

## EARTHQUAKE UNIT



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**Head of Unit**

### **INTRODUCTION**

The Earthquake Unit (EQU) is a research unit in the Department of Geography and Geology that is funded directly by the Government of Jamaica (GOJ) as the sole agency responsible for the monitoring of earthquakes and research in seismic hazards in Jamaica. The EQU budget is supported by the Government of Jamaica with allocations through the Ministry of Science Technology Energy and Mining (MSTEM). The budgetary allocation to the EQU by the GOJ during this financial year amounted to J\$29,995 million. This has put the EQU in a position to improve its network to a fully digital network.

### **WORK OF THE UNIT**

The addition of another broadband seismometer during this period to the Jamaica Seismograph Network now puts the unit in a position to

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operate fully as a digital network. The short period network is now being phased into a secondary network acquisition source of the Jamaica Seismograph Network.

As part of this improvement a digital radio link was built from MBJ (Kempshot-Montego Bay St. James) via Ayr Hill and Cooper's Hill to UWI as a means to improve data transfer between Montego Bay and UWI. This radio link was through the assistance of the Aeronautical Telecommunications Limited Jamaica (AEROTEL). With this broadband network the EQU is now using Seiscomp3 software for the earthquake data analysis solutions (preliminary solutions -testing phase). Earthquake events can be done and bulletins provided to relevant persons and the media within a few minutes of the event then later can be rechecked for accuracy by the Seismic Analyst as is done in bigger modern networks. The EQU is now sharing real-time data with International Seismic networks such as Incorporated Research Institute of Seismology (IRIS), regional seismic networks such as the Puerto Rican Seismic Network and the Cuban Seismic Network as broadband data is accessible real time from the EQU network.

The seismic site effect/microzonation of Kingston has now been completed and also the update of Probabilistic Seismic Hazard Maps for Jamaica. These are very significant developments for engineering designs and the update of the seismic code that is of national significance. All these data and maps are available at the EQU and also in peer reviewed journals.

The EQU is now paying serious attention to the installation of strong motion seismometers (accelerometers) in critical facilities across highly populated centres across the island. The accelerometers record ground response after major earthquake events and will provide data to better understand site specific ground response in order to improve seismic microzonation and the building code. Instruments located on buildings can be used as tools for providing retrofitting assessment in the event of a major damaging earthquake.

The EQU has acquired funding to add eight (8) accelerometers to the Jamaica Strong Motion Network. Two (2) of these instruments were

acquired through a collaborative proposal with the Seismic Research Centre (SRC) in St. Augustine to the Caribbean Catastrophe Risk Insurance Facility (CCRIF) with an objective to strengthen and support the strong motion network in the Caribbean in order to better evaluate and mitigate seismic risks in the Eastern Caribbean and Jamaica. Location for the installation of these instruments has already been determined with one instrument for the Kingston Container Terminal and the other in the Long Mountain. The idea behind these locations is to monitor ground motion on a hard rock site (Long Mountain) and a soft rock site (Kingston Container Terminal). This data will be invaluable to engineering designs. Funding of the other six (6) instruments came through the Office of Disaster Preparedness and Emergency Management (ODPEM). The location of these instruments has also been determined with two (2) to be placed on the ODPEM building, two (2) at the Kingston Hospital and the other two (2) instruments will be located at the Portmore HEART Academy. It is expected that these instruments will be delivered by the end of 2013. The installation of these instruments should bring the network to sixteen instruments scattered across the island mostly in Kingston. These instruments operate in a standby mode and start recording when triggered by earthquakes typically greater than magnitude 3.5. They are very important in acquiring data that are used in seismic hazard assessment, studying the response of sites to ground shaking and provide parameters to be used in constructing or retrofitting important structures.

The project towards the monitoring of the fault activity is now being supported by the three (3) permanent GPS stations; a part of the United States funded University Consortium (UNAVCO) Caribbean Continuously Operating GPS Network (COCONET). In addition, data is now being provided to this project by the National Land Agency from their thirteen (13) permanent GPS stations, a part of their Land Administration and Management Project (LAMP). Data from these instruments are shared with the EQU collaborators and then incorporated with the data obtained from the other thirty-six (36) points that are currently monitored under the “Measuring slip rates on local and regional faults” project through collaboration with geophysicist Chuck De Mets from the University of

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Wisconsin. Throughout this year efforts have been made to ensure that the GPS instruments located on Pedro and Morant Cays are functioning. A number of maintenance trips were made to these cays with the assistance of the JDF Coast Guard and the Port Authority of Jamaica. The JDF and the Port Authority of Jamaica continue to pledge support to the EQU to ensure that maintenance trips to the instruments on the cays will be supported.

Continued sonar mapping and liquefaction assessment of the Kingston harbour and Port Royal, respectively occurred in January with a group from the Southern Methodist University, Dallas Texas. We also did further sonar mapping in St. Thomas. In this project a number of gravity cores were obtained to date the history of tsunami deposits in the Kingston Harbour which are evident on sonar profiles. The analysis of these cores is expected to be completed by December.

With the funding of new equipment to the Comprehensive Test Ban Treaty Organization's (CTBTO's) National Data Centre (NDC) at the Earthquake Unit during last year, installation of this hardware was done during the course of this year. A training course on the "NDC in a box" for processing of the CTBTO data at the National Data Centre (NDC) was also done during the installation by the visiting engineer from the CTBTO.

The Jamaica Seismograph Network continues to operate at a reasonably efficient level; however, there are challenges in getting the stations to work at full efficiency due to shortage of spares and also due to acts of nature such as the most recent Tropical Storm Sandy, lightning damages and technological issues. However, we are always working assiduously to mitigate and repair within an acceptable time frame. The network saw some improvement in the infrastructure at a number of the seismic stations as follows:

**Yallahs (YHJ):** Antenna heightened – resulting in an improvement in the digital link to the Central Recording Station at the EQU Unit.

**Bamboo (BBJ):** The addition of a 130 watts solar panel and installation of equipment in a housing (built by EQU but fell into disrepair through

nonuse) that was recently repaired. This allows the station to operate independently of Aerotel which owns and operates a telecommunication network at this location. The EQU was dependent on Aerotel for providing electrical power and storage of the EQU equipment.

**PIKE (CVJ):** Seismic equipment was transferred outside of Aerotel housing to a concrete pad that was constructed at the same location. A two inch galvanized pole for the antennas was installed closer to the enclosure with lightning and grounding rod installed. All the equipment including the GPS NETRS receiver and seismometer are now installed in this new fiberglass housing.

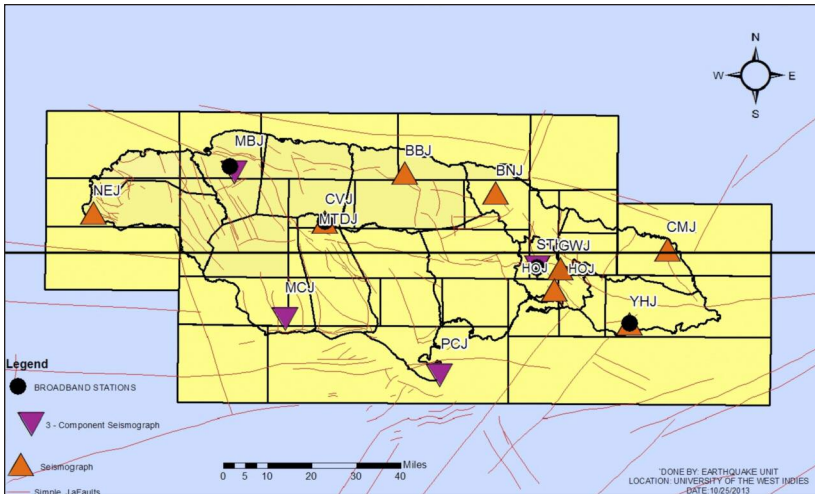
**MONTEGO BAY, KEMPSHOT (MBJ):** MBJ was upgraded to a new six channel digital station with the installation of a broadband seismometer, accelerometer with a digitizer and communication module.

The Earthquake Unit also saw the addition of two new members of staff, both short term employments: Ms. Zeaundra Gayle and Mr. Travis Edwards, both worked as GIS officers. Ms. Gayle is no longer with the unit; however, Mr. Edwards, who started as part of an internship programme by UTech, continues to work as a part time staff to assist with GIS and mapping needs.

## **OUTREACH ACTIVITIES**

A number of primary and high schools visited the EQU, totaling 497 students and 29 teachers. The Seismic Analyst and Education Officer provided presentation to the visitors on the operation of the Seismic station and also information on Jamaica's seismic activity earthquake awareness. Visitors included students from the teachers colleges, UTech and UWI. The presentation and visits are all designed to complement the curriculum in the primary and high schools and also provide tertiary students with resources for research papers and thesis. Members of staff of the EQU also visited a number of private sector organizations, community organizations, colleges and expos to educate the public in an effort to fulfill its mandate towards educating the society about seismic occurrence and vulnerability.

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**Figure 1:** Location of seismic stations that forms the Jamaica Seismograph Network (JSN). Location of the analog short period seismographs, 3-component seismograph and the updated digital broadband seismometers are shown. Stations are shown in relation to the JSN subarea division and the lineations of the dominant faults in Jamaica.

The EQU Library now has a list of its collection in a database online so that the wider university community can have information on the holdings of the EQU and can visit the unit to use any of this collection. The focus is the development of a collection that can attract students and the wider community to utilize the resources of the EQU.

There were also several media interviews and forum to discuss matters relating to earthquake and development.

### **EARTHQUAKES RECORDED**

The JSN saw slightly higher numbers of earthquakes recorded this year with an additional fifteen percentage (15%) increase in the number of events. Similarly, an increase in the number of felt events during the period also shows an increase of forty-five (45%) percent. However, in real numbers thirteen (13) felt events occurred this period as against nine

(9) from last period. No distinct trends were seen along any fault line although in areas such as the south-western end of the island along the Montpellier-Newmarket subarea an increase in the activity was seen. Some of these events could also be attributed to aftershocks from the largest event recorded (Magnitude 4.2 ) during this period that had an epicentre in this subarea.

In total the JSN recorded and processed two hundred and sixty seven (267) events, twenty two (22) of which were determined to be blasting events. Of the remaining two hundred and forty five (245) earthquakes during this period (August 2012–July 2013), only one hundred and one (101) were local events. (See table 1).

**Table 1:** Events recorded by the Central Recording Station at the EQU, of the 101 local events, only 13 were felt.

#### Earthquake Event Summary, August 2012–July 2013

Year	Month	Located Events			Recorded Events					Total recorded	Felt Event
		Local	Near	Total located	Local	Near	Regional	Distant	Blasts		
2012	Aug	6	0	6	6	0	8	1	3	18	1
2012	Sep	9	4	13	9	4	11	0	0	24	0
2012	Oct	3	4	7	3	4	9	0	2	18	1
2012	Nov	12	3	15	12	3	11	0	2	28	0
2012	Dec	12	3	15	12	3	10	0	1	26	1
2013	Jan	4	1	5	4	1	4	0	1	10	0
2013	Feb	15	6	21	15	6	5	0	2	28	3
2013	Mar	5	5	10	5	5	7	0	3	20	1
2013	Apr	8	6	14	8	6	7	1	3	25	1
2013	May	11	4	15	11	4	7	1	1	24	1
2013	Jun	8	5	13	8	5	7	0	4	24	2

The earthquake activity along subareas follows previous trends. The most active sub-area (as seen in Figure 2) was the Blue Mountain Block followed by Rio Minho–Crawle River Fault and the Montpellier-Newmarket Fault. There were thirteen (13) felt earthquakes during this period with the largest local event on February 10. There were at least two aftershocks recorded in the same area on that morning; however, there were no reports of damages associated with this event. Figure 3 shows the location of earthquake events across the island.

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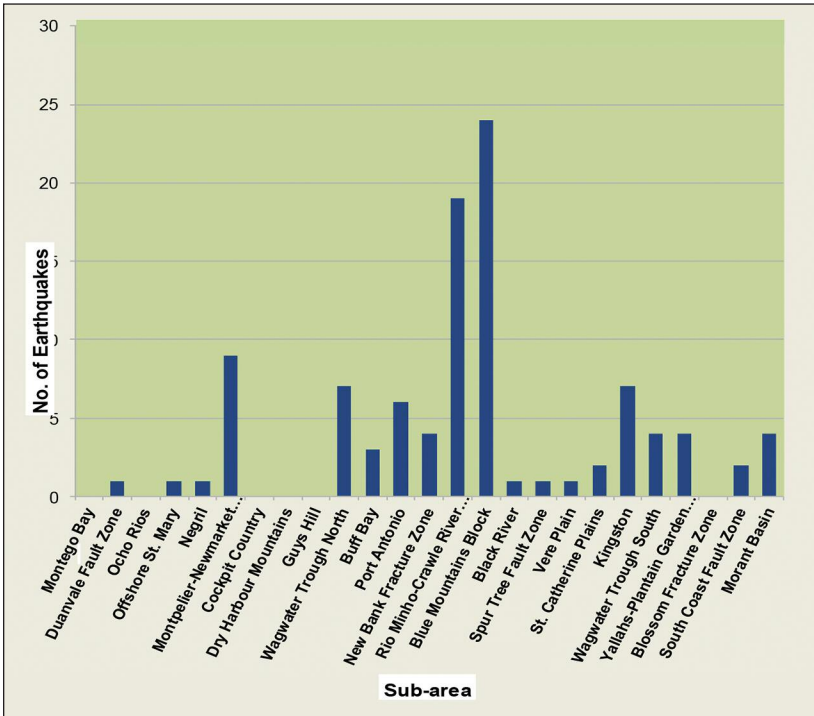


Figure 2: Seismic activities in the Jamaica local sub-areas for August 2012–July 2013.

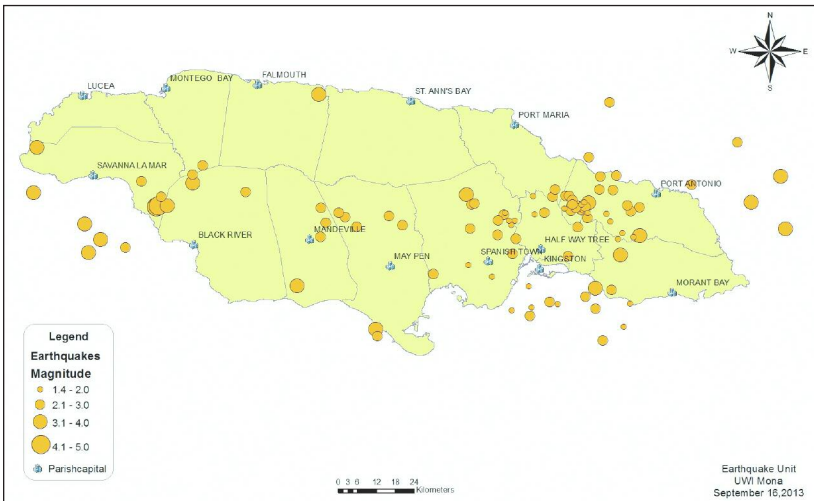


Figure 3: Seismic activity within the local region sub-areas of Jamaica during the period of August 2011–July 2012. Felt events are typically magnitudes greater than 3; bulletins for these events are provided to the media.



## **PRESENTATIONS**

### **Lyndon Brown (Research Fellow/Head)**

- Brown, L. Blake, S., Murray. D.; “Seismic vulnerability of critical facilities in Jamaica; Rapid Visual Screening of Fire Station in Kingston & St. Andrew” Jamaica Institute of Engineers Conference, Kingston, September 2012, 10 p.
- December 2012: American Geophysical Union (AGU) Annual Conference: San Francisco December 2012: “Key geophysical indicators of seismic vulnerability in Kingston, Jamaica”. December 2012.
- Cuba: ICTP activity in Santiago de Cuba: Status of Research on the Gonave Microplate. Implications for Seismic Vulnerability in the Region. December 2012.
- “Jamaica’s vulnerability to earthquakes with particular emphasis on the newly discovered fault in Kingston Harbour”. ODPEM symposium, UWI. February 2013
- Seismic Vulnerability of Kingston – latest research findings. Grace Kennedy, July 2013.

### **Paul Williams (Network Manager/Engineer)**

- Poster – “Use of Alternative Energy at EQU”. UWI Research Day: February 2012.

### **Karlene Black (Education Officer)**

- Earthquake Summary poster for 2012, Earthquake Awareness Week, ODPEM and Research Day, UWI. January 2012.
- “Towards An Earthquake And Tsunami Ready Nation”. ODPEM Earthquake Awareness Week Symposium, January 24, 2013.
- The Development Gap Health Fair: Brooks Park, Mandeville. February 2, 2013
- Manchester Local Sustainable Development Plan – 2030. The

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Healthy Lifestyle Fair was organized in collaboration with RADA.

- National Minerals Week Expo: National Minerals Week Expo, Ministry of Science, Technology, Energy and Mining (MSTEM). June, 28–29, 2013
- “Seismic Risk in Jamaica” at the Seminar on Humanitarian Aid and Civil Protection Department of the European Community Humanitarian Office (ECHO) as part of the Disaster Preparedness European Community Humanitarian Office DIPECHO Action Plan for the Caribbean 2011–2012. Challenges & experiences in seismic risk reduction in the Caribbean, Santo Domingo, Dominican Republic. August 8–10, 2012.
- ODPEM workshop ‘Introduction to damage assessment and needs analysis visual application (DANAVISUAL)’. August 22, 2012
- HelpAge International /DIPECHO National Country Risk Management Profile (Country Document) Consultation “Helping Vulnerable Populations and Communities to Manage Risks associated with Hurricanes and Floods”. August 29, 2012.
- Haiti Meetings Re: Gem and Polytechnic University of Madrid Collaboration Project. March 11–12, 2013.
- Global Earthquake Model (GEM) and the Polytechnic University of Madrid, Spain through the Haitian collaboration of the National Environmental agency in Haiti, (ONEV).

### **Raymond Stewart: (Seismic Analyst)**

- Earthquake presentation at the Mary Seacole Hall. October 20, 2012.
- Climate change Education Expo, A GOJ/EU/UNEP Climate Change and Adaptation and Disaster Risk Reduction. April 20, 2013
- Attended ODPEM’s disaster preparedness expo in Port Maria, St Mary. June 27, 2013.

## **PUBLICATIONS**

### **Referred Journals**

- W Salazar, L **Brown.**, and G Mannette. “Probabilistic Seismic Hazard Assessment for Jamaica”. *Journal of Civil Engineering and Architecture*, (2013) Vol. 7, No. 9 (Serial No. 70), pp. 1118–1140., USA.
- W Salazar, L. **Brown.**, W Hernández, and J Guerra. “An Earthquake Catalogue for El Salvador and Neighboring Central American Countries (1528-2009) and Its Implication in the Seismic Hazard Assessment”. *Journal of Civil Engineering and Architecture*, (2013) Vol. 7, No. 8 (Serial No. 69), pp. 1018–1045, USA.
- R. Koehler, P. Mann, C. Prentice, L. Brown, B. Benford, M. Grandison-Wiggins: “Enriquillo-Plantain Garden fault zone in Jamaica: paleoseismology and seismic hazard”. *Bulletin of the Seismological Society of America* (2013) Vol. 103, No. 2A 971–983.

### **Technical Report**

- L. Brown, Seismic Microzonation of Falmouth (July 2013): ODPEM supported project.

## **TRAINING AND PERSONAL DEVELOPMENT**

### **Dr. Lyndon Brown**

- CTBTO: Surrogate Inspector Training Exercises
- Surrogate Inspectors Health and Safety Training Exercise. November 2012:
- Build Up-Exercise (Simulation) for CTBTO Exercise in Jordan 2014. May–June 2013.

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### Ms. Karleen Black

- CTBTO, One Month Analyst Training Course. April 2013.

### Mr. Raymond Stewart

- Attended the CTBTO two weeks Regional Training Course on NDC Capacity Building in Vienna, Austria. Accessing and analysis of waveform data and International Data Centre (IDC) products. June 3 –4, 2013.

### **FUNDING EXTERNAL/CONSULTATIONS**

Local Consultation: \$J220,000

ODPEM: \$US47,549.00

### **COMMUNITY SERVICE**

The Earthquake Unit works in close collaboration with ODPEM and the Jamaica Institution of Engineers in disseminating the findings of research. The EQU also provides information/advice that is of national significance to both institutions.