

REPORTING PERIOD: 1 AUGUST 2018 - 31 JULY 2019

1. Director's Summary

The UWI Seismic Research Centre (SRC) is the regional institution responsible for surveillance of and fundamental research into volcanoes and earthquakes for the English-speaking islands of the Eastern Caribbean. The SRC provides the governments of its 9 contributing territories¹ with accurate and up-to-date information about earthquake, volcanic and other geologic activity, including 19 live volcanoes, in the Eastern Caribbean. The Centre has been providing these services for over 65 years. Its work has and will continue to have direct impact on vulnerable island communities throughout the Eastern Caribbean. All aspects of the work undertaken by the SRC are of direct and immediate relevance and importance to public safety and sustainable development in the region.

The income received from our contributing territories continue to be inconsistent and provide only sufficient funds for routine monitoring (i.e. operation of a minimal seismic network). We continued to lobby vigorously during the year for payment of outstanding debts. All other work, including most research, major developments in the network and outreach, were undertaken through grant funding mainly from external sources or from applications to the SRC Departmental Consultancy Fund (DCF).

Geologically the high level of seismicity being seen in recent years, in the Eastern Caribbean, persisted. The seismograph network recorded more than 11,000 earthquakes, which includes more than 4,600 low magnitude volcanic earthquakes, occurring in the area of responsibility. Locations were determined for about 2,420 earthquakes, with magnitude greater than 2.0. At least 46 of these events were reported felt. The largest earthquake for the period occurred west of Trinidad, on 2018/08/21, and was of magnitude 6.9. It was felt from as far south as Suriname and as far north as Dominica. The event caused damage to some structures and was associated with a large-scale ground failure episode in Los Iros, Trinidad. The second largest event, at magnitude 6.0, was in the aftershock sequence of the

¹ St. Kitts & Nevis, Antigua & Barbuda, Montserrat, Dominica, Saint Lucia, St. Vincent & the Grenadines, Barbados, Grenada, Trinidad & Tobago

magnitude 6.9 earthquake and occurred, approximately 16 hours later, on 2018/08/22. Our region has not seen its largest earthquake for well over 150 years. Since 2013, there has been a rate increase in earthquakes of magnitude greater than 6.0 and background seismicity in the region appears to be intensifying. It for this reason that we seek to foster collaborations that allow us to enhance our monitoring and seismic hazard and risk capability, take an active role in promoting the development and legislation of Building Codes and our Education and Outreach thrust is being maintained at a high level.

It should be noted that volcanic earthquakes were generated in two unrest episodes: one at the Kick-‘em-Jenny submarine volcano and the other, still on-going, in southern Dominica. Volcanoes in the region, other than the two discussed above, exhibited background levels of activity during the reporting period. Activity at the Soufrière Hills Volcano in Montserrat, which is now at a low level, continues to be closely monitored by the Montserrat Volcano Observatory.

2. Report

A. STAFF

Appointments

- Dr Patrick Smith, Research Fellow (Seismologist) resigned effective February 8, 2019.
- Mr. Kisira Odero assumed duty as an IT Officer II on June 6, 2019.

Awards

- December 2018: Celebrating UWI Women – a UWI 70th Anniversary project award. IGDS Awardee for the year 2008 “Trailblazer of Volcanology for Tourism” to Dr. Erouscilla Joseph (Research Fellow, Volcanology).
- April 2019: Dr Roderick Stewart was appointed Honorary Fellow of the University of Edinburgh.

B. STUDENTS

Postgraduate Programme

During the reporting period the SRC's Postgraduate programme expanded with a total of nine (9) postgraduate students employed as Research Assistants working on projects that contribute to our key areas of research and monitoring. Of these, three (3) were registered for postgraduate degrees in Seismology and four (4) for postgraduate degrees in Volcanology. The other two (2) postgraduate students were part of joint projects in collaboration with the Departments of Geography and Engineering.

Creating Opportunity from Research Experience (C.O.R.E.) Internship

The C.O.R.E internship for tertiary level students interested in pursuing geoscience careers at the end of the 2018 academic year (June-August) was again advertised. Three interns were selected and had an opportunity to work closely with a supervisor on a specific subject along with time in each department at the Centre and at the MVO. At the culmination of the time period, the interns presented on the work they undertook and any new findings and results.

C. RESEARCH & INNOVATION

Volcanology

- i) **Disaster risk management in the Caribbean, support for the Seismic Research Centre.** This project funded by the Government of New Zealand through its Ministry of Foreign Affairs and Trade was extended by one year to allow completion of all activities. It involves GNS Science of New Zealand helping the SRC to build capacity in: a) continuous monitoring of volcano-hydrothermal systems using remote techniques; b) ground deformation monitoring using remote sensing and c) improved alerting systems for volcanic emergencies.

The prototype volcano-hydrothermal monitoring stations have since successfully been tested in New Zealand at White Island and Te Maari with the parameters of temperature and water levels of pools being monitored. The pilot "hydrothermal

station” will be installed at Sulphur Springs in St. Lucia during the 1 - 15 December, 2019. (Project team members Dr. E. Joseph and Dr. G. Ryan)

- ii) **Geochemistry and microbial ecology of hydrothermal areas in Dominica, Lesser Antilles.** (CRP.3.MAR19.4) Funding: TT\$44,700.00 (Principal Investigator Dr. E. Joseph). The SRC is also collaborating with the Department of Life Sciences (Professor Jayaraj Jayaraman and Dr. Adesh Ramsubhag) to study the relationship between the geochemistry of hydrothermal gas and waters at various hydrothermal areas of Dominica in relation to the microbial ecology that exists at these sites. The results of this study will help contribute to the monitoring of chemical changes in hydrothermal fluids at geothermal systems in Dominica, as well as to identify microbiotic species with the potential for bioprospecting.

- iii) **UK Global Challenges Research Fund (GCRF). Caribbean Resilience and Recovery Knowledge Network.** Funding: £144,963.00 (Project partner: Dr. Erouscilla Joseph) The SRC will contribute to the GCRF Caribbean Resilience and Recovery Knowledge Network in collaboration with Dr. Emily Wilkinson (Overseas Development Institute) and Dr. Donovan Campbell (UWI, Mona). The overall aim of the Caribbean Knowledge Network is to create a new culture for responding to and preparing for hazardous events; one that promotes sustainable and equitable recovery and resilient development pathways in Caribbean islands. Three key activities will all happen in the region: a forensic workshop, scenario roadshows and an interdisciplinary webinar series. New knowledge will be co-produced between the research, practitioner and policymaker communities. This will take the form of policy briefs, scenario exercises, new (bespoke) principles and strategies for disaster recovery and new research manifestos and proposals.

- iv) **Volcano-Ready Communities in St. Vincent.** (Project leader Prof. R. Robertson) This is a project funded by a grant of US\$618,700 from the Community Disaster Risk Reduction Fund administered by the Caribbean Development Bank that is being done in St. Vincent in collaboration with the National Emergency

Management Organization of St. Vincent and the Grenadines. It involves the provision of scientific information and its downscaling to support community level volcano contingency planning, community-led multi-hazard mapping and capacity building for disaster risk reduction

- v) **InSAR monitoring of volcano deformation.** Dr. Victoria Miller (Project partner) completed a research project with collaborators at Geoscience Australia, Rabaul Volcano Observatory, Icelandic Meteorological Office and Curtin University to develop the methodology and code to incorporate InSAR monitoring of volcano deformation into operational capability at volcano observatories, with a particular emphasis on applicability in a resource-constrained context. A simplified approach to operational InSAR monitoring of volcano deformation in low- and middle-income countries: Case study of Rabaul Caldera, Papua New Guinea. The project is the first step towards volcano monitoring of 40+ active volcanoes in Papua New Guinea that currently have no ground-based monitoring systems in place. Publication of the method provides an opportunity for other volcano observatories to explore the potential application of these tools for their operational requirements.

- vi) **Quantitative methods for hazard assessment at the Soufriere Hills Volcano, Montserrat.** Dr. Victoria Miller (Principal Investigator) is leading a research project to employ quantitative methods for hazard assessment at the Soufriere Hills Volcano, Montserrat. A new hazard map will be developed in collaboration with researchers at The University of Edinburgh, scientists at UWI-SRC and the Government of Montserrat, with a focus on pyroclastic flows and lahars, to differentiate hazard levels within the existing Zone V (exclusion zone). The microzonation of Zone V will provide input to risk assessment for the volcano and an evidence base for decision-making regarding access management and long-term development planning on the island of Montserrat.

Geophysics

- i) The UWI SRC Geophysics team continues this year to work on the **Trinidad & Tobago Microzonation project (TTMP)**, funded by the Ministry of Planning &

Development. The area of investigation this year is Diego Martin basin, and operations included extensive geological surveys and geophysical prospecting. The team also got involved in the archaeometric investigation of the Banwari Burial Heritage Site in St. Francique, Siparia. Operations started in February 2019 and are expected to conclude in September 2019, and a comprehensive report to be submitted to The National Trust of Trinidad & Tobago early in 2020. (Project leader Dr. I. Papadopoulos).

- ii) The UWI SRC continues to expand the **urban strong-motion network** with additional installations of stations in Port of Spain and Diego Martin. Currently there are eight stations in Port of Spain and one in Diego Martin, recording continuously the seismic activity and online streaming data back to The UWI SRC. (Project leader Dr. I. Papadopoulos).

- iii) The section designed and implemented a **GPS campaign at Los Iros**, Trinidad to measure post-earthquake ground motion using GPS measurements. Student research included the use of LANDSAT thermal infrared data to determine surface temperatures and thermal output of the Sulphur Spring geothermal system in St Lucia, petrophysical measurements, modelling volcanic deformation in the Eastern Caribbean and investigating ongoing deformation of the Los Iros slump using static GPS observations. (Project leader Dr. G. Ryan).

D. OUTREACH

The Education and Outreach section aims to bridge the gap between the science of the geological hazards monitored by the Centre and public understanding and knowledge of these phenomena in the region. The magnitude 6.9 earthquake on August 21st, 2018 prompted a Facebook Live session where we provided information to the public regarding the event. A press conference was held at the Centre the following day and media

interviews were conducted by staff throughout the region while infographics and other material were shared on our social media pages and website.

In Trinidad and Tobago, seven student outreach sessions were conducted at locations throughout the island for the reporting period. Tours to the Centre recommenced in the last quarter of 2018 and seven institutions visited the Centre. Science and safety sessions were given to organizations at their request inclusive of The UWI Department of Pre-Clinical Sciences and The UWI Open Campus Saint Lucia. Earthquake sensitization workshops were continued with various local government Disaster Management Units led by SRC Research Fellow, Dr. Papadopoulos. Guest lectures were given by members of staff to students of the Departments of Physics and Geography. In light of the magnitude 6.9 event, the Centre partnered with the Human Resources department to conduct an 'Earthquake and Mental health' seminar for The UWI St. Augustine staff at the Alma Jordan Library.

Special collaborations and projects locally and regionally included the Seismology in Schools (SIS) with NIHERST (inclusive of a week-long internship at the Centre for five 4th Form students), the Trinidad & Tobago Mall Tour, Volcano Awareness Week (St. Vincent), Earth Science Week (Saint Lucia), Earthquake and Tsunami Week (Barbados), Earthquake and Tsunami Week (St. Kitts and Nevis) and the Centre's annual 8-week internship programme, C.O.R.E (Creating Opportunity from Research Experience).

Cassie Roopnarine interned at the Montserrat Volcano Observatory and worked on a project entitled "GPS surveying of volcanoclastic deposits at Soufrière Hill Volcano Montserrat" and was co-supervised by Dr Karen Pascal and Dr Victoria Miller, with additional support provided by Dr Stuart Hatter and other members of staff at the Montserrat Volcano Observatory. At the Centre, Ms Aruna Kudan worked under the supervision of Dr Erouscilla Joseph on a project looking at 'Investigating the potential for modelling volcanic gas plumes using passive diffusion tube measurements' at the Sulphur Springs, St. Lucia. Ms J'velle Holder joined the TTMP research team and undertook data measurements to attempt to 'Quantify liquefaction potential in urban Trinidad' with Dr Ilias Papadopoulos acting as her supervisor.

The section continued to monitor and populate its social media pages by creating engaging posts, producing scientific and safety videos and conducting live videos sessions during periods of elevated seismicity or volcanic unrest that allowed real time engagement between the scientists and the public within the region and the Caribbean diaspora.

E. STRATEGY REVIEW

Please see Appendix I:

3. Distinguished Visitors

- The Honourable Prime Minister Dr. Keith Rowley
Prime Minister of Trinidad & Tobago
- Professor Willy Aspinall
Emeritus Professor
School of Earth Sciences
University of Bristol, UK.
- Prof. Stephen Hailes
Head of Department
Department of Computer Science
University College London (UCL), UK
- Dr. Hazel Napier
Team Leader, Geoscience & Society
British Geological Survey, U.K.

4. Public And Professional Staff

- Dr. Victoria Miller, Chair, IAVCEI – INVOLC (International Network for VOLcanology Collaboration)² . Dr. Miller secured several grants (IUGG, IAVCEI, VUB, UWI) that facilitated the hosting of an international workshop at UWI, St.

² Aligned to AG2.

Augustine, 4-7 June 2019 entitled “Fostering developed-developing country partnerships for the advancement of global volcano science.” The workshop brought together 25 volcanologists from 20 countries worldwide to conduct an assessment of the needs and expectations of volcanologists in low- and middle- income countries (LMICs) and to formally define the goals, functions and composition of a new international network to support volcanologists in LMICs. The outcomes of the workshop directly fed into the proposal to establish a new network within IAVCEI with the aim of supporting scientists working in a resource- or technology-constrained context e.g. LMICs. A report on the findings of the workshop has been written and made available publicly. Dr. Miller, as chair of the IAVCEI-INVOLC, led the development of the funding proposals and the proposal to IAVCEI to incorporate the new network. The network (INVOLC) was officially inaugurated as part of IAVCEI in July 2019. INVOLC has been established with the aim of “Fostering Cross-Country Partnerships to Overcome Challenges in Resource-Constrained Settings for the Advancement of Global Volcanology.” The enablement of respectful partnerships between scientists in different countries will promote both the creation and sharing of information, knowledge and tools in a sustainable way to bridge the gap in these data-sparse regions, and ultimately support global volcanology more broadly.

Appendix I: Report submitted to the Bursary for the Biennial Estimates 2020/2021-2021/2022

In addition to routine monitoring operations, the key projects with which the Centre was engaged during the period are summarized below with an indication of their alignment with the University's 2017-2022 Strategic Objectives provided in the footnotes. *All of these projects are ongoing and will continue during the 2019/2020 period.*

1. **Management of the Montserrat Volcano Observatory³**. Successful execution of the new contract signed in 2016 for the management of the Montserrat Volcano Observatory continued. The contract is for a **fixed sum of EC\$17.9 million** and largely supports the employment of 8 members of staff (6 based at MVO and 2 at SRC).
2. **Seismic Microzonation Studies in Trinidad and Tobago⁴** – This Ministry of Planning and Sustainable Development, Government of Trinidad and Tobago funded project continued with the collection of data moving to the Diego Martin area. It caters for microzonation of ten major population centres in Trinidad and Tobago over the next 10 years and has a total budget of **US\$1.7M**.
3. **C.O.R.E. (Creating Opportunity from Research Experience) Programme⁵**. This is the SRC annual summer internship program for highly motivated university level students interested in pursuing geoscience careers. The programme is **funded entirely** from the **SRC Departmental Consultancy Fund** and caters for up to three interns spending 2 months attached to the SRC either based in Trinidad or at the Montserrat Volcano Observatory.
4. **Disaster risk management in the Caribbean, support for the Seismic Research Centre⁶**. This project funded by the Government of New Zealand through its Ministry of Foreign Affairs and Trade was extended by one year to allow completion of all activities. It involves GNS Science of New Zealand helping the SRC to build capacity in: a) continuous monitoring of volcano-hydrothermal systems using remote techniques; b) ground deformation monitoring using remote sensing and c) improved alerting systems for volcanic emergencies.
5. **Seismology in Schools project⁷**. This is an ongoing collaboration with NIHERST, Trinidad that involves several involving UK based researchers from Imperial College, London; Durham University; British Geological Survey.
6. **Montserrat Geothermal Project⁸**. This is a multiple component project involving the analysis of drill cores and modelling of the Montserrat geothermal system by various techniques. Funding is from various sources including DFID, Campus Research Fund and SRC DCF.
7. **VOILA (Volatile recycling at the Lesser Antilles)⁹**. This is a collaborative project with several UK institutions (including Bristol, Durham & Imperial College). It involves deployment of Ocean Bottom Seismometers and the conduct of active source experiments to collect a series of seismic profiles across the plate boundary.

³ Aligned to AC3 through expansion of CORE internship to MVO & AG2 through consultancy funding received.

⁴ Aligned to AC4

⁵ Aligned to AC3

⁶ Aligned to AC4

⁷ Aligned to AC3

⁸ Aligned to AC4

⁹ Aligned to AC4

8. **Volcano-Ready Communities in St. Vincent**¹⁰. This is a project funded by a grant of **US\$618,700** from the Community Disaster Risk Reduction Fund administered by the Caribbean Development Bank that is being done in St. Vincent in collaboration with the National Emergency Management Organisation of St. Vincent and the Grenadines. It involves the provision of scientific information and its downscaling to support community level volcano contingency planning, community-led multi-hazard mapping and capacity building for disaster risk reduction.

Main objectives for the current academic year and planned activities for 2019/2020 and 2020/2021 indicating their alignment with the University's 2017-2022 Strategic Objectives

The income received from our contributing territories has been inconsistent (TT\$5.5-11.6M during the period 2008-2018) and provide **only sufficient funds for routine monitoring (i.e. operation of a minimal seismic network)**. **All other work**, including most research, major developments in the network and outreach, **has to be undertaken through grant funding mainly from external sources or from applications to the SRC Departmental Consultancy Fund (DCF)**.

In addition to routine monitoring operations and continuing of ongoing projects previously listed, the main new areas with which the Centre will be engaged during the 2019-2021 period are summarized below with an indication of their alignment with the University's 2017-2022 Strategic Objectives in footnotes.

- I. **Establish a communications hub co-located with a multi-parametric monitoring station (consisting of 3-component broadband seismic station, accelerometer & continuous GPS station) at Mt. St. Benedict's**¹¹. This will involve the construction of a vault, erection of a communications tower and installation of seismic monitoring equipment. This work is being **entirely funded** from the SRC Departmental Consultancy Fund.
- II. **Explore options for developing and expanding work in terms of geothermal consultancy services**¹². This will involve an investigation of the demand for and requirements of providing professional services to geothermal production companies in the Eastern Caribbean.
- III. **Ongoing improvement of existing facilities for post-graduate students**¹³ including new offices, improvements in library services, support and encouragement to attend on overseas conference per year, training in monitoring techniques, attachment to the Montserrat Volcano Observatory and accessing funds for attachments to collaborating Universities for specialized training.
- IV. **Finalize the outfitting and occupation of the entire new SRC building**¹⁴. This includes a) provision of space for postgraduate students and the Education and Outreach section; b) provision of space for lectures and c) transferral of our existing IT server room to the new building. We anticipate that we can raise sufficient funds from our DCF to enable these activities to be undertaken. It should be noted that thus far the entire outfitting and

¹⁰ Aligned to AC4, AL3 & AG2

¹¹ Aligned to AC4 & AG5

¹² Aligned to AC2, AC4 & AG2

¹³ Aligned to AC3

¹⁴ Aligned to AG4 & AG5

modifications necessary for occupation of the new building as with this planned work has been funded from **SRC DCF**.

- V. **Revised web site for the SRC & more effective use of social media and developing video products¹⁵**. Work on our revised website is now nearly completed and is expected to be launched during the 2019-2020 period. Attention will continue to be focused on enhancing the education and outreach work of the Centre to vulnerable island communities using social media but also developing short videos.
- VI. **Re-location of computer servers to new building and expansion of the SRC IT infrastructure¹⁶**. This work is still outstanding but expected to be completed during the upcoming year. The estimated cost is as follows: servers for data - **US\$32K**, storage for data - **US\$15K**, network infrastructure (racks, switches, UPS) - **US\$50K**. (**TOTAL ~US\$100K from SRC DCF**)

¹⁵ Aligned to AL1 & AC3 as is all of the Education & Outreach work undertaken by the SRC.

¹⁶ Aligned to AG4 & AG5

Appendix II: Conference Presentations and Publications

Conference Proceedings

- **Joseph, Erouscilla**, Beckles, Denise, Cox, Leonette, Hailes, Stephen, Kilburn, Christopher, Jackson, Viveka and Lara, Smale (2019): Volcano Tourism in St. Lucia and Dominica: Combining Science and Community. 1st Biospheres International Conference, Université des Antilles-Martinique, 18 – 20 June, 2019.
- Jade H. W. Eyles, Jessica H. Johnson, **Patrick J. Smith**, and Jenni Barclay. Seismicity timeline of Soufrière Hills Volcano, Montserrat: 1995-2010. Poster abstract. Cambridge-EnvEast Doctoral Alliance (CEEDA) Symposium 2019, April 2019.
- L. Cox; **E.P. Joseph**; I. Jagassar; and D.M. Beckles (2019): Demonstrating the Impact of Community-Based Participatory Research Approaches from Process to Outcomes. Biennial Regional Conference and Expo (BRCCE) 2019, UWI St. Augustine, Trinidad; 22-24 May 2019.
- **Miller, V.L.**, Garthwaite, M.C., Saunders, S., (2019). Breaking down barriers to operational InSAR monitoring of volcanoes in resource-constrained settings. 27th IUGG General Assembly, Montreal, Canada
- **Stinton, A.J.**, Sparks, R.S.J., Tucker, M., Boudagher-Fadel, M.K., 2019. That sinking feeling: Evidence for significant syn-arc development subsidence in the NE Lesser Antilles. Volcanic and Magmatic Studies Group Annual Meeting, 8-10 January 2019, University of St Andrews, St Andrews, Scotland. [Oral Presentation]
- **Erouscilla Joseph**, Danielle Charlton, Lara Smale, Stephen Hailes, Christopher Kilburn, Reni Magbagbeola and Carlisle Williams (2018): The use of affordable technology to mitigate community concerns of volcanic emissions. Conference: Cities on Volcanoes 10, 2-7 September 2018, Naples, Italy.
- **Miller, V.L.**, Peters, L.E., Ammon, C.J., Smith, P., **Stewart, R.**, Voight, B., (2018). Optimising the focal mechanism solution uncertainties from volcano-tectonic earthquakes recorded on small-aperture seismic networks: A case study from the Soufrière Hills volcano, Montserrat. Cities on Volcanoes 10, Naples, Italy

- **Juman, A.M.,** S. Edwards, R.E.A Robertson, O. Graham, T. Henry-Ramos and C.Ash. (2018). ‘Use and impact of social media in disseminating alert level changes and information for the Kick-‘Em-Jenny Submarine Volcano.’ International Association of Volcanology and Chemistry of the Earth’s Interior (IAVCEI) Cities On Volcanoes, Naples, Italy (Oral Presentation).
- **Juman, A.M.,** S. Edwards, R.E.A Robertson, O. Graham, T. Henry-Ramos and C.Ash. (2018). ‘Reaching out to young students – experience of primary school outreach in St. Vincent & the Grenadines.’ International Association of Volcanology and Chemistry of the Earth’s Interior (IAVCEI) Cities On Volcanoes, Naples, Italy (Oral Presentation).
- **Camejo-Harry M,** Melekhova E, Blundy J, **Robertson, R.** The magmatic systems beneath Kick-‘em-Jenny and Kick-‘em-Jack submarine volcanoes, Lesser Antilles. Oral session presented at: VMSG Annual Assembly; 2019 January 8-10; University of St. Andrews, Scotland, UK.
- **Basant, R. and Ryan, G.A.** (2019), Interpreting the Structural Features of the Montserrat Geothermal System with the Fuzzy c means Technique. Faculty of Science and Technology science and Technology Week, University of the West Indies, St. Augustine, Trinidad, 20 – 24 May.
- **Kanhai, J. and Ryan, G. A.** (2019), Investigating ongoing deformation at the Los Iros Slump using Static GPS Observations. Faculty of Science and Technology Science and Technology Week, University of the West Indies, St. Augustine, Trinidad, 20 – 24 May.
- **Manzano, J.** (2019). The Geological and Geophysical Characterization of the Diego Martin Basin. Faculty of Science and Technology science and Technology Week, University of the West Indies, St. Augustine, Trinidad, 20 – 24 May. (Poster)
- **Sobion, C.** (2019). Analysis of the Magnitude 6.9 Earthquake on 21st August 2018 using Strong Motion Data and Felt Reports. Faculty of Science and Technology science and Technology Week, University of the West Indies, St. Augustine, Trinidad, 20 – 24 May. (Poster).

- Lehuger, U., M. O'Sullivan, J. O'Sullivan, J. Popineau, and **G. A. Ryan** (2018), Computer modelling of Montserrat geothermal field, paper presented at New Zealand Geothermal Workshop, Taupo, New Zealand, 14-16 November.
- Dinko Sindija, J. W. Neuberg, and **Patrick J. Smith**. Resolution test for moment tensor inversions of very-long-period seismo-volcanic signals. In Geophysical Research Abstracts, volume 20, pages EGU2018–10765. (European Geosciences Union, General Assembly), 2018.

Journal Manuscripts

- **Erouscilla P. Joseph**, Holli, M. Frey, Matthew, R. Manon, Mazi-Mathias C. Onyeali, Karyn, DeFranco, Tara Metzger & Carl Aragosa (2019): Update on the fluid geochemistry monitoring time series for geothermal systems in Dominica, Lesser Antilles island arc: 2009–2017. Journal of Volcanology and Geothermal Research, Vol. 376, pp. 86-103, <https://doi.org/10.1016/j.jvolgeores.2019.03.010>. **May2019**
- P.D. Cole, **R.E.A. Robertson**, L. Fedele, C. Scarpati (2019): Explosive activity of the last 1000 years at La Soufriere, St. Vincent, Lesser Antilles. Journal of Volcanology and Geothermal Research, Vol. 371, pp. 86-1000, <https://doi.org/10.1016/j.jvolgeores.2019.01.002>. **Feb2019**
- **Michal Camejo-Harry**, Elena Melekhova, Jon Blundy & **Richard Robertson** (2019): Evolution in magma storage conditions beneath Kick-'em-Jenny and Kick-'em-Jack submarine volcanoes, Lesser Antilles arc. Journal of Volcanology and Geothermal Research, Vol. 373, pp. 1-22, <https://doi.org/10.1016/j.jvolgeores.2019.01.023>. **Mar2019**
- Harnett, C.E., Kendrick, J.E., Lamur, A., Thomas, M.E., **Stinton, A.**, Wallace, P.A., Utley, J.E., Murphy, W., Neuberg, J., Lavallée, Y., 2019. Evolution of Mechanical Properties of Lava Dome Rocks Across the 1995–2010 Eruption of Soufrière Hills Volcano, Montserrat. Frontiers in Earth Science 7, 7. <https://doi.org/10.3389/feart.2019.00007>
- **Dondin, Frédéric J.-Y., Lynch, Lloyd, Ramsingh, Chan, Ryan, Graham A., Papadopoulos, Ilias, Rueppel, Daniel, Joseph, Erouscilla P., Latchman, Joan L., Robertson, Richard E. A., Nath, Nisha, Mathura, Ranissa, Balchan, Amit, George, Stephen, Juman, Ian, Madoo, Farrah, Manette, Garth, Ramsingh, Hannah** (2019): The University of the West Indies-Seismic Research Centre Volcano Monitoring Network: Evolution since 1953 and Challenges in Maintaining a State-of-the-Art Network in a Small Island Economy. Geosciences, 9 (2), 71, <https://doi.org/10.3390/geosciences9020071>. **Jan2019**

- Garthwaite, M.C., **Miller, V.L.**, Saunders, S., Parks, M.M., Hu, G., Parker, A.L. A Simplified Approach to Operational InSAR Monitoring of Volcano Deformation in Low- and Middle-Income Countries: Case Study of Rabaul Caldera, Papua New Guinea. *Frontiers in Earth Science*. 24 January 2019. doi: 10.3389/feart.2018.00240. **Jan2019**
- **Joseph, E.P.**, Jackson, V.B., Beckles, D.M, Cox, L. & **Edwards, S.**, (2018): A citizen science approach for monitoring volcanic emissions and promoting volcanic hazard awareness at Sulphur Springs, Saint Lucia in the Lesser Antilles arc. *Journal of Volcanology and Geothermal Research* 369. 50-63, DOI: 10.1016/j.jvolgeores.2018.11.005. **Jan2019**
- **Camejo-Harry, M**, Melekhova, E, Blundy, J, Attridge, W, Robertson, R, Christopher, T (2018). Magma evolution beneath Bequia, Lesser Antilles, deduced from petrology of lavas and plutonic xenoliths. *Contributions to Mineralogy and Petrology*, 173: 77. <https://doi.org/10.1007/s00410-018-1504-z>
- Barrett, T.J., **Joseph, E.P.** (2018). Extreme alteration in an acid-sulphur geothermal field: sulphur springs, Saint Lucia. *Chemical Geology*. **September 2018**. DOI: 10.1016/j.chemgro.2018.09.028.
- Melissa Plail, Marie Edmonds, Andrew W. Woods, Jenni Barclay, Madeleine C.S. Humphreys, Alexandros P. Poulidis, Jeremy C. Phillips, Ian A. Renfrew, Jenni Barclay, Andrew Hogg, Susanna F. Jenkins, **Richard Robertson** & David M. Pyle (2018): Meteorological controls on local and regional ash dispersal revealed using high-resolution dispersion modelling: The eruptions of Soufriere St Vincent. *Scientific Reports*, 8:6873, DOI:10.1038/s41598-018-24651-1.
- Allen, R. W., Berry, C., Henstock, T. J., Collier, J. S., **Dondin, F. J.-Y.**, Rietbrock, A., **Latchman, J. L.** and **Robertson, R. E. A.** (2018): 30 Years in the Life of an Active Submarine Volcano: A Time-Lapse Bathymetry Study of the Kick-‘em-Jenny Volcano, Lesser Antilles. *Geochem. Geophys. Geosyst.*, doi:10.1002/2017GC007270.
- Alexandros P. Poulidis, Jeremy C. Phillips, Ian A. Renfrew, Jenni Barclay, Andrew Hogg, Susanna F. Jenkins, **Richard Robertson** & David M. Pyle (2018): Meteorological controls on local and regional ash dispersal revealed using high-resolution dispersion modelling: The eruptions of Soufriere St Vincent. *Scientific Reports*, 8:6873, DOI:10.1038/s41598-018-24651-1.
- Lindsay J.M and **Robertson R.E.A** (2018): Integrating Volcanic Hazard Data in a Systematic Approach to Develop Volcanic Hazard Maps in the Lesser Antilles. *Front. Earth Sci.* 6:42. doi: 10.3389/feart.2018.00042.

Technical Reports

- **Reddock, K., J. Manzano and I. Papadopoulos.** Interpreting the morphology of the interface between the alluvium of the Port of Spain Gravels and the underlying rock formations in Port of Spain. Geological Society of Trinidad and Tobago Hammer Magazine. July 2018
- **Latchman, J.L., , I. Papadopoulos, K. Reddock, J. Manzano, J.D. Kanhai, G. Ryan, M Johnson, L. Lynch, , R. E. A. Robertson, S. Edwards, C. Ash, N. Nath, F. Madoo, H. Ramsingh and I. Juman.** 2018/08/21 Magnitude 6.9 West of Port of Spain Earthquake Report on the 2018/08/21 Earthquake: Characteristics and Impact. In Preparation for the Government of Trinidad and Tobago
- **Latchman, J.L.** - 2019/03/25 – 07/12 Weekly Dominica Scientific Advisories 01-42 201812_Dca_13-201812_Dca_42.
- **Miller, V.,** Fontijn, K., and INVOLC team (2019). Fostering developing-developed country partnerships for the advancement of global volcano science. Workshop report for the inaugural meeting of IAVCEI-INVOLC – International Network for VOLcanology collaboration, 4-7 June 2019, St. Augustine, Trinidad and Tobago
- **Papadopoulos, I., J. L. Latchman, R. Robertson, L. Lynch, K. Reddock, C. Ash, J. Manzano, C. Sobion, J. Seemungal.** Trinidad and Tobago Microzonation Project Monthly Reports January -July 2019
- **Papadopoulos, I., J. L. Latchman, R. Robertson, L. Lynch, K. Reddock, C. Ash, J. Manzano, C. Sobion, J. Seemungal.** Trinidad and Tobago Microzonation Project Progress Report -25 2019
- **Kanhai, J. and Ryan, G. A.** (2019). Remotely monitoring thermal flux at the Sulphur Springs Geothermal Field St. Lucia.
- **Stinton, A., Bass, V., Christopher, T., Fergus, Marlon, Hatter, S., Miller, V., Pascal, K., Smith, P., Stewart, R.,** 2019. MVO Scientific Report for Volcanic Activity between 1 October 2018 and 31 March 2019 (MVO Open File Report No. 2019– 01).
- **Smith, P., Bass, V., Christopher, T., Edgecombe, N., Hatter, S., Miller, V., Pascal, K., Stewart, R. and Syers, R.** (2018). MVO Scientific Report for Volcanic Activity between 1 April and 30 September 2018. Open-file Report 18/02, Montserrat Volcano Observatory, 2018.

Press Releases and Non-refereed Articles

- 23/08/2018- ‘Answers about the Quake’. UWI Today Article. Written in house.
- 02/10/2018 - High levels of Seismicity reported at Kick 'em Jenny Volcano
- 07/12/2018 - UWI-SRC Volcanologist Selected as an Outstanding Woman of the UWI
- 24/04/2019 - UWI to host workshop fostering international cooperation in volcano science.

Meetings & Workshops

- 2018/08/31 – Pre-Conference Meeting on Social Media and Volcanic Crises, at International Association of Volcanology and Chemistry of the Earth’s Interior (IAVCEI) Cities on Volcanoes 10, Naples, Italy. (A. Juman)
- 2018/09/04. DNN (Developing Nations Network): IAVCEI network to support scientists working in a resource- or technology- constrained context. Invited presentation at the IAVCEI Executive Committee meeting at Cities on Volcanoes 10, Naples, Italy. (Dr V. Miller).
- 2018/09/02 – 2018/09/07 - Cities on Volcanoes 10, Naples, Italy. (Dr R. Stewart)
- 2018/10/17 Symposium – OECS Observance of International Day for Disaster Risk Reduction: Organizer Dr. Veronica Simon, The University of the West Indies, Open Campus Saint Lucia. Presentation: Seismic Hazards in the Eastern Caribbean via Zoom (Dr J. Latchman).
- 2018/11/26 – 2018/11/29 - WOVOdat: International Workshop on "Optimizing the use of Volcano Monitoring Database to Anticipate Unrest", Indonesia (Dr R. Stewart)
- 2019/31/01 -2019/02/01 Represent SRC at the Multi-Hazard Early Warning system (MHEWS) (Dr. G. Ryan).
- 2019/05/19- Consortium meeting in St. Lucia (Organised by CDEMA) (Dr. G. Ryan).
- 2019/04/14 - 2019/05/19 - Martinique “Colloque ‘Aleas telluriques aux Antilles’ workshop. (Dr. G. Ryan).
- 2019/07/08. International Network for VOLcanology Collaboration – INVOLC: Fostering cross-country partnerships to overcome challenges in resource-constrained settings for the advancement of global volcano science. Invited presentation at the IAVCEI Executive Committee meeting at 27th IUGG General Assembly, Montreal, Canada (Dr. V. Miller)
- 2019/03/25 – 2019/03/27 - ESMAP Gender and Geothermal Development Workshop for Small Island Developing States (SIDS), Guadeloupe. (R. Bassant)