems. Both activities are symptomatic of the Unit's thrust towards (a) building a more robust monitoring network that can reliably deliver its products faster to our stakeholders and (b) enhancing and diversifying our products in education and outreach such that a wider variety of methods are used to deliver relevant scientific information to vulnerable communities in the Caribbean.

The general pattern of seismicity experienced in the Eastern Caribbean remained unchanged during the period. The Eastern Caribbean Seismograph Network recorded a minimum of 964 earthquakes in our area of responsibility, of which a total of 619 events were located (64%). Activity at volcanoes in the Eastern Caribbean remained low during the period with the exception of the Soufriere Hills Volcano which continued the eruption that began in 1995.

The year in review also saw the retirement of some of our long-serving members of staff and the recruitment of new staff in what has increasingly become a younger and more female dominated staff complement. We have continued to vigorously pursue various avenues to supplement our recurrent budget and in this regard we were able to secure grant funding from a number of regional and international agencies - including the Caribbean Development Bank, USAID/OFDA, the International Development Research Centre of Canada, the United Nations Development Program and the UWI Disaster Risk Reduction Centre - to undertake various projects. We have successfully managed to increase our revenue from Consultancy work such that we are now able to finance one additional staff to supplement our severely under-staffed IT department.

In addition to network improvements and education and outreach, our main organisational focus has been the development of a strategic plan to guide the Units' operations for the next 5 years. This plan is now very near completion and has taken full cognizance of the UWI Strategic Plan of 2007/2012.

Our outreach activities during the year were not only limited to the implementation of a training course but also involved a significant increase in the submission of articles to the print media (including UWI STAN, Pelican and UWI Today); an increased number of appearances on live and pre-recorded television and radio programmes and contributions to charity. This has all been part of our plan to forge stronger connections with the UWI St. Augustine Campus Community.

The involvement of a UWISEISMIC Team in the BG T&T Energy Challenge was a major undertaking which increased our profile not only on the UWI's St. Augustine Campus but also amongst the main players in the Energy Sector, potential sources of funding for monitoring and research projects. Participation in this event was the most significant team building event of the year as it required and obtained the full participation of all staff and resulted in a total of approximately US$2,500 being raised for charity. Employee volunteerism is a new area of activity which we will review in the new year.

Our collaboration with regional agencies such as the Montserrat Volcano Observatory, the Institut de Physique de Globe du Paris (Observatories in Guadeloupe and Martinique) and FUNVISIS was increased during the year with exchange visits of staff to all of these organisations. We have continued to work with colleagues at the Puerto Rico Seismic Network in the development of a tsunami warning system for the Caribbean and Adjacent Areas. Our involvement in this UNESCO/IOC driven effort has also meant greater collaboration with various UN agencies including the IOC, IOCARIBE, WMO, and the UNDP. In recognition of our key roles in this effort the Unit was recently invited to become an Observer member of the ICG-CARIBE-EWS, the governmental body responsible for the establishment of a Tsunami Warning System in the Caribbean. Linkages with institutions outside the region have continued to increase with staff visiting the University of Bristol and the University of Blaise Pascal. An MOU was signed with the University of Bristol during the year and has already resulted in several joint research projects.

Our main focus for the upcoming year will be the implementation of our Strategic Plan one of the key elements of which is the construction of a new building to house the Unit. We will continue to build on existing collaborations with external agencies and internal UWI departments as we develop our small post-graduate research degree programmes in volcanology and seismology. All attempts will be made to ensure that all contributing territories are fully- current with their annual contributions to the Unit's budget. We anticipate that it will be another busy year as we take measures to improve and increase the Unit's local, regional and international profile as a centre of excellence for volcanology and seismology in the Caribbean.

Operations

The Seismograph Network: The current seismograph network employs a combination of both conventional and modern instruments throughout the Eastern Caribbean (see Figure 1). Data acquisition and monitoring is distributed amongst several sub-networks each of which consists of a highly configurable data acquisition/monitoring system. A high quality sensor is directly connected to the recording system at each hub where radio telemetered data from up to twelve short period stations may be monitored and logged. Data may be logged continuously or by event triggering methods which utilise a choice of highly efficient triggering algorithms to detect and save only signals which resemble genuine seismic events. Each remote data acquisition/monitoring systems is linked to the SRU headquarters in Trinidad via the public switched telephone network and the Internet.

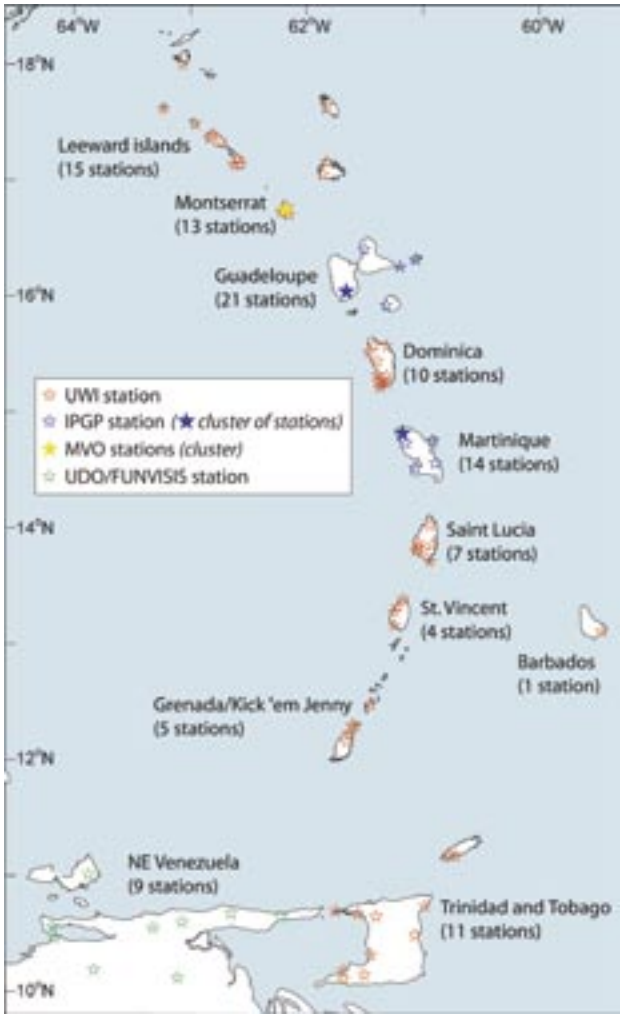
In summary the current network consists of the following components:

- One broadband station (ALNG, Trinidad) is additionally equipped with a Kinemetrics K2 accelerograph which is designed with extended dynamic range to make accurate recording of ground motions up to two times as large as acceleration due to gravity. The K2 is interfaced to the RS232 (COM Port) of the computer. Three other Kinemetrics K2 strong motion accelerographs were operated successfully in Trinidad, during the period of this report. Although these autonomously recording instruments are primarily intended to record strong earthquakes, some are fitted with gain boards to provide increased sensitivity to smaller earthquakes. Data are usually collected from these instruments when needed (e.g. after a felt earthquake).
- Three of the thirteen remote data acquisition/monitoring stations are equipped with three-component short-period seismometers. These are the St. Eustatius, Saba and Barbados installations. Barbados is also equipped with a

three-component long period sensor.

- There are thirty-vie (35) conventional short period stations and there is recording capacity to operate more than twice this number. These installations are equipped with single vertical component seismometers and are linked to a sub-network data acquisition system via analogue radio telemetry systems. The signals are retrieved at the hub and recorded alongside the broadband signals. Short period station data is substantially less accurate than broadband data but nevertheless these stations play key roles in constraining earthquake source parameters and are very useful in providing early information about volcanic unrest. They are far less expensive and much easier to procure, deploy and operate.
- All remote acquisition and monitoring stations send their data, and those from associated single component stations, to an Internet FTP server from where they are downloaded to Trinidad when required. This is done routinely but data may also be retrieved on demand by direct telephone connection. Real-time processing of data is limited by the constraints of the access communications network. Should the activity at a particular subnet increase to critical level staff may be deployed to man the system locally and carry out processing in real time.

Figure 1: The Eastern Caribbean Seismograph network.



Ground Deformation Networks: Ground deformation monitoring is one of the most important tools for volcano monitoring, along with seismology. It usually gives information about magma refill in depth, changes of hydrothermal activity and structural adjustments of collapsed areas and calderas. The main type of deformation monitoring conducted at SRU utilises Ground Positioning System (GPS) and has been used since 2001 for some of the volcanic islands of the Lesser Antilles (L.A.). Alternative techniques were used prior to 2001 (e.g., levelling, tiltmetry), essentially at Soufriere of St Vincent.

cGPS antenna in operation in Dominica.

Two main types of ground deformation monitoring are routinely conducted by SRU: (1) periodic GPS campaigns targeted towards volcano deformation monitoring and (2) continuous GPS stations (cGPS).

Campaigns (1) involve periodic measurement of the precise locations of a network of benchmarks on and around volcanoes in the L.A. All volcanoes under the responsibility of SRU are presently covered by GPS benchmarks. The frequency of GPS network occupation varies from every few months to every few years, depending on the state of volcanic activity at any given volcano. SRU also runs continuous GPS stations in 4 islands (cf details below) which are used as reference for the survey type of monitoring, as well as research on the Caribbean plate dynamics.

Surveys of benchmarks were done in Dominica (December 2006 and June 2007), St Vincent (January 2007) and Grenada / Kick'em Jenny (June 2007). None of these surveys showed significant ground deformation.

Continuous GPS stations were installed in St Vincent, Antigua, Dominica and Grenada. The first three are part of a cross-Faculty effort with the Department of Surveying and Land Information (Faculty of Engineering, UWI), whereas the latter is part of a collaboration with the University of Boulder, Colorado, USA (hurricane forecasting). Data are automatically streamed hourly to SRU via the Internet. Short-term plans for the last quarter of 2007 involve automated GPS processing of these cGPS stations, as well as the installation of a fifth cGPS station (Saint Lucia or St Kitts). Mid-term plans involve at least one cGPS station per island in the Lesser Antilles and discussions are underway with other Caribbean institutions (MVO for Montserrat and IPGP for Guadeloupe and Martinique) regarding data exchange and close collaboration for an optimum regional geodetic network.

Scientists descend into Dominica's Valley of Desolation to collect gas samples.

In 2007, SRU also became a lifelong member of the UNAVCO (international consortium of universities and research centres focusing on geodetic monitoring, research and education).

Geothermal Monitoring: Sampling campaigns were carried out in Dominica, Saint Lucia and St Vincent. A collaboration with the GeoForschungsZentrum (GFZ) institute (Postdam, Germany) permitted the installation in December 2006 of sensors at the Boiling Lake in Dominica. These sensors allow continuous recording of temperature at the bottom of the Boiling Lake, as well as pressure (the hydrostatic pressure being directly related to the lake level). A temperature profile of the lake carried out during the installation of the setup showed no vertical variations of temperature in the lake. This is consistent with constant overturn (hence homogenization of the lake water) in the lake.

Seismic Activity 2006-2007: The general pattern of seismicity seen in the Eastern Caribbean was maintained during the period. The distribution of earthquakes was somewhat changed, however, with activity in the vicinity of the Paria Peninsula north-west of Trinidad dominating output. The TRN network stations recorded a minimum of 964 earthquakes in the area of responsibility, of which a total of 619 events were located (64%), using our own data and the data contributions from Martinique, Guadeloupe, Puerto Rico and Venezuela. The daily generation of located earthquakes of magnitude, Mt, >2.0 is shown in Figure 2. The elevated activity seen in late September 2006 resulted from the Mt=5.8

event, the largest for the year, which was located under the Northern Range, Trinidad (see ALNG section). In the region, there were 13 earthquakes with magnitude higher than 4.5, 43 events in the 4.0-4.5 magnitude range and 85 in the 3.6-3.9 magnitude range. The magnitude distribution of the located events for the period is shown in Figure 3. There were 28 events reported felt for the period.

Epicentral locations of the events for the period are shown in Figure 4. The densest concentration of epicentres for the year is seen near the Paria Peninsula. More than 60% of the total number of earthquakes occurred south of 11.5 ºN latitude. Activity in the area within 16 ºN - 19 ºN and east of 62.5 ºW, which from past patterns is usually on par with that seen in the Paria Peninsula area has been at a reduced level in recent years and contributed approximately 12% to the total number. On the other hand, the area north of 19 ºN continues to manifest a somewhat elevated level of activity with just above 6% of the total output for the year.

Figure 2: Daily Seismicity in the Eastern Caribbean 1 August 2006 to 31 July 2007.

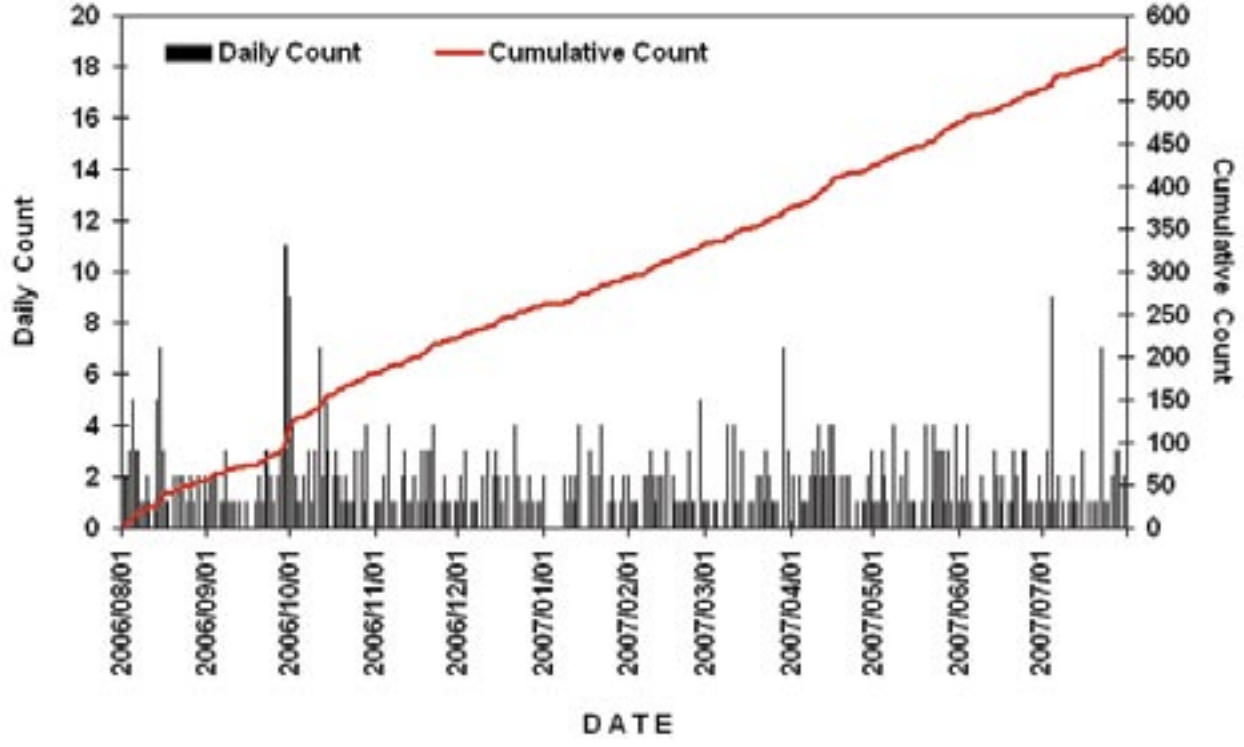
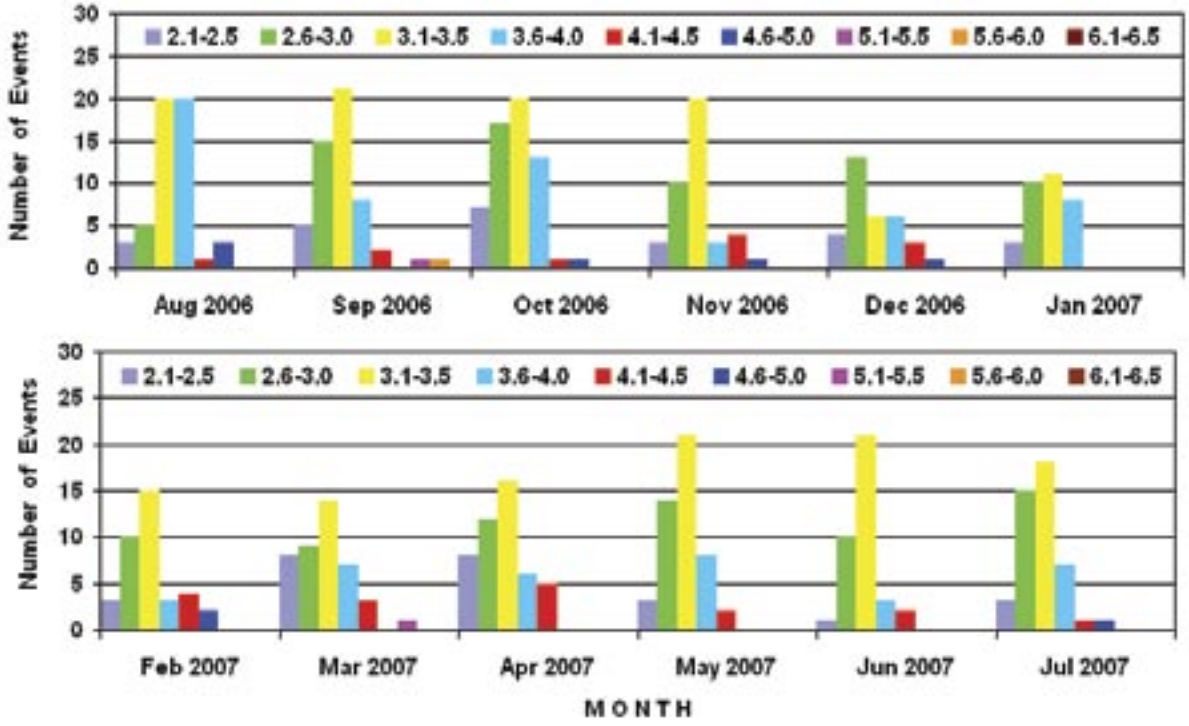


Figure 3: Magnitude distribution of Eastern Caribbean earthquakes, 1 August 2006 to 31 July 2007.



Magnitude Distribution: The two largest events for the year were of magnitudes 5.8 and 5.3 and occurred on 29 September 2006 on land Trinidad under the Northern Range at depths near 50 km. Both events were widely felt throughout Trinidad with damage seen in the epicentral area and in isolated cases at distances extending out to 65 km (see ALNG section). The next largest magnitude was 5.0. One such event occurred on the 15 August 2006 north of the Virgin Islands and the other was located in the Paria Peninsula on the 15 November 2006.

Special Projects (Seismology)

Atlantic LNG Seismograph Network

Trinidad seismicity: There were 127 earthquakes located in the area bounded by 9.5 ºN - 11 ºN and 60 ºW - 62 ºW during the period 1 August 2006 – 31 July 2007. Figure 5 is an epicentral map for the period. It was in this area that the largest event for the year occurred. On 29 September 2006, at 09:08 a.m. (local time) an earthquake of duration magnitude, Mt, 5.8 occurred under the Northern Range, Trinidad. The event was felt throughout Trinidad and was reported felt as far

Figure 4: Eastern Caribbean earthquakes for the period 1 August 2006 to 31 July 2007.

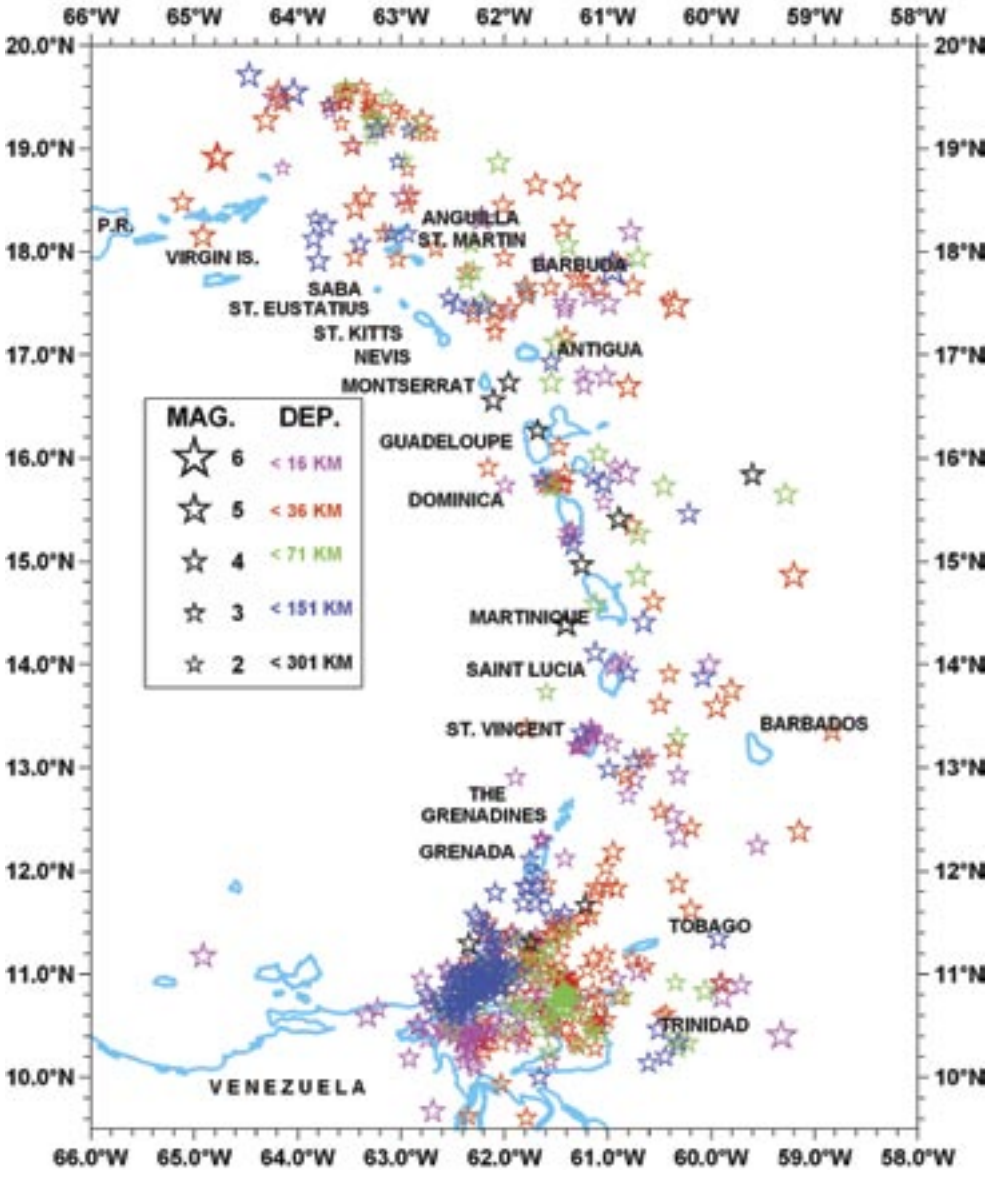


Table 1: Felt Earthquakes in the Eastern Caribbean 1 August 2006 to 31 July 2007.

DATE YR MM DD	TIME (UTC) HR MM SS.SS	LAT. (°N)	LONG. (°W)	DEPTH (KM)	MAG. (MT)	REMARKS
2006/08/08	23:55:04.39	14.406	60.655	75.34	4.0	South-east of Martinique. Felt reports from Soufriere Gardet [Dennery], Morne Fortune Entrepot, Monier and Gros Islet Town Saint Lucia and Portsmouth, Dominica.
2006/09/03	06:22:13.4	18.182	63.168	33.6	3.1	Near west coast of Saint Martin. Felt reports from both sides of the island.
2006/09/10	11:18:45.4	10.907	62.175	61.33	3.9	North of Paria Peninsula. Reported felt Chaguaramas, Trinidad – MMI III.
2006/09/29	13:08:25.7	10.704	61.428	50.53	5.8	North Trinidad. Damaging. Felt from Guyana in the south to Saint Lucia in the North. Maximum MMI VI.
2006/09/29	18:23:05.9	10.705	61.447	46.72	5.3	North Trinidad. Damaging. Felt from Guyana in the south to Saint Lucia in the North. Maximum MMI VI.
2006/09/30	08:20:46.86	10.769	61.424	34.71	3.3	North Trinidad. Felt in Chaguanas.
2006/09/30	19:24:08.43	10.804	61.429	38.47	3.6	Off north coast of Trinidad. Felt in Tunapuna, Trinidad.
2006/10/29	01:55:57.46	11.565	62.281	133.57	4.0	South-west of Grenada. Felt Diego Martin and Woodbrook, Trinidad.
2006/11/15	20:25:51.61	10.743	62.575	95.62	5.0	Paria Peninsula. Reported felt in western Trinidad from Buenos Ayres to Westmoorings. MMI III.
2006/11/17	08:33:36.98	11.381	62.181	125.78	4.5	North of Paria Peninsula. MMI II
2006/12/04	02:52:43.55	10.635	61.669	37.25	3.8	Chaguaramas Peninsula. Felt from Port of Spain to Tacarigua, Trinidad MMI II-III.
2006/12/16	20:19:16.06	11.293	62.343	155.18	3.7	North of Paria Peninsula. Felt in Carenage, Trinidad.

DATE YR MM DD	TIME (UTC) HR MM SS.SS	LAT. (°N)	LONG. (°W)	DEPTH (km)	MAG. (Mt)	REMARKS
2006/12/22	01:29:58.82	13.976	60.96	9.2	2.8	Northern Saint Lucia. MMI III.
2006/12/22	01:43:41.62	14.015	60.92	14.31	3.0	Northern Saint Lucia. MMI III.
2007/02/03	05:31:08:01	11.127	61.621	24.4	3.0	North of Trinidad. Felt Carenage, Trinidad MMI II.
2007/02/13	05:29:30.00	18.531	62.978	10	4.1	North of Anguilla. Felt in St. Martin.
2007/02/23	14:48:20.6	10.692	61.486	53.69	4.8	Near west coast of Trinidad. Felt in northern Trinidad MMI III.
2007/02/27	09:42:40.61	17.109	61.487	51.36	4.6	East of Antigua. Felt throughout Antigua MMI IV. Also felt in Guadeloupe, St. Kitts,
2007/02/27	13:25:47.47	10.709	62.449	112.22	4.3	Paria Peninsula. Felt in north-west Trinidad.
2007/02/28	07:58:46.97	14.862	60.703	68.22	4.2	East of Martinique. Reported felt in Martinique and Saint Lucia.
2007/03/12	23:23:53.66	10.9	62.063	57.31	4.1	North of Paria Peninsula. Felt in north-west Trinidad
2007/03/29	05:24:44.37	13.59	59.946	15.26	4.4	North-west of Barbados. Reported felt in Saint Lucia and Martinique.
2007/04/17	03:45:10.98	11.064	62.247	86.7	3.5	North of Paria Peninsula. Felt in Maraval and Woodbrook, Trinidad MMI II.
2007/04/19	23:13:20.53	17.659	61.798	34.5	3.9	Barbuda. Reported felt in Antigua.
2007/07/16	01:32:18.9	10.632	62.354	89.77	4.9	Paria Peninsula. Felt in northern Trinidad MMI III, southern Trinidad and Tobago MMI II.
2007/07/16	03:39:08.29	11.033	60.704	11.07	4.0	North-west of Trinidad. Felt in Marabella and Tobago MMI III and Curepe MMI II.

Figure 5: Trinidad earthquakes for the period 1 August 2006 to 31 July 2007.

Figure 6: Modified Mercalli Intensity Map of Trinidad for the near north coast of Trinidad earthquake of 29 September 2006 at 13:08 UTC.

south as Guyana, as far north as Saint Lucia and is reported by the Trinidad Guardian of 30 September 2006 to have sent Venezuelans "scampering into the street". The maximum intensity associated with the reports coming into the Seismic Research Unit was MMI VI, which is the level that minor damage begins to be seen. The strongest aftershock was of Mt=5.3 and occurred 5.25 hours later, at 02:23 p.m. (local time). Both events occurred at a depth near 50 km. The large aftershock was also widely felt throughout the country. Another significant aftershock of Mt=4.8 occurred, five months later, on 23 February 2007. There were more than 80 events in the sequence, 49 of which were located events.

The three biggest events in the Northern Range sequence represent all that were of magnitude larger than 4.5 in the Trinidad area for the period. There were six events in the magnitude range 3.6-4.0. The earthquakes not associated with the sequence were diffusely distributed throughout the area with no obvious preferred feature. The five small events near the east coast represent continuing aftershock activity in the sequence associated with the 2 December 2004 Mt=5.5 near east coast of Trinidad earthquake. Figure 6 is an isoseismal map for the mainshock based on intensities reported via telephone and gathered in a field survey.

Strong Motion Records: Figures 7a and 7b show the records from the strong-motion station at Atlantic LNG (ALNG) for the mainshock of the Northern Range sequence at 09:08 a.m. (local

Figure 7a: Atlantic LNG accelerograms from the magnitude 5.8 earthquake which occurred on 29 September 2006 at 09:08 a.m. (local time).

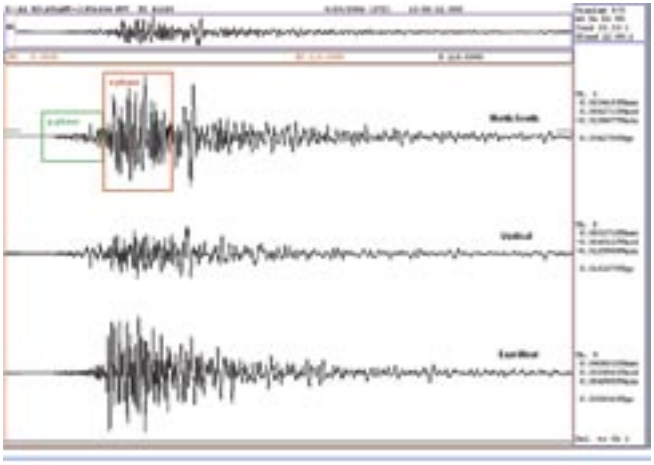
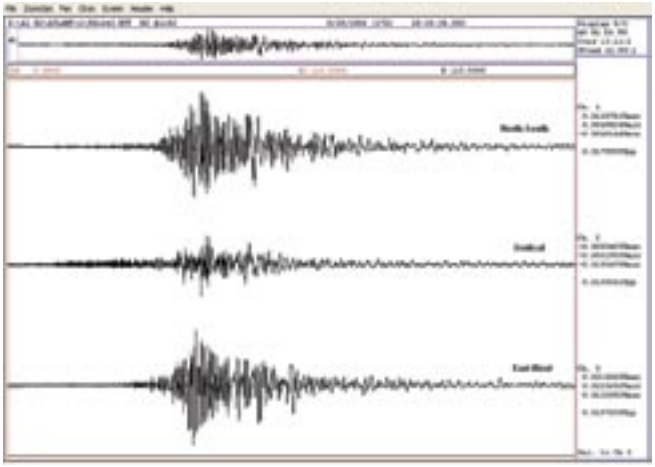


Figure 7b: Atlantic LNG accelerograms from the magnitude 5.3 earthquake which occurred on 29 September 2006 at 02:23 a.m. (local time).



time) and the largest aftershock at 02:23 p.m. (local time). Unfortunately, within seconds of the first earthquake at 09:08 a.m. (local time), electrical power was interrupted at Brigand Hill (TBH) and as a result there is no strong-motion record for that event from that station. However, restoration of the electricity supply allowed a record to be written for the largest aftershock at 02:23 p.m. (local time). Other technical problems caused there to be no data recorded on the stations at Chaguaramas (CHAG) and West Moorings (TWMO).

On the records shown in Figures 7a and 7b, the amplitude of the wave relates to the strength of the shaking at the recording site. A near straight line indicates no significant shaking. The unit of measure is the volt. The instruments are calibrated such that, on all components, a voltage of 1.25V represents an acceleration of 1g. At ALNG, for the Mt=5.8 event, (Figure 7a), noticeable shaking continued for about 47 sec with the sustained stronger shaking lasting for about 18 sec, and then another strong 4 sec pulse. For the Mt=5.3 event, Figure 7b, noticeable shaking continued for 24 sec with the strongest lasting for about 15 sec. The 4 sec low frequency strong shake near the end is also observed on this record. The significant shaking on TBH continued for about 9 sec with the strongest lasting about 3 sec. At ALNG, as expected, higher "g" values were generated by the bigger event. For the second event, for which records from two different stations are available, the station closer to the earthquake, TBH, experienced slightly higher "g", but ALNG recorded more prolonged

Table 2: Peak ground accelerations at Atlantic LNG and Brigand Hill, generated by the significant near north coast of Trinidad events of 29 September 2006 (09:08 a.m. and 02:23 p.m., local time). The three orientations of the sensors are in the North-South, Vertical and East-West planes.

Stations	Acceierations		
	ALNG Mt=5.8 09:08 a.m.	ALNG Mt=5.3 02:23 p.m.	TBH Mt=5.3 02:23 p.m.
Distance	59 km	59 km	47 km
Ch (North-South)	0.030g	0.017g	0.021g
Ch (Vertical)	0.004g	0.001g	0.020g
Ch (East-West)	0.051g	0.040g	0.072

shaking, which may be as a result of differences in the nature of the sites. The voltages, and calculated peak ground accelerations generated by the events, at each site, are shown in Table 2.

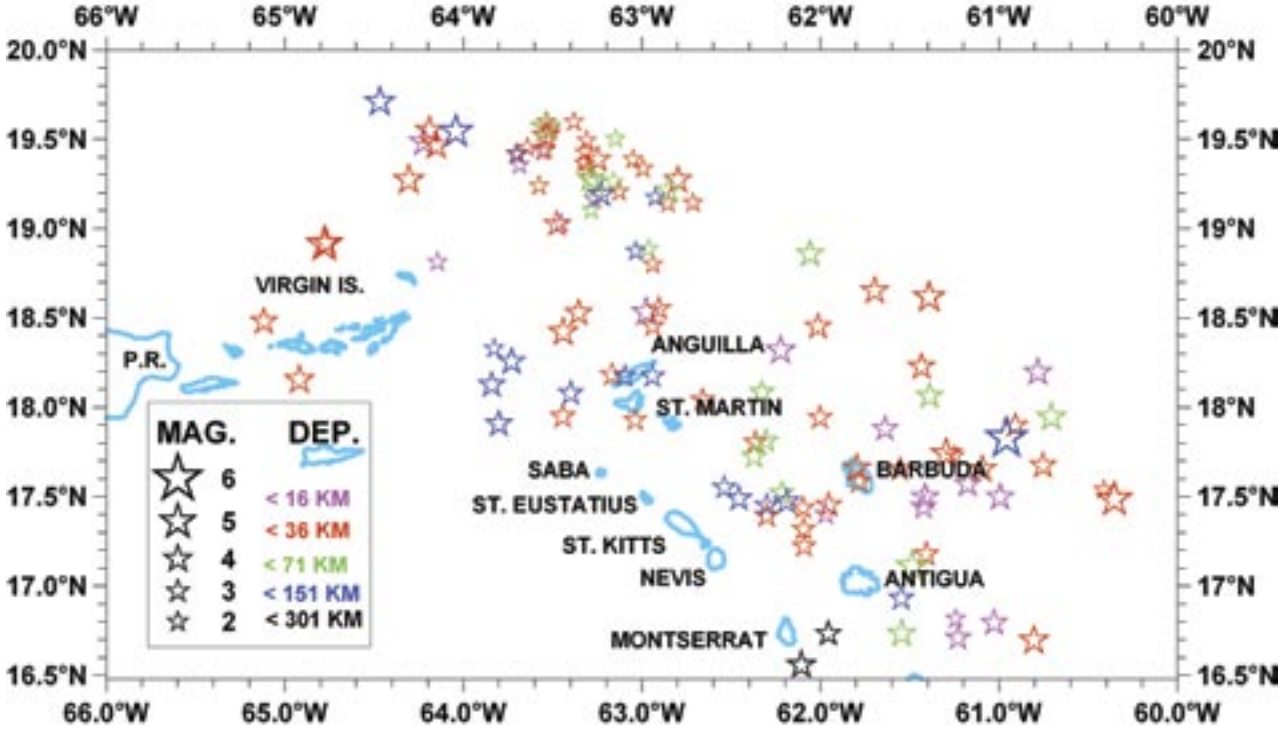
Netherlands Antilles Seismograph Network.

There were 115 earthquakes located in the area bounded by 16.48 ºN - 20 ºN and 60 ºW - 66 ºW during the reporting period. Figure 9 is an epicentral plot of these events. The largest event in the area was of Mt=5.0 on 15 August north of the Virgin Islands. However, two smaller events one on 3 September of Mt=3.1, which occurred near the west coast of St. Martin and the other on 13 February of Mt=4.1, north of Anguilla, were reported felt in St. Martin. Recently, there has been elevated seismic output from an area about 150 km north of Anguilla. The largest events in the cluster during the period were of Mt=4.7. The elevated level of activity seen in the area of the Virgin Islands since 2001, mentioned in previous reports, continues to be maintained. Any strong earthquake, of magnitude >6.0, in that general area is expected to be strongly felt in the northern Dutch Antilles.

Damage to a building in Trinidad following the 29 September 2006 earthquake.

Volcanic Activity 2006-2007: Activity of volcanoes in the Lesser Antilles remained low during the 2006-2007 period, with the exception of the Soufriere Hills Volcano, which is monitored by the Montserrat Volcano Observatory. From 21 January 2007 and continuing for about a week, unusual low magnitude seismic events were recorded by the summit seismic station at the Soufriere volcano, St. Vincent. These coincided with several significant landslides inside the active crater, from the eastern crater walls. It remains unclear as to whether the landslides were

Figure 9: Northern Leeward's earthquakes for the period 1 August 2006 to 31 July 2007.



caused by the seismic activity or if the landslides were the origin of the recorded seismic activity. However, surveys on site (geological, ground-deformation and gas) immediately after the events indicated no connection with magmatic activity. The frequency of ground deformation measurements at the volcano was increased as a precautionary measure.

Special Projects (Volcanology).

Continuous GPS Network: The SRU continuous GPS (cGPS) Network which begun to be established during the past two years, has continued to grow. It is now the widest network of cGPS stations in the Eastern Caribbean and is comprised of Trimble NetRS receivers with Zephyr Geodetic antennae. Data are collected remotely through TCP/IP communication and so are controlled remotely by the receivers. Through a number of collaborative agreements with the Caribbean Climate Change Centre and the University Corporation for Atmospheric Research (UCAR), Boulder, Colorado, USA, there are now over 5 cGPS in operation in the Eastern Caribbean (Antigua, Dominica, St Vincent, Grenada and Trinidad). These stations are under SRU's umbrella

and data are collected automatically at St Augustine. At least one station will be added (Saint Lucia or St. Kitts), late 2007 - early 2008. The plan for the last quarter of 2007 is to automate data collection and storage to a data repository located at SRU. This repository will be available on demand to geodesists and surveyors. The main objective for the mid-2008 is to completely automate the data processing in such a way that data can be used for both volcano monitoring and plate tectonics, using the GAMIT/GLOBK processing code. Processed data will also be displayed on-line on SRU's new website. We are currently putting in place a collaboration with other regional institutes (e.g. IPGP in Guadeloupe and Martinique; MVO in Montserrat) to homogenize the various geodetic networks in the Eastern Caribbean, strengthen data exchange and interchange feedback and experience on data processing for volcano and earthquake monitoring.

Opening Photo: Satellite dish at seismic network hub, St. Augustine, Trinidad.

Closing Photo: St. Vincent's La Soufriere at sunset.


MICROMASS

Research

The work of the Unit is focused primarily on seismology, volcanology and outreach with a view towards improvement in our ability to provide accurate and up-to-date information about earthquakes and volcanic activity in the Eastern Caribbean. The Unit's regular budget only provides sufficient funds for the basic, routine monitoring and all other work, including major developments in the network, has to be undertaken through projects for which funding is sought elsewhere. This section summarises all activities related to projects, both research and otherwise, with which the Unit is involved.

Major Projects Completed

Kick 'em Jenny: A successful attempt was made to utilise all funds remaining in a Caribbean Development Bank grant of 2000 given for improvements in the monitoring system established for Kick 'em Jenny submarine volcano. These funds enabled the purchase of equipment to replace all monitoring stations which had been severely damaged due to the passage of Hurricane Ivan in 2004. New communications equipment (VSAT satellite) was also purchased for the Kick-em-Jenny Observatory located at Marli in the north of the island. This will enable real-time transmission of seismic data to the SRU headquarters in Trinidad and significantly improve the Unit's ability to rapidly detect changes at the volcano. A quantity of educational materials for use in public education and information programs in Grenada and the Eastern Caribbean was also designed and printed using the funds.

Volcanic Hazard Atlas - DVD Version: After a number of unanticipated delays the DVD version of the Volcanic Hazard Atlas of the Lesser Antilles was finally completed in June 2007. This electronic version of the Atlas contains the entire print version as Adobe Acrobat PDF files along with a number of videos files which illustrate the major types of volcanic hazards to which vulnerable island populations are exposed. Free copies of the DVD will be circulated to disaster management agencies and educational institutions during 2008.

Ongoing Projects

VSAT – Seismic Network Upgrade: With the generous support of the American People through the USAID/OFDA and the Government of Trinidad and Tobago, the SRU secured grants of US$249,680 and US$140,200 respectively to fund a project that allowed for a critical upgrade of the Unit's seismic monitoring network. The grants also provided funding to develop data sharing policies between earthquake monitoring agencies in the Caribbean, Central America and the northern countries of the South American continent. In sum, this enterprise will be exigent for the progress of a tsunami early warning system in the Caribbean.

The project for which funding was received has two major objectives: (1) to upgrade a sub-set of the existing seismograph network and (2) to establish clear policies for exchanging data between seismological agencies in different countries. Earthquake monitoring (seismic) stations will be enhanced in the islands of St. Kitts, southern Dominica, Saint Lucia, St. Vincent, Tobago and Trinidad as part of the first initiative. As a part of another project, there have been three installations in the islands of Barbados, Grenada and Barbuda through the United States Geological Survey (USGS) that will be integrated into the improved network. At the completion of the project, the Seismic Research Unit will have the capability to detect and classify potential tsunami-generating earthquakes in less than 3 minutes during normal working hours with the added capacity to publish data to a regional Tsunami Warning Centre in real-time.

ICG-CARIBE EWS: The SRU is collaborating with

Technicians install VSAT equipment as part of a project to upgrade the seismic monitoring network.

the Caribbean Disaster Response Agency (CDERA) and its participating states to empower coastal communities to prepare for and respond to tsunamis and coastal hazards (in support of the Tsunami and Coastal Hazards Warning System – TCHWS). Funding is being provided for the development of community-based education materials and information which aim to heighten the awareness of vulnerable populations – particularly those located on or near the coast. The project also involves the development of warning dissemination protocols and the procedures for their transmission to the vulnerable communities. The project is being funded by a grant from USAID/OFDA to CDERA of US$475,200.

ICT Applications in Disaster Management: The SRU is collaborating with the Caribbean Disaster Response Agency (CDERA) and the National Disaster Organizations in the Caribbean to test and analyze the role of ICTs to strengthen community knowledge and support in the collection of post event information for earthquake in the Eastern Caribbean. This project, funded by the International Development Research Centre of Canada (a grant of US$354,766 to CDERA), seeks to enhance the effectiveness of Disaster Management practices in the Caribbean through the identification and testing of Information and Communication Technology (ICT) applications. The project provides funding for a 2-year MPhil student to undertake the work required.

Earthquake readiness capacity building: This project seeks to assist CDERA participating states in benchmarking their earthquake preparedness capacity; review and enhance earthquake contingency plans, enhance search and rescue techniques and promote earthquake awareness. The SRU will work closely with CDERA and its participating states to develop earthquake contingency plans etc. Funding has been secured through a grant from the Government of Austria of US$519,614.

Strong Ground Motion Studies: The project seeks to upgrade the current seismic network in the islands of Trinidad and Tobago with a focus on data collection of strong ground motion. This project secured a competitive financial award of US$36,102 from the Government of Trinidad and Tobago Research Fund. The project started on January 1 2007. Data collection of strong ground motion from the existing network of stations and analysis of this data is currently underway.

Study of magma rheology and flow: This project will utilise Caribbean volcanism as a natural laboratory for the investigation of multiphase magma rheology. It is a collaborative project with the Physics Department at UWI and the University of Bristol. It seeks to combine the experimental capabilities of the Physics Department and the Department of Earth Sciences at Bristol University. This project secured partial funding of US$39,936 from the Government of Trinidad and Tobago Research Fund and has since January 2007 been seeking unsuccessfully to obtain the required additional funds. Despite this setback work has begun and efforts are ongoing to secure additional funding.

Opening photo: Stable isotope analysis as part of a geochemical research visit to the University of Bristol.

Closing photo: Instrumentation Engineer, Lloyd Lynch, supervises site preparation for the installation of the main satellite dish for the VSAT project.


JCB
TBV
6426

Outreach

During the 2006/2007 academic year, the Seismic Research Unit was involved in a rich variety of education and outreach activities which served to meet the Unit's ongoing goal of promoting geologic hazard awareness across the region. Additionally, these activities significantly enhanced the Unit's public image as the foremost authority for information on geologic events in the region. Highlights during the year included the development of a professional-quality travelling exhibition, production of new information pamphlets and the hosting of the Caribbean Training Course in Seismology & Tsunami Warnings.

Website: Efforts towards the development of a new website continued throughout the year but the new website was not completed as planned. This was primarily due to limited human resources and priority being given to other Eduation and Outreach projects during the reporting period. The existing website continued to serve as a valuable communication and education tool during the year.

Information Material: The following information material was either revised or created during the year:

- Seismic Research Unit pamphlet (new)
- Tsunamis, Personal Safety Guidelines pamphlet (new)
- Earthquakes, Personal Safety Guidelines pamphlet (revised)
- Earthquake safety magnets & stickers (new)
- Volcanic Hazard Atlas of the Lesser Antilles DVD (new)

This information material was widely distributed and well received by disaster managers and the public. There was a notable demand for earthquake safety material, particularly in Trinidad & Tobago where the Office of Disaster Preparedness and Management (ODPM) sponsored a reprint of the *Earthquakes: Personal Safety Guidelines* pamphlet. Saint Lucia's National Emergency Management Organisation (NEMO) has also expressed an interest in mass producing some of the pamphlets for use in its public awareness campaigns. It is hoped that sufficient funding will allow for other disaster

management agencies in the region to participate in this partnership. During 2007/08 most of the existing volcano-themed pamphlets will be revised and there are plans to develop at least two new pamphlets.

Workshops, Conferences & Seminars:

Caribbean Training Course in Seismology & Tsunami Warnings: Over forty participants from more than twenty countries in the Caribbean and Latin American region convened on UWI's St. Augustine campus for a six-day Caribbean Training Course in Seismology and Tsunami Warnings. The Course was part of an ongoing regional effort to establish a tsunami warning system for the Caribbean and Adjacent areas. It provided participants with an understanding of the science behind tsunami warnings and exposed them to operational best-practices of warning centres. Coordinated by the SRU, the Course was organized in conjunction with the:

- United States Geological Survey (USGS)
- International Tsunami Information Centre (ITIC)
- Puerto Rico Seismic Network (PRSN)
- National Oceanographic and Atmospheric Administration (NOAA)
- Intergovernmental Oceanographic Commission (IOC)
- UNESCO

At the close of the Course, participants provided recommendations which included the need for a commitment by "…National Governments to ensure that Tsunami Preparedness becomes a more significant part of their multi-hazard early warning and mitigation system as well as encourage the establishment of National Early Warning System Committees inclusive

Participants at the Caribbean Training Course in Seismology & Tsunami Warnings. St. Augustine, Trinidad

of their Tsunami Warning Focal Point and Tsunami National Contact…" as guided by the International Oceanographic Commission.

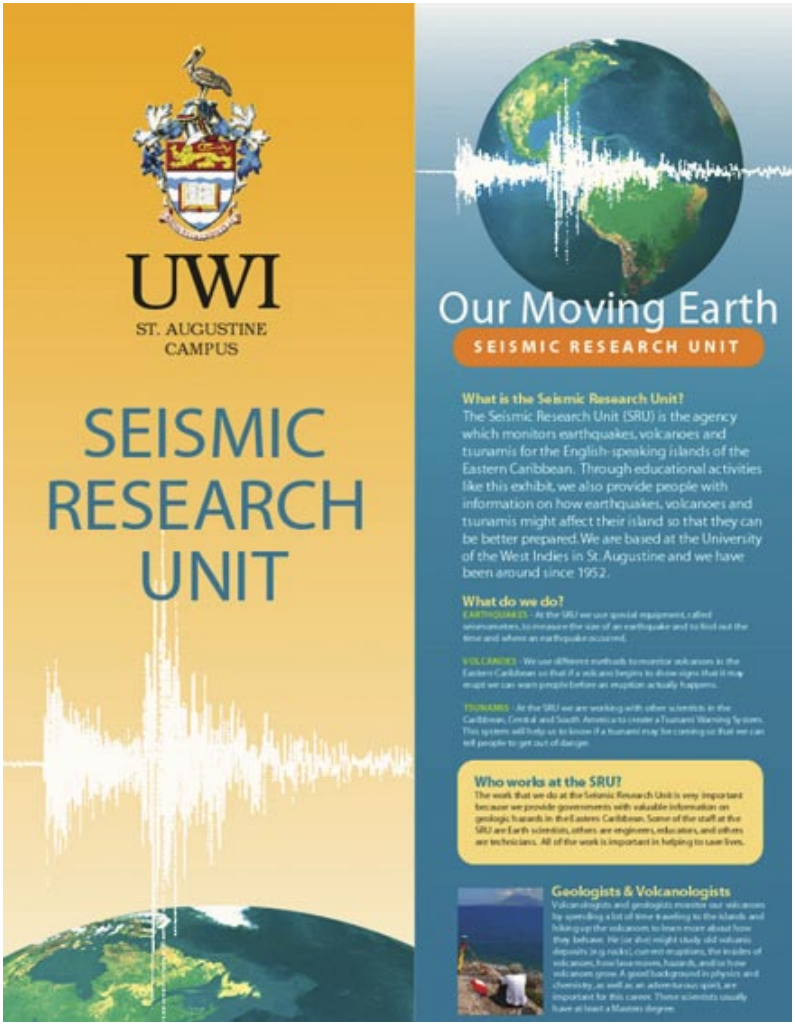
The Course was funded by the USAID Office of Foreign Disaster Assistance (USAID/OFDA), the United Nations Development Programme (UNDP), and the UWI Centre for Disaster Management and Risk Reduction.

Earthworm Training Course: Running concurrently with the Caribbean Training Course in Seismology and Tsunami Warnings was a training programme for seismic technicians in the use of EARTHWORM, a seismic data processing package used in managing real-time seismic data streams. This Course was coordinated and funded by the SRU and USGS and participants included technicians from St. Vincent, Dominica and Jamaica in addition to relevant SRU staff.

Outreach

Student Lectures: During the reporting period a decision was made to relocate the technical staff to an area that had been formerly used to accommodate student visits to the Unit. As such, student visits to the Unit have been disallowed from January 2007 until further notice. Off-site lectures by SRU staff are still delivered upon request. From August-December, 2006 five student lectures were delivered both on and off site in Trinidad.

During the school year, we continue to receive



"Frontispiece" to the portable display system developed by the Seismic Research Unit during 2006/2007

a fair number of requests for student lectures with teachers broadly identifying topics to be included in these lectures. Although teachers seem to be satisfied with presentations that cover a wide range of topics, we believe that these lectures could be significantly improved if they focused on one or two areas. We therefore propose to develop a standard set of lectures covering various themes in depth that we hope will offer a more engaging experience for students. There is also a greater need to incorporate feedback from both students and teachers in preparing these lectures.

Public Lectures: At least twelve public lectures on earthquake safety were delivered to a combination of general audiences and special interest groups in Trinidad. These included:

- Trinidad & Tobago Field Naturalist Club
- Association of Trinidad & Tobago Insurance Companies (ATTIC)
- Association of Business Continuity
- bpTT
- Bhp Billiton
- San Francique Hindu Temple
- Community Emergency/Disaster Response Planning Workshop
- The University School staff
- UWI Credit Union Annual General Meeting
- Disaster Management Workshop Series, Saint Lucia & Barbados (Co-ordinated by Tropical Shipping and respective national disaster management agency).

Following the 29 September, 2006 magnitude 5.8 earthquake near Trinidad, there have been numerous requests from Health & Safety personnel at both

A visitor reads the SRU's new travelling exhibit during CDERA's CDM conference in Barbados.

private and public agencies for lectures on earthquake vulnerability and preparedness. A proposal for a series of such seminars for this group is being considered.

Exhibitions: During the year, a portable display system was purchased for mounting information panels. This system has significantly enhanced the Unit's travelling exhibition by creating an attractive and professional display. The Unit participated in exhibitions at the following events:

- NIHERST Sci-TechnoFest 2006: A three-week, biennial national science and technology fair. Trinidad & Tobago.
- CDM Conference & Knowledge Fair: A regional conference on Comprehensive Disaster Management, coordinated by CDERA. Barbados.
- Barataria Senior Secondary School. Posters were loaned to the school for a three-day science exhibition. Trinidad & Tobago.
- Earthquake, Volcanoes & Tsunamis Exhibit: A one-day national exhibition coordinated by the National Emergency Management Office and the Soufriere Monitoring Unit. St. Vincent.
- UWI Credit Union Annual General Meeting: To accompany the feature address which was delivered by staff member Mr. Lloyd Lynch, the exhibition was mounted at the meeting venue. Trinidad & Tobago.

Media Relations

Print: During the reporting period at least nine (9) feature articles were produced by or written about activities at the Seismic Research Unit. These articles were featured in regional, local (Trinidad & Tobago) and UWI media. These feature articles are separate and apart from scientific press releases disseminated to disaster management agencies and the media following a geologic event and news stories written by journalists that relate to the work of the Unit.

Television & Radio: Staff participated in numerous radio interviews and at least five television programmes and/or documentaries across the region. These interviews were conducted both in response to specific geologic events as well as to promote public awareness of geologic hazards. Television documentaries for which staff were interviewed included:

- Blue: The Caribbean documentary series. Produced by Anthony Gunn.
- Natural Hazards DVD. Produced by the Trinidad & Tobago Ministry of Education.
- Earthquakes in Tobago. Produced by the Tobago House of Assembly Information Division.
- Bords de Mer: Iles de Feu. Produced by Patrick Sardi Productions

Press Conferences: During the reporting period two press conferences were held where various members of the print and electronic media were in attendance.

NADMA Headquarters, Grenada: A press conference held to discuss activities during a routine volcano monitoring visit to Grenada.

NADMA Headquarters, Grenada: A press conference

held to discuss deployment of an ocean bottom seismometer in the crater of the submarine volcano Kick 'em Jenny.

Community Service

Radix Point Mud Volcano: SRU was one of a number of agencies involved in helping the ODPM to identify and assess an underwater mud volcano that was active in July 2007, located about four miles off Radix Point in eastern Trinidad. SRU staff took part in site visits, scientific discussions, press briefings as well as a public meeting.

BG T&T Energy Challenge 2007: This is an annual fund-raising event where teams are required to hike selected mountain trails in Trinidad and complete a series of activities - all within twenty-four hours over a full weekend. The main objectives of the Challenge are to raise money for charity and to foster team-building within participating organizations. For the first time, UWI participated in the Challenge with six of the seven team members being staff of the Seismic Research Unit. Through various fund-raising ventures, the team raised US$2,500 for charity and placed nineteenth (19) out of the forty participating teams on the hike, a significant achievement for a small Unit. Special mention must be made of the following organizations who contributed towards making the Unit's participation in this event a success:

- SCRIP-J
- Talisman (Trinidad) Petroleum Ltd.
- Cool Connection Ltd.
- Lake Asphalt of Trinidad & Tobago Ltd.
- Forestry Division (Ministry of Agriculture)
- Yvette's Creole Food

Erouscilla Joseph, Research Assistant (Volcanology) talks to students of the San Juan Government School in Trinidad.

Table 3 Feature articles related to the Seismic Research Unit.

Article Title	Article Description	Media
An Inconvenient Truth	Article on the meeting of Regional Seismic Network Operators held in Trinidad and coordinated by the SRU.	STAN*
Caribbean Tsunami Early Warning System on its way	Article on the receipt of funding from USAID/OFDA and the Government of Trinidad and Tobago for the upgrade of the seismic monitoring network.	UWI Today* Newsday** Gayelle TV** Radio 97.1** Radio 98.1** CDERA website*** TsuInfo Alert***
The Day the Earth Moved	Article following the 29th September, 2006 earthquake near Trinidad.	UWI Today*
Reducing earthquake risk	Article on earthquake preparedness and safety	TCL Conveyor Magazine***
Vulcan's Law	Interview with SRU scientist Nicolas Fournier on Caribbean volcanoes.	STAN*
Caribbean Tsunamis	Article on tsunamis in the Caribbean. (Cover story).	The Pelican*
Tsunami Warning Systems on ALERT in the Caribbean	Article on the Caribbean Training Course in Seismology & Tsunami Warnings hosted by SRU.	UWI Today*
UWI Workshop sheds light on Tsunamis	Article on the Caribbean Training Course in Seismology & Tsunami Warnings hosted by SRU.	Trinidad Express Newspapers**
UWI Families Search for Mermaids	Article on Charity Hike fundraiser in aid of the UWI-SEISMIC team for the BG T&T Energy Challenge.	UWI Today*
The Big One	Interview with SRU staff Joan Latchman and Patricia Joseph on the experiences of women scientists.	Trinidad Express Newspapers (Express Woman magazine)*

* UWI Media
** Local media (Trinidad & Tobago)
*** Regional Media
**** International Media

- Barbecue JOE
- Kamo Designs Ltd.
- Wanter Enterprises Ltd.

Although the scale of the event proved to be challenging, this activity was indeed beneficial for building team spirit among the staff and it is recommended that consideration be given to participating in a charitable event each year, perhaps on a much smaller scale.

Opening photo: Chan Ramsingh (SRU) and Clairmonte Williams (Barbados Meteorological Services) collaborate during the Caribbean Training Course in Seismology & Tsunami Warnings. St. Augustine, Trinidad**.**

Closing photo: Members of the UWISEISMIC team descend Trinidad's El Tucuche mountain during a training hike for the BG T&T Energy Challenge.

Staff

Changes

Academic, Senior Administrative and Professional Staff

Ms. Meagan Sylvester joined the Seismic Research Unit in January 2007 after having signed an 18-month contract to manage the Caribbean Tsunami Early Warning System – Communications and Protocols project made possible by USAID/OFDA. Additionally, Ms. Sylvester will be collaborating with SRU staff to develop project proposals and to identify appropriate funding agencies with a view to securing funds to increase the monitoring capacity of the Unit.

Mr. Roderick Stewart joined the Unit in May 2007 as a Volcano Seismologist. Mr. Steward comes to the Unit with over 25 years experience in seismology in government, academic, commercial and international environments: both research and practical application. He has worked in a variety of cultures and has wide-spread experience in teaching, training and outreach. Rod's initial focus will be to assist with the implementation of a major upgrade in the seismograph network that is currently underway at the Unit. In the future he is expected to play a leading role in the monitoring and interpretation of seismicity and seismic activity associated with volcanism in the Lesser Antilles.

Administrative, Technical and Service Staff

Ms Nisha Nath, who joined the Unit in February 2000, was promoted to the post of Chief Technician from July 2007.

Mr. Barry Jordan, who had joined the Technical Staff in February 2006 resigned after five months and Ms Kym Chan Chow, who joined the seismology team on 1 June, 2005, resigned with effect from 1 June, 2007. It was hoped that these two members of staff could be groomed to bring the team back to full strength following the retirement in January 2006 of Mr. Lutchman Pollard, former Chief Technician and Mr. Godfrey Almorales in November 2004.

Mr. Amit Balchan is the newest recruit to the team and came on board on 1 September, 2006.

Mr. Lutchman Pollard and Mr. Godfrey Almorales, both of whom, during their time at the Unit, provided invaluable support in helping to effectively service the volcanic and seismic crises that occurred and routinely ensured that the database and archives were maintained at the best possible standard, have been retained on contract to fill the void created by their retirement and the recent resignations.

Mr Kumar Rampersadsingh retired from the Unit in June 2007 after 31 years of service with the University. Mr. Rampersadsingh started at the Main Library in 1976, where he worked for one year before moving to the Unit.

Other staff activities

Stacey Edwards

Contribution to UWI Life and Goals

- Co-ordinator, UWI-SEISMIC Team for BG T&T Energy Challenge 2007
- Member of the Organizing Committee and Participant in the "Caribbean Training Course in Seismology and Tsunami Warnings" organized by SRU at UWI, St. Augustine, June 25-30, 2007
- Member of the Organizing Committee of the "Earthworm Training Course" organized by SRU at UWI, St. Augustine, June 22-26, 2007
- Field assistant for geothermal monitoring trip to Dominica
- Presented seminar for SRU staff on Communicating Effectively

Service

- Public Relations Officer, The University School

UWISEISMIC team undergo training for BG T&T Energy Challenge. SRU staff raised TT$15,520 for charity.

Parent-Teacher-Network

- Member, The University School Association

Scholarly and Profession Activity

Membership of professional organisations:

- Member (Council), International Geoscience Education Organisation

Nicolas Fournier

Research

Multiphysics fluid dynamics modelling of the Boiling Lake, Dominica: This research involve multiphysics fluid dynamics modelling of the Boiling Lake, Dominica long term stability and short-term variations, Dominica and is being done in collaboration with the University of Bristol, UK (Fred Witham). Results have been submitted to the Journal of Geophysical Research (cf abstract bellow and reference in the list of publications):

"The Boiling Lake of Dominica has exhibited stable, high temperature behaviour for at least 150 years. This stability is punctuated by occasional crises involving rapid filling and draining of the lake and changes in water temperature. The most recent such crisis occurred in December 2004-2005. We review the available literature on the Boiling Lake, and combine existing knowledge with data from several field excursions. Using the results of previous theoretical and experimental work on analogous systems, we present a combined thermal, hydrological and fluid mechanical model of the Boiling Lake. The lake

Volcanology Team

Back row, L to R: Nicolas Fournier (Volcanologist), Frederic Dondin (Visiting Fellow, Volcanology);

Second row, L to R: Euroscilla Joseph (Research Assistant, Volcanology), Deborah Robertson (PhD student);

Front row: Magali Fournier (PhD student).

appears to be suspended above the local water table by a constant supply of rising steam bubbles - sourced from the boiling of groundwater near an igneous intrusion. These bubbles condense in the Boiling Lake, maintaining the temperature at over 90 °C. The geometry of the lake-conduit system provides a mechanism for instability. Following a sufficiently large perturbation, the whole lake rapidly drains until the surface is at the local water table level. The persistent gas supply then re-initiates filling. We propose that local seismic activity may have caused shock nucleation of bubbles within the conduit and triggered the instability of the Boiling Lake."

Micro-gravity and deformation surveys in the southern collapse structures of Dominica: This research is being done in collaboration with the GeoForschungsZentrum Potsdam (GFZ), Germany's National Research Centre for Geosciences (Dr. Thomas Walter, Joel Ruch). It examines short term variations of geothermal activity at the Boiling Lake using temperature and pressure sensors installed for the experiment.

Micro-gravity study at the Soufriere Hills Volcano on Montserrat: This research is being done in collaboration with the University of Bristol, UK and involves deformation surveys to assess mid-term deep volcanic processes (Steffi Hautmann) and continuous gravity high temporal resolution deformation to assess short-term shallow volcanic processes (Dr. Joachim Gottsmann).

Feasibility study of near-real time GPS processing for volcano monitoring (GAMIT/GLOBK – TRACK): This work is being done in collaboration with the Montserrat Volcano Observatory (MVO), Montserrat and the Massachusetts Institute of Technology (MIT), USA).

Teaching and Mentoring

- Jointly developed and proposed the introduction of a six-credit, Graduate Course in Volcanology to be run by the SRU.

Lectures

- Invited lecturer for the Earth materials, Earth Processes and seismology course (PHYS 3393 – P39D, Advanced Level Undergraduate) course (Department of Physics, UWI St. Augustine): Geophysics and Physical Volcanology.
- Co-leader of geological field trip in Tobago for the same course (Course leader: Dr. I. Haraksingh. Department of Physics, UWI St Augustine).

Graduate Students

- Erouscilla Joseph (PhD, 2004-present): Geochemical studies of hydrothermal areas of the Lesser Antilles: Implications for geothermal and volcano monitoring (co-supervisor: Dr. D. Beckles, Department of Chemistry, UWI St Augustine).
- Frederic Dondin (PhD, 2005-present): Geology and physics of pyroclastic density currents in the Lesser Antilles: mixed approach field survey / numerical modelling. (co-supervisor: Prof. A. Randrianasolo, Geology Department, University of Antilles Guyane, Guadeloupe, France).
- Deborah Robertson (PhD, 2006-present): Experimental study of three-phase magma rheology and flow and its implications for persistent volcanic activity in the Caribbean.

(co-supervisor: Dr. J. Knight, Department of Chemistry, UWI St Augustine and Dr. H. Mader, Department of Earth Sciences, University of Bristol, UK)

Undergraduate students

- Lauriane Chardot (B.Sc. Geophysics, EOST, Strasbourg, France / MVO, Montserrat, 2007): Geodetic monitoring at Soufriere Hills Volcano using GAMIT-GLOBK and near-real time kinematics processing.
- Lauren Sylvester (B.Sc. Hons. Physics, UWI, 2006): Volcano deformation monitoring at Nevis, W.I.: differential processing of GPS data (co-supervisor: Dr. I. Haraksingh, Physics Department, UWI St. Augustine)

Contribution to UWI Life and Goals

- Resource person for a pilot series on "Science and Scientists in the Caribbean" (Producer: Dr. Shirin Haque, Department of Physics, UWI St Augustine)
- Member, UWI-SEISMIC Team for BG T&T Energy Challenge 2007

Service

- TV documentary about Kick'em Jenny and Montserrat volcanoes for the series "Bords de Mer" (French overseas TV, Martinique)

Scholarly and Professional Activity

Invited reviewer for:

- Jackson T., Scott P.W., Donovan S.K., Pickerill R.K., Portell R.W. and Harper D.A.T, The volcaniclastic turbidites of the Grand. Bay formation, Carriacou, Grenadines, Lesser Antilles, *Caribbean Journal of Science* (submitted)

Seismology Team

Back row, L to R: Lutchman Pollard (Seismic Technician), Rosemarie Mohais (Geophysicist), Godfrey Almorales (Seismic Technician), Joan Latchman (Seismologist), Roderick Stewart (Volcano-Seismologist);

Front row: Nisha Nath (Senior Seismic Technician), Amit Balchan (Research Technician).

- Smith T.E., Holm P.E. and Thirwall M.F., The Geochemistry of the Volcanic Rocks of Canouan, Grenadine Islands, Lesser Antilles Arc. *Geological Journal, Special Issue 'Crustal & Biotic Evolution of the Caribbean Plate'* (submitted)

Consultancy:

- Scientist/volcanologist at the Montserrat Volcano Observatory / British Geological Survey in Montserrat: 3 weeks in 2006 and 4 weeks in 2007.

Membership of professional organisations:

- Member, International Association of Volcanology and Chemistry of the Earth's Interior
- Member, American Geophysical Union

Erouscilla P. Joseph

Research

PhD. Research (Volcanology)

This PhD. falls under the Seismic Research Unit, Dr. Nicolas Fournier is the supervisor. The research involves two main topics:

- Geochemistry of hydrothermal systems in Dominica and Saint Lucia: sampling and analysis of volcanic gas and hot springs on both islands; characterization of their geothermal systems; and use of fluid geochemistry as a tool for volcanic monitoring.
- Influence of geothermal/volcanic fluids and emissions on human health: investigating the levels of exposure, the concentration of potentially dangerous elements, and the effects of volcanic discharges, to which humans are exposed when using geothermal fields for recreational purposes.

Contribution to UWI Life and Goals

- Member of the Organizing Committee and Participant in the Caribbean Training Course in Seismology and Tsunami Warnings organized by SRU at UWI, St. Augustine, June 25-30, 2007
- Member of the Organizing Committee of the Earthworm Training Course organized by SRU at UWI, St. Augustine, June 22-26, 2007

Scholarly and Professional Activity

A visiting fellowship was obtained to the Department of Earth Sciences, University of Bristol, UK: February 9 to April 5 2007. It was funded through a Special Award granted by the Royal Commission for the Exhibition of 1851, and the UWI Research and Publication Fund Committee. Activities and research conducted included:

- The analysis of geothermal fluids using Atomic Absorption Spectroscopy, Ion Chromatography, and Spectrophotometer.
- Assisting UoB students (Ellie Scours and Fred Whitlam) on collaborative research project analysing sediments from the Boiling Lake (Dominica), as well as the cause of rapid changes in the water levels at the Boiling Lake.
- Visiting the British Geological Survey, Key worth, Nottingham laboratories to conduct stable isotope (oxygen and hydrogen) analyses on geothermal fluids.
- Attending Physical Volcanology Courses (in BSc. Geology Programme).
- Working with Prof. Dave Sherman (Department of Earth Sciences) on the mineralogy of St. Lucia

and Dominica geothermal systems.

Membership of professional organisations:

- Member, International Association of Volcanology and Chemistry of the Earth's Interior
- Member, International Volcanic Health Hazard Network
- Member, American Geophysical Union

Joan Latchman

Research

PhD. Research (Seismology)

This PhD falls under the Faculty of Engineering and the Seismic Research Unit. The thesis title is "T*obago and Earthquakes*" and three (3) main themes investigated and passed to supervisors in 2003. Thesis submitted in August 2006.

1. "Forecasting of the strongest 1997 earthquake near Tobago using b-value analysis, and other indicators" – this theme reports on the b-value analysis conducted during the activity of 1997, which led to the projection that a stronger earthquake was imminent; examine the data for other short-term indicators of stronger activity.
2. "Projected seismicity near Tobago based on past seismicity near, and in the far-field off the east of Tobago" – this theme examines the entire database of significant earthquakes near, and in the far-field off the east of Tobago, as far as the Vema Fracture Transform, with a view to improving the understanding of the tectonics at work in the generation of earthquakes near Tobago. The possibility of faults being pushed closer to failure by remote earthquakes is becoming of more interest in the seismological community, and this particular chapter is currently being tailored for journal submission at an early date.
3. "Hydrological effects of the 1997/04/22 Tobago earthquake" – this theme documents, and analyses the groundwater impact of the strongest shock of the 1997 series, by collecting information from government agencies and property owners. A possible model consistent with the observations is used to determine the change in the size of crack

Electronics & IT Team

L to R: Garth Mannette (Electronics Technician), Chandradath Ramsingh (IT Specialist), Lloyd Lynch (Instrumentation Engineer), Ian Juman (Electronics Technician).

apertures, which gave rise to the large volume of observed groundwater discharge. Completing this chapter required fieldwork and interviews in Tobago.

Service

- SRU representative at the XV Board of Directors Meeting of CERESIS held in Lima, Peru from March 10-14, 2007
- Resource person & invited speaker at the Disaster Management Workshop Series organised by Tropical Shipping and National Disaster Coordinators in Saint Lucia, Barbados and Trinidad held during June-August 2007
- SRU representative at the CDERA Comprehensive Disaster Management Workshop held in Barbados on September 15, 2007

Scholarly and Professional Activity

Training Courses attended:

- June 25-30, 2007: Caribbean Training Course in Seismology and Tsunami Warnings, UWI, St. Augustine, Trinidad.
- June 23-26, 2007: Earthworm Training Course, UWI, St. Augustine, Trinidad.
- June 17, 2007: Tectonics and Basin Analysis Course with Jim Pindell, Hilton Hotel, Port of Spain, Trinidad.
- November 8-9, 2006: Tsunami Early Warning Systems, Palmer, Alaska, USA sponsored by United States Telecommunications Training Institute.

Consultancy:

- Chief respondent to enquiries re: felt earthquakes and their possible impact from insurance companies, the energy sector and the general public

Membership of professional organisations:

- Member, Seismological Society of America
- Member, Geological Society of Trinidad & Tobago

Lloyd Lynch

Research

PhD Research (Computer Sciences)

This PhD falls under the Department of Computer Sciences and involves the application of Distributed Computing Techniques in earthquake and volcano monitoring: The project is primarily concerned with the integration of Information and Telecommunication Technology into the regional seismic data acquisition/monitoring network. Investigations continued in the following three areas:

- Use of broadband internet access technology and digital radio telemetry to improve the "last mile" segment of the seismic data communication network.
- Use of Watchdog Timer and other techniques to improve the availability and reliability of the remote data acquisition/monitoring systems
- Development of a middleware software package that is suitable for computer-networking infrastructure in the Eastern Caribbean.

Seismic Hazard Assessment

This research involves the study of ground motion attenuation patterns using unclipped broadband recordings of strong earthquakes. This will provide better insights into the best attenuation relationship to use in future seismic hazard assessments.

Earthquake Risk Reduction in Schools:

The aim of this project is to develop an earthquake preparedness model plan for schools that can be adapted and put into effect on a national scale.

Service

- SRU Representative to the Incorporated Research Institutions for Seismology

Scholarly and Professional Activity

Membership of professional organisations:

- Member, APETT sub-committee for seismic provision for the Building Code
- Member, Intergovernmental Oceanic Commission Tsunami Group of Experts
- Invited Expert to Working Group 1 on Monitoring and Detection Systems and Warning Guidance of the ICG/CARIBE EWS

Rosemarie Mohais

Research

Funded Projects:

Strong Ground Motion Studies in Trinidad and Tobago: This project secured a competitive financial award of US$36,172 from the Government of Trinidad and Tobago Research Fund. The main aims of the project are as follows:

- To determine three sites in Trinidad and Tobago at which three strong motion accelerometers will be usefully deployed. This incorporates studying geological maps of the islands, site visits and feasibility studies.
- To purchase and deploy three strong motion accelerometers in the islands of Trinidad and Tobago to enhance the existing strong motion monitoring network of the Seismic Research Unit. The instruments deployed will be used to determine peak ground acceleration and peak ground velocity associated with large earthquakes.
- To collect, filter and analyse strong motion records received at the seven strong motion stations. For earthquakes of magnitude greater than 3.5, correlation plots of parameters such as epicentral distance, peak ground acceleration, depth and magnitude will be derived.

The Strange Pattern of Migration of Volcanic Earthquakes in Dominica - Causes and Implications: This research is being done in collaboration with Dr. Jean Battaglia of the Laboratoire Magma et Vulcans, Blaise Pascal University, Clermont Ferrand. Partial funding (US$3,551) for this project was obtained through The Office of the Campus Principal, UWI, St. Augustine, Office of Research, UWI, St. Augustine and The Seismic Research Unit. This funding facilitated a visit to the Laboratoire Magma et Vulcans in July of 2007.

Other Research

Heat propagation through a lava channel, the base of which is lined with a permeable magmatic foam: This is being done in collaboration with the Department of Math & Computer Science (Professor Bhatt, UWI, St. Augustine). This is an extension of the paper: Mohais R., Bhatt B. How does permeability affect the heat transfer profile of fluid flow within a partially permeable channel with an accelerating surface velocity? Progress in Computational Heat and Mass Transfer Volume 1. (Eds. R. Bennacer, A.A.

Mohamad, M.E. Ganaoui, J. Sicard), pp. 363-366. Lavoisier 2005.

Heat transfer between rotating permeable discs moving towards each other within an orthogonal magnetic field: This research has been completed and a full paper has been sent to the International Journal of Heat and Mass Transfer. This work is an extension of the paper: Bhatt, B., R. Mohais. Temperature and heat transfer profiles of a fluid film squeezed between two permeable isothermal discs rotating within a magnetic field. In 'Simulation of Electrochemical Processes'. (Eds. A. Brebbia, V.G. Degiorgi, R.A. Adey), pp. 119-129. WITpress, 2005. The results of this research were first presented at a public seminar held at the Seismic Research Unit.

Earthquake Classifying Neural Networks Trained with Random Dynamic Neighborhood PSOs: Research is being done in collaboration with the Department of Math & Computer Science (Arvind Mohais) in the area of Artificial Intelligence. Using the extensive database of signals collected from the strong ground motion monitoring network, artificial neural networks developed by Arvind Mohais were first trained to discriminate the earthquakes from the non-earthquakes using a sorted dataset. Subsequent unsorted datasets were sorted by the trained neural networks with 97% accuracy. The efficient use of artificial intelligence in this field will significantly reduce the time spent on sorting through the raw data collected at strong motion seismic stations. The results of this collaboration were published at the GECCO 2007 Conference.

Chaos analysis of volcanic earthquakes: Studies are being conducted using the swarm of volcanic events that occurred in Dominica over the period 1998-2001. Using preliminary ideas presented in the Volcanic Hazard Atlas of the Lesser Antilles, waveform data is being re-examined to test the hypothesis whether the swarm of events exhibit chaotic behaviour. Also investigations are being conducted on whether there is a chaotic attractor associated with the volcanic system in southern Dominica. The results of these analyses

Support Staff

Nolan Ali
Maintenance

Kumar Rampersadsingh
Office Assistant

Armoogan Moonsammy
Groundsman

Margaret Nero
Cleaner

will enable researchers to make better informed decisions on volcanic hazards.

PhD Research (Mathematics):

This PhD falls under the Department of Mathematics & Computer Science. Professor Balswaroop Bhatt is the supervisor. The title of Rosemarie's thesis is: Heat Transfer Studies of Coupled Fluid Flow in Porous Media. The thesis was submitted in February 2007 and is currently under examination. The research investigates the three main geometries through examination of channel flow, flow between discs and spherical bodies. The thesis uses analytical and numerical techniques to investigate the effect of variations of temperature on the heat profiles of specific bodies which exist in Newtonian fluids. Applications of the specified geometries to geophysical fluid dynamics are currently being developed.

Teaching and Mentoring

Undergraduate student projects

- Krystle Swamber: (Final Year B.Sc. Geology, UWI, Mona, Jamaica, 2007): Extraction of wave form data from SRU database. 3 weeks during June 2007

Contribution to UWI Life and Goals

- Member of the Organizing Committee and Participant in the Caribbean Training Course in Seismology and Tsunami Warnings organized by SRU at UWI, St. Augustine, June 25-30, 2007
- Member of the Organizing Committee of the Earthworm Training Course organized by SRU at UWI, St. Augustine, June 22-26, 2007

Service

- Member, American Geophysical Union
- Member, American Mathematical Society
- Member, American Society of Mechanical Engineers

Scholarly and Professional Activity

- Visit to the Laboratoire Magma et Vulcans, Blaise Pascal University, Clermont Ferrand in July 2007 to study relocation techniques used in volcano seismicity

Richard Robertson

Research Funding

Lead author of the following successful proposals for grant funding of research and monitoring activities

- Tsunami and Coastal Hazards Workshop for Senior Technical Network Representatives of Caribbean Basin Seismic Agencies - USAID/OFDA ~ US$17K
- Strengthening the Capacity of the Seismic Research Unit to respond to events of tsunamigenic potential - Government of The Republic of Trinidad and Tobago ~US$140K
- Caribbean Tsunami Early Warning System - Communications and Protocols - USAID/OFDA; ~ US$249K
- Caribbean Training Course in Seismology and Tsunami Warnings - USAID/OFDA, DRRC, UNDP - ~US$55K
- Enhancing the Effectiveness of Information and Communication Technology Applications and Tools for Disaster Management in the Caribbean Region - IDRC, Canada - US$27K

Teaching and Mentoring

- Designed and submitted proposal to Campus

Committee, in collaboration with Dr. Nicolas Fournier, three new graduate courses
- Member of the Advisory Committee for Nikolaiski Ali, MPhil in Land Surveying and Land Information
- Member of the Advisory Committee for Magali Fournier, MPhil in Petroleum Geosciences.

Graduate students

- Sian Crosweller, PhD, 2004-present. The Centre for Environmental Risk, University of East Anglia, UK. Topic: Tools for Trust: Assessing the most effective methods for hazard communication. Co-supervisors Drs Jenni Barkley and Mr. Paul Simmons
- Catherine Lowe, PhD, 2006-present. University College London, UK. Topic: A GIS-based method for risk and vulnerability assessment of volcanic islands. Co-supervisors Professor Bill McGuire, Drs Muki Haklay and Paul Longley
- Jessica Roberts, MSc, 2006. School of Earth and Environmental Science, University of Portsmouth. Topic: An Investigation into the Flow of Risk Communication within the Small Island States of the Eastern Caribbean - Case Study: Dominica. (Co-supervisor Dr. Carmen Solana)
- Megan Davies, MSc, University College London. Topic: An Investigation into the Preparedness of Dominica for a Volcanic Event
- Tim Over, MSc, 2007. School of Earth and Environmental Science, University of Portsmouth. Topic: Creating and using Volcanic Hazard maps to assess the perception of residents on Saint Lucia, West Indies

Contribution to UWI Life and Goals

- Member of the Review Team for the Review of the Geology Programme, Mona Campus, UWI,

Administration & Outreach Team

L to R: Meagan Sylvester (Administrative Assistant), Carol Liverpool (Clerical Assistant), Richard Robertson (Director), Yvonne Joseph (Secretary), Shaun Boodhoo (Office Assistant), Stacey Edwards (Education Officer);
Missing: Susan Carr (Library Assistant).

Jamaica (April 2-5, 2007)

- Member, UWI-SEISMIC Team for BG T&T Energy Challenge 2007
- Dojo Director (i.e. Head) of UWI Shotokan Karate Club

Service

- Member, Board of Directors of the Montserrat Volcano Observatory
- Member, Technical Advisory Team on Disaster Management in Trinidad and Tobago
- Member, Montserrat Scientific Advisory Committee
- Secretary, Trinidad Karate Association

Scholarly and Professional Activity

- Member, American Geophysical Union
- Member, Geological Society of London
- Member, Geological Society of Trinidad and Tobago
- Member, International Association of Volcanology and Chemistry of the Earth's Interior

Invited reviewer for:

- A. Samper, X. Quidelleur, G. Boudon, A. Le Friant & J.C. Komorowski: Radiometric dating of three large volume flank-collapses in the Lesser Antilles Arc. Submitted to J. Geol. Soc. Lond. (March 2, 2007
- Georges Boudon, Jean-Christophe Komorowski, Benoît Villemant, Michel P. Semet. A new scenario for the last magmatic eruption of La Soufrière de Guadeloupe (Lesser Antilles) in 1530 A.D: Evidence from stratigraphy, radiocarbon dating and magmatic evolution of erupted products. Submitted to Journal of Volcanology and Geothermal Research, Special issue: Evaluating Explosive Risk at European Volcanoes.

Invited articles:

- Invited article on "Geology of the Lesser Antilles" for publication in 2008 University of California Press Encyclopedia of Islands to be edited by Rosemary Gillespie and David Clague

Invited lectures:

- Invited lecturer at 2005 SPIDER Network Workshop, UK & BA Festival of Science, UK
- Guest lecturer Caribbean Youth Science Festival

Meagan Sylvester

Research

PhD. Research (Sociology)

This PhD falls under the Faculty of Social Sciences and involves the following themes:

- Strategic Management and Organisational Change and Development in selected companies in the Trinidad, Barbados and Jamaica. The University of the West Indies, St. Augustine Campus
- Examining the psycho-social impact of geo-physical hazards on vulnerable populations in the Eastern Caribbean

Teaching and Mentoring

- Lecturer, Department of Behavioural Sciences, Faculty of Social Sciences: The Evening University, The University of the West Indies, St. Augustine Campus
- Mentor, The UWI Alumni Association, Trinidad and Tobago Chapter Mentorship Programme

Contribution to UWI Life and Goals

- Fund-raising Co-ordinator – UWI-SEISMIC BG Energy Challenge

Service

- Assistant Secretary, The University of the West Indies Alumni Association, T&T Chapter
- Public Relations Officer, Caribbean Tertiary Level Personnel Association (CTLPA)
- Member, Association of Caribbean Higher Education (ACHEA)
- Member, Caribbean Studies Association (CSA)
- Member, American Sociological Association (ASA)
- Member, British Sociological Association (BSA)
- Member, Sociological Association of Trinidad and Tobago (SATT)
- Member, Women and Development Studies Group, The University of the West Indies, St. Augustine Campus

Opening photo: GPS monitoring on St. Kitts with St. Eustatius in the background.

Closing photo: Investigating the crater of St. Vincent's La Soufriere volcano.

Partnerships

The Unit collaborates with a wide variety of individuals, institutions and corporations at various levels in the execution of it mandate and the work of its staff. The list below provides a summary of the main partnerships with which the Unit has been engaged during the period under review.

INTER-FACULTY (UWI)

Faculty of Agriculture & Natural Sciences

Department of Mathematics and Computer Science
UWI St. Augustine campus
Professor Balswaroop Bhatt
Arvind Mohais

Faculty of Engineering

Department of Surveying & Land Information
UWI St. Augustine campus
Dr. Keith Miller

ACADEMIC INSTITUTIONS

Blaise Pascal University

Laboratoire Magma et Volcans
FRANCE
Dr. Karim Kelfoun
Jean Battaglia

Grand Valley State University

Department of Geology
USA
Dr. John Weber

Massachusetts Institute of Technology

USA
Prof. F.D. Morgan
Dr. Bob King

Royal Melbourne Institute of Technology

Centre for Risk and Community Safety

AUSTRALIA
Dr. Katharine Haynes

University of Antilles Guyane
Physics Department
GUADELOUPE (F.W.I.)
Professor Narcisse Zahibo

University of Boulder
USA
Dr. John Braun

University of Bristol
Department of Earth Sciences
UNITED KINGDOM
Professor Steve Sparks
Dr. Tim Elliot
Dr. Heidi Mader

University College London and the Benfield Hazard Research Centre
Department of Earth Sciences
UNITED KINGDOM
Professor William J. McGuire
Dr. Christopher Kilburn
Ms Catherine Lowe

University of East Anglia
School of Environmental Sciences
UNITED KINGDOM
Dr. Jenni Barclay

University of Portsmouth
School of Earth & Environmental Sciences
UNITED KINGDOM
Dr. Richard Teeuw
Dr. Carmen Solano

SRU electronics technician, Ian Juman, works with scientists from the Woods Hole Oceanographic Institute to deploy a seismometer in the crater of Kick 'em Jenny, a submarine volcano north of Grenada.

University of South Florida
Department of Geology
USA
Dr. Diana C. Roman

MONITORING & DISASTER MANAGEMENT

Caribbean Disaster Emergency Response Agency
BARBADOS
Jeremy Collymore
Donovan Gentles
Elizabeth Riley

Fundación Venezolana de Investigaciones Sismológicas
VENEZUELA
Dr. Gustavo Malavé Buccé
Dr. Herbert Rendon

Institut de Physique du Globe de Paris
Dr. Steve Taitt
Dr.François Beauducel
Dr. Sara Bazin

Instituto Nazionale di Geofisica e Vulcanologia
ITALY
Dr. Warner Marzocchi

Montserrat Volcano Observatory
MONTSERRAT
Dr. Sue Loughlin
Dr.Vicky Hards
Dr.Graham Ryan

NGI, Norwegian Geotechnical Institute
Dr. Oddvar Kjekstad
Norway

NORSAR
POB 53, NO-2027 Kjeller, Norway
Dr. Hilmar Bungum

Puerto Rico Seismic Network
University of Puerto Rico at Mayagüez
USA
Christa G. von Hillebrandt-Andrade

UNESCO
Intergovernmental Oceanographic Commission
Dr. Laura Kong

Opening Ceremony for the Caribbean Training Course in Seismology & Tsunami Warnings. L to R: Dr. Richard Robertson (Head, SRU), Dr. Bhoendradat Tewarie (Campus Principal), Dr. Roy Austin (US Ambassador), Dr. Gari Mayberry (USAID/OFDA Geoscience Advisor), and Ms Joan Latchman (Seismologist, SRU).

Dr. Bernardo Aliaga
US Geological Survey
USA
Dr. Walter D. Mooney
Dr. Daniel E. McNamara
Dr. Annabel Kelly

FUNDING AGENCIES

Caribbean Development Bank
BARBADOS
Valerie Murphy
Karen Cummings
USAID-OFDA
USA
Julie Leonard
Dr. Gari Mayberry
Tim Callaghan

PRIVATE CORPORATIONS

Aspinall & Associates,
UNITED KINGDOM
Dr. W.P. Aspinall

Opening photo: Nicolas Fournier (SRU) and Racquel "Tappy" Syers (MVO) set up a tripod to conduct a GPS survey for volcano ground deformation monitoring in Grenada.

Closing photo: Geothermal field in the Valley of Desolation, Dominica.

Publications

Seismic authors in **bold** text

Theses, Books and Book Chapters

Sylvester, M.A. (2007): The globalization of higher education. Assessing the response of the University of the West Indies. In *Schooling and Education in Global Societies*. Eds. Carol Camp Yeakey, Rodney Hopson and Francis Musa Boakari. Yeakey's book series Advances in Education in Diverse Communities: Research, Policy and Praxis, Elsevier Inc.

Mohais, **R.** (2007): Heat Transfer Studies of Coupled Fluid Flow in Porous Media. *PhD thesis (Mathematics)*. Under examination at the University of the West Indies, St. Augustine Trinidad.

Refereed Journals,

Trofimovs, J., L. Amy, G. Boudon, C. Deplus, E. Doyle, **N. Fournier**, M.M.B. Hart, J.C. Komorowski, A. Le Friant, E. Lock, C. Pudsey, G. Ryan, R.S.J. Sparks and P.J. Talling. (2006) Submarine pyroclastic deposits formed at the Soufrière Hills Volcano, Montserrat (1995-2003): what happens when pyroclastic flows enter the ocean? *Geology*, 34 (7), 549-552.

Mohais A., **Mohais R.**, Ward C. and Posthoff C. 2007. Earthquake Classifying Neural Networks Trained with Random Dynamic Neighborhood PSOs. *Proceedings of the 9th Annual Conference on Genetic and Evolutionary Computation*, London, England, pp. 110 - 117, ISBN: 978-1-59593-697-4.

Conference proceedings, abstracts & posters

Edwards, S. (2006): *Volcanic Hazard Atlas of the Lesser Antilles – Multimedia Version*. International Geoscience Education Organisation GeoSciEd VBayreuth, Germany. Poster

Fournier N., Ryan G. and Strutt M. (2007) Volcano relaxation following great dome collapses: impact on magma volume retrievals from geodetic monitoring at Soufriere Hills Volcano, Montserrat, West Indies. *EOS Trans. American Geophysical Union*, 88 (23), Jt.

Assembly. Suppl., Abstract V34-04.

Fournier, N., Lynch, L., Robertson, R., Latchman, J., Mohais, R. and Ramsingh, C. (2007): Multi-Hazards Geophysical Monitoring Through the Eastern Caribbean Islands arc: Strategy, Challenges and Future Development. *EOS Trans. American Geophysical Union*, 88 (23), Jt. Assembly. Suppl., Abstract U53B-04.

Moreau-Fournier, **M., Fournier, N. and Robertson, R.** (2007): Geophysical Investigations of Soufriere Volcano Crater, St Vincent, West Indies: Where is the Lake? *EOS Trans. American Geophysical Union*, 88 (23), Jt. Assembly. Suppl., Abstract V22A-07.

Witham, F. and **Fournier, N.** (2007): Understanding the weird behaviour of Dominica's Boiling Lake. *VMSG Winter Meeting*, Oxford, UK. Poster

Hautmann, S,. **Fournier, N.**, Gottsmann, J. and Sparks, S. (2006): Mass and density changes associated with the ongoing eruption of Soufrière Hills volcano, Montserrat (W.I.) via a new joint elevation and microgravity network. *AGU Fall-meeting*, San Francisco, USA. Poster

Latchman, J. L., Robertson, R.E.A., Lynch, L. (2007): Recent onland, Trinidad earthquakes and their implications. *4th Geological Conference & Exhibition, Geological Society of Trinidad and Tobago*, 17-22 June, 2007, Hilton Hotel. Oral

Latchman, J. (2007): Hydrological effects of the 1997/04/22 Tobago earthquake. *4th Geological Conference & Exhibition, Geological Society of Trinidad and Tobago*, 17-22 June, 2007, Hilton Hotel. Oral

Latchman, J. (2007): Temporal changes in the cumulative piece-wise gradient of a variant of the Gutenberg-Richter relationship, and the imminence of extreme events. *European Geosciences Union General Assembly*, 15-20 April, 2007, Vienna, Austria. Poster

Mohais, R. (2006): Heat Transfer within a Fluid Filled Deformable Permeable Spherical Shell in Slow Viscous Flow. , *EOS Trans. American Geophysical Union*, 87(52), Fall Meet. Suppl., Abstract #H33D-1544. Poster

Mohais, A. and **Mohais, R.** (2006): Possible Origins of the 'free T phase' Seismic Signals Generated by the Kick 'em Jenny Volcano. *EOS Trans. American Geophysical Union*, 87(52), Fall Meet. Suppl., Abstract #V23B-0618. Poster

Crosweller, S., Barclay, J., Simmons, P., **Robertson, R.** (2006): Eruption without historical precedent: Mental models of volcanic hazards in the absence of direct experience in Dominica, West Indies. *Managing Volcanic Crises: Effective Integration of Science, Policy and Practise, The UCL Johnston-Lavis Conference 2006*, University College London, 20-21 April September 2006. Poster

Richard R. (2006): The preparation of a Volcanic Hazard Atlas for the Lesser Antilles. Invited talk given at *Science and Policy Interfaces for Disaster Reduction Network Workshop*, School of Environmental Sciences, University of East Anglia, 8 September 2006. Oral

Richard R. (2006): Volcanoes, tsunamis & earthquakes in the Caribbean - The Work of the Seismic Research Unit. Invited talk given at the *BA Festival of Science Workshop on Clear and present*

danger, School of Environmental Sciences, University of East Anglia, 7 September 2006. Oral

Catherine Lowe, Muki Haklay, Bill McGuire and **Richard Robertson** (2006): Mapping Vulnerability, Exposure and risk to Volcanic Hazards with GIS: A study of St. Vincent, West Indies. *Managing Volcanic Crises: Effective Integration of Science, Policy and Practise, The UCL Johnston-Lavis Conference 2006*, School of Environmental Sciences, University of East Anglia, 8 September 2006. Poster

Jessica Roberts, M. Carmen Solana and **Richard Robertson** (2006): Reducing Vulnerability in Islands: The Case of Dominica. *Managing Volcanic Crises: Effective Integration of Science, Policy and Practise, The UCL Johnston-Lavis Conference 2006*, School of Environmental Sciences, University of East Anglia, 8 September 2006. Poster

Technical Reports

Latchman, J. L. (2007): Earthquake and Volcanic Activity in and around St. Vincent. *Prepared for Ing. Leonardo Perez in response to an emailed request for information with regard to the construction of a new international airport in St. Vincent*.

Latchman, J.L., Robertson R.E.A. and Lynch L.L. (2006): Report on the 29th September 2006 near North Coast of Trinidad Earthquake Sequence. *Prepared for the Prime Minister, Ministry of National Security and ODPM as a response to continuing unprecedented, instrumentally recorded earthquake sequences on land Trinidad.*

Papers under review

Fournier N, Witham F, Fournier M, Bardou L High-temperature crater lakes dynamics: bubble driven buoyancy at the Boiling Lake, Dominica, W.I. *Journal of Geophysical Research (submitted)*

Latchman, J.L., F.D. Morgan, and W.P. Aspinall. Temporal changes in the cumulative piece-wise gradient of the Gutenberg-Richter relationship, and the imminence of extreme events. *Earth Science Reviews. (submitted)*.

Rosemarie Mohais and Balswaroop Bhatt, 2007. Heat Transfer through a lava channel with a permeable base. *Journal of Volcanology and Geothermal Research. (submitted)*

Rosemarie Mohais and Balswaroop Bhatt, Heat Transfer of Permeable Discs Rotating in a Magnetic Field. *International Journal of Heat and Mass Transfer. (submitted)*

Other reports and regional journals

Joseph, E. 2007. Sampling of geothermal features in Saint Lucia 20th – 23rd May 2007. *Internal report: Seismic Research Unit*, University of the West Indies, St. Augustine. Trinidad.

Joseph, E. 2007. Sampling of geothermal features in Dominica 4–8th June 2007. Internal report: Seismic Research Unit, University of the West Indies, St. Augustine. Trinidad.

Joseph, E. 2006. Sampling of geothermal features in Dominica 23rd – 29th August 2006. Internal report: Seismic Research Unit, University of the West Indies, St. Augustine. Trinidad.

Erouscilla Joseph 2007. Geothermal Monitoring in the Lesser Antilles: Implications for Volcanic Surveillance. Seismic Research Unit, University of

the West Indies, St. Augustine. Trinidad. Department of Earth Sciences, University of Bristol, UK: 22nd March 2007.

DVDs, television and radio programs

Volcanic Hazard Atlas of the Lesser Antilles, 2007, DVD, Seismic Research Unit, UWI, Edited by Jan M. Lindsay, Richard E.A. Robertson, John B. Shepherd and Shahiba Ali.

Opening photo: Landslip damage in Dauphine, St. Vincent.

Closing photo: The Pitons, Saint Lucia

Projected activities 2007/2008

Distinguished Speaker Series

The Unit intends to propose several names as possible invitees for the UWI Distinguished Open Lecture Series. We hope to bring a leading expert in the field of Quantitative Risk Assessment and Volcano Seismology to share with us and the wider community the use of expert elicitation.

VSAT Network

During 2007, the Unit began a major project to upgrade its seismograph network in the Eastern Caribbean which involved the installation of a VSAT network. This upgrade will be completed early in 2008 along with the complementary upgrade of the seismic data acquisition and processing system. The VSAT network will enable automatic detection and location of earthquakes and will greatly enhance the Unit's ability to provide timely advice on earthquakes throughout the region.

Internal and External Works

Internal modifications to existing buildings will continue in 2007/2008 in an attempt to alleviate our severe office and storage space problems. These will include changes to the patio, workshop and foyer of the building. Attempts will be made to fix a number of long-standing problems with our building such as the leaking roof and falling ceiling tiles. External modifications to the compound will include repair & extension of car park and landscaping of the grounds.

Regional Meeting of Seismic Network Operators

As part of the USAID project to upgrade our seismograph network, a regional meeting of senior seismic network operators will be held during the first quarter of 2008. This will be a follow-up to a previous meeting held in 2006. The major focus of the meeting will be the agreement on a set of protocols to guide the exchange of seismograph data between networks in the Caribbean and adjacent areas.

Strategic Plan

The Unit's Strategic Plan is now being finalised and will be published during the first quarter of 2008. The plan will guide the Unit's operations during the period 2007-2012 and it has been adjusted to take full cognizance of the recently published UWI Strategic Plan.

Collaborations with CDERA

Collaboration with the Caribbean Disaster Emergency Response Agency is at an all time high and the Unit will be working closely with this organisation in the implementation of at least three major projects over the next two years. Attempts will be made during 2007/2008 to strengthen our linkages with the signing of an MoU for continued work and collaborations in the future.

Proposals to the Energy Sector

Following closely on the Unit's participation in the BG T&T Energy Challenge and the contact made with several companies in the Energy sector, the Unit will begin canvassing for support for several project during 2007/2008. At present, proposals have been drafted requesting support for a Geohazards Resource Centre, the development of a Strong Motion Seismograph Network and the development of a Rheology Laboratory at the UWI.

Education and Outreach

The primary focus of the Education & Outreach department for the 2007/2008 academic year is the revision and production of new resource material relating to geologic hazards in the Eastern Caribbean. Some of the proposed activities are as follows:

- Revision of current pamphlets
- Production of pamphlets on additional themes (e.g. volcanic hazards)
- Production of information posters
- Information postcards
- Launch of new website
- SRU orientation handbook
- Posters and images for internal display at SRU headquarters
- Refurbishment of display at Kick 'em Jenny Observatory
- Public awareness campaign for northern Dominica.
- Earthquake safety seminar for Health & Safety personnel in Trinidad & Tobago's energy industry – this is to be coordinated in conjunction with the Office of Disaster Preparedness and Management and bpTT.

Telecommunications

Several changes are currently being implemented in the telecommunications infrastructure used for the receipt and transmission of data. These will continue in 2007/2008 and amongst others it will include the following activities:

1. Upgrade of the internal telephone system operated at SRU including the addition of one new telephone line;
2. Installation of a satellite based broadband connection for reliable transmission and exchange of seismic data;
3. Testing of data transmission speeds and reliability of local high-speed internet service providers.

Electronics technician, Ian Juman, mounts a communication tower during a routine maintenance visit in the field.

Continuous GPS Network

Streamlining of data collection and archiving for the continuous GPS stations operated by the SRU. Preliminary data processing and establishment of procedures for continuous GPS data to be made available to the public will be implemented during 2007/2008.

Staff Training

Attempts will be made to arrange personal and professional development training for staff at various levels at the Unit. This will include in-house training of staff through lectures and short courses delivered by members of the professional staff on all aspects of the operations of the Unit. This will be combined with the service of private companies to present a range of opportunities for staff to develop the capacity required to effectively implement the Strategic Objectives of the Unit over the next five years.

Upgrade of seismograph stations

During the past decade, the Unit has been slowly transforming its seismograph network from an analogue to a digital network. Our plan for the new two years will be to complete the transformation of at least 10 analogue stations in Trinidad and Tobago and to begin the transformation of the other 38 analogue stations in our Eastern Caribbean Seismograph Network. Once the transformation is complete the Unit would have made the leap into the digital era with a number of benefits in terms of the products it can deliver to stakeholders in the Eastern Caribbean.

Upgrade of the ICT infrastructure

The fundamental shift that is currently taking place

in the Unit's seismograph network to a digital real-time network; the increased number of continuous GPS stations and our plans for integration of other monitoring data (e.g. cameras) has necessitated the upgrade of the local area network and basic ICT infrastructure at the Unit headquarters in Trinidad. Some of this will begin 2007/2008 but it will be completed during 2008/2009. Once completed the Unit will be able to adequately manage the large quantity of high quality digital data that will increasingly be acquired in the future.

Provision for additional staff

The increased number of remote monitoring stations and the move towards the digital era requires additional staff with specialisation in computing and electronics. We propose recruiting two staff members over the next 2 years; one professional IT Specialist/Software Engineer and one Electronics/Computer technician. A request has been made for adjustments to the recurrent budget from 2008 and 2009 for the technical position and professional position respectively.

Improvement in Security

A new internal alarm will be installed with provision for coverage to the second building on the compound which currently houses post-graduate students. Arrangements will be made with a private security firm to provide on-site security during public holidays and after regular working hours.

Opening photo: Sulphur deposits at Sulphur Springs, Dominica.

Closing photo: The Quill volcano, St. Eustatius

UWI
SEISMIC RESEARCH UNIT
St. Augustine, Trinidad and Tobago, W.I.
Tel: (868) 662-4659 • Fax: (868) 663-9293
Email: uwiseismic@uwiseismic.com
www.uwiseismic.com