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Science in a crisis: Assembling volcanic knowledge in twentieth century Montserrat

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ABSTRACT

In the 1930s Montserrat, part of the British Leeward Islands colony, experienced a prolonged period of seismic unrest which many on the island interpreted as presaging a volcanic eruption. During the crisis several international scientists visited Montserrat and advised the local and imperial authorities on the likelihood of an eruption, and the island became a key node in an increasingly global volcanology. The process of assembling reliable knowledge about the volcanic system and its likely future behaviour was nonetheless heavily structured by colonial hierarchies and contestations over the reliability of different observers and the utility of long term monitoring. When the volcano eventually began erupting in 1995 it put paid to lingering governmental doubts over its very existence. We propose that work on the geographies of science has so far paid insufficient attention to the spatialities of crisis science, and that doing so can shed new light on both the history and persistence of colonial practices in the environmental sciences and in disaster management. Adopting longer perspectives on the politics of crisis science can yield new insights into the geographies and political geologies of a crisis-ridden present.

Introduction: geographies of crisis science

Moments of 'crisis', whether or not recognized as such by historical actors, tend to see the proliferation of forms and sources of expertise as collectives at various scales attempt to make sense of the nature, meaning and implications of crisis conditions.[1] Scholars in environmental geography and science & technology studies (STS) have a long history of engaging with the politics of crisis and emergency situations, emphasising how engagements with time-critical issues requiring rapid action shape a particular politics of expertise, which poses challenges to conventional norms and practices of scientific research.[2] Such 'post-normal' conditions, within which 'facts are uncertain, values in dispute, stakes high and decisions urgent', bring scientific expertise into dialogue with complex decision-making processes, diverse public values, and timescales of work with which many scientists may be unfamiliar.[3] Scientific advisory processes and moments of what we call here 'crisis science' change the geographies of scientific practice - its venues, spatial practices and forms of mobility, the intensity of knowledge circulation and openness or otherwise to public and political scrutiny.[4] Nonetheless, work on the historical geographies of science has arguably paid insufficient attention to the consequential space-times of crisis science, giving more attention to the situated production of spaces reserved for science than to the intersection of scientific practice with wider social and political formations.[5]

This is not to understate the significance of moments of scientific *controversy* within geographical contributions to science studies. On the contrary, these have been used by geographers to

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[1] Wendy Larner, 'C-change? Geographies of Crisis', *Dialogues in Human Geography* 1 (2011) 319–335.
[2] Amy Donovan, 'Experts in Emergencies', *International Journal of Disaster Risk Reduction* 56 (2021) 102,064.
[3] Silvio Funtowicz and Jerry Ravetz, 'Science for the Post-normal Age', *Futures* 25 (1993) 739–755 (p.744).
[4] James Palmer et al., 'Perfecting the 'Elevator Pitch'? Expert Advice as Locally-Situated Boundary Work', *Science and Public Policy* 46 (2019) 244–53.
[5] Jessica Lehman, 'Making an Anthropocene Ocean: Synoptic Geographies of the International Geophysical Year (1957–1958)', *Annals of the American Association of Geographers* 110 (2020) 606–22.

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show how the establishment of scientific truths is shaped by space and place, and how moments of crisis *within* science have been central to shaping the fortunes of fields, disciplines and consequential ideas.[6] Nonetheless, Diarmid Finnegan has urged more work on how the spaces of science get "plugged into' the wider world', for example through the shaping of laboratory science by the workings of late-modern capitalism.[7] But between the emergence and stabilisation of fundamentally local scientific cultures, and the shaping of science by epochal and globe-spanning socio-economic forces, there remains the unstable - but increasingly well-documented - ground of science venturing out of the laboratory or the observatory to participate in the wider governing of populations and environments; processes whose challenges, tensions and transformative effects are particularly apparent during self-conscious moments of 'crisis'.

In this paper, we put forward moments of volcanic and seismic crisis as important windows into the spatial politics of knowledge and expertise. Focusing on a period of seismic crisis in Montserrat in the 1930s, along with its reverberations and echoes in the 1990s eruptive crisis, we join wider contributions to the study of 'political geology' - the entwining of human politics and culture with the rocky substrata of the Earth.[8] In particular, we respond to the growing interest in the history and geography of twentieth century volcanology as a field of science which is uniquely revealing of the intersection of diverse knowledge systems, of the emergence of new forms of prediction and anticipatory governance, of competing imperial interests, and of the reach and limits of the state.[9] We contend that the political geology of twentieth century Montserrat, now a British Overseas Territory in the Eastern Caribbean, was shaped both by the ruptures of volcanic crises as well as by repetition and continuities in how the island's volcano was made knowable and governable under conditions of ongoing colonial rule.

Situating crisis science: where does trustworthy knowledge come from?

Moments of crisis almost invariably feature intensified efforts to assemble actionable knowledge in place, to render diverse forms of knowledge commensurable, and to find new channels of communication with decision-makers and affected publics. Scientists are liable to be plucked from their institutional homes and thrust into new spaces - the government department, the newsroom or perhaps the field, to directly encounter the source of the crisis conditions. Decision-makers and publics meanwhile seek to determine which sources of knowledge are the most trustworthy, authoritative and reliable. As geographers have shown, the spatial practices of science are intimately related to these questions of trust.[10]

The production of authoritative, trustworthy knowledge happens both 'in place' and 'on the move'.[11] Increasing historical attention has been given to scientific expeditioning for example: a 'structured practice of mobile knowledge production, supported or directed by an institutional benefactor'.[12] While exploration tended towards grand, often militant politico-epistemic aims of conquering the unknown, expeditions tended to be organized around more particular objectives: observing and mapping discrete phenomena or testing scientific theories, albeit still with 'important and at times inextricable ties to military, commercial, and imperial or national interests'.[13] Geographers have done much to reconstruct the evolution of expeditionary science over the eighteenth and nineteenth centuries, documenting complex and frequently exploitative relationships between expeditions and indigenous and local communities,[14] the instabilities of material infrastructures and instrumentation,[15] and contestations over the authority of different methods, techniques and observers.[16]

Accounts of scientific expeditioning in the twentieth century have emphasised the increasing prominence of expeditions into much more extreme, unpeopled environments (the deep ocean, outer space).[17] Yet the historiography of recent expeditionary science has arguably overlooked the persistence of more mundane expeditionary practices, particularly under bodies like the Royal Society, and the emergence of expeditions instigated to study the dynamics of 'natural disasters', such as volcanic crises, and health crises such as the early twentieth century sleeping sickness epidemics in East and Central Africa.[18] In this paper, we aim to show how expeditionary science emerged as a mode of response to volcanic crises, albeit one which was deeply contested as a mode of assembling volcanic knowledge.

Practices of mobile science have existed in complex relationships with more sedentary forms of knowledge-making. The geographical fixity and carefully regulated spaces of laboratories and observatories helped them emerge as fixed 'truth spots',[19] while other scientific disciplines heralded mobility and field experience as the font of credible knowledge.[20] Nonetheless, recent work has complicated the relationship between science in place and on the move. Naylor and Schaffer show how practices of movement and stasis in nineteenth century survey sciences were mutually supportive, as in John Herschel's vision of placing the coordination of the accounts of expeditioners and explorers 'under the control of fixed survey stations' to generate, as he put it, 'complete acquaintance with our globe as a whole'.[21] Survey sciences such as terrestrial magnetism and meteorology proceeded

[6] David N. Livingstone, *Dealing with Darwin* (Baltimore, MD: JHU Press, 2014); Simon Naylor, *The Observatory Experiment* (Cambridge: Cambridge University Press, 2024).

[7] Diarmid Finnegan, 'Science, Geography Of', in *International Encyclopedia of the Social & Behavioral Sciences*, ed. by James Wright (London: Elsevier, 2015), p.239.

[8] *Political Geology*, ed. Adam Bobbette and Amy Donovan (Basingstoke: Palgrave, 2019).

[9] Adam Bobbette et al., 'Unstable Grounds: Volcanology, Politics, and Knowledge in the Twentieth Century', *Isis* 115 (2024) 816–19.

[10] Charles Withers, 'Trust — in Geography', *Progress in Human Geography* 42 (2018) 489–508.

[11] Simon Naylor, 'Historical Geography: Knowledge, in Place and on the Move', *Progress in Human Geography* 29 (2005) 626–34.

[12] Noam Leshem and Alasdair Pinkerton, 'Rethinking Expeditions: On Critical Expeditionary Practice', *Progress in Human Geography* 43 (2019) 496–214 (p.497).

[13] Richard J. Sorrenson, 'Expeditionary Science', in *The Cambridge History of Science*, ed. Hugh Slotten et al. (Cambridge: Cambridge University Press, 2020), pp.137–38.

[14] Daniel Clayton, *Islands of Truth* (Vancouver: UBC Press, 2011).

[15] Jane Wess and Charles W.J. Withers, 'Instrument Provision and Geographical Science', *Notes and Records* 73 (2019) 223–41.

[16] Lawrence Dritsas, 'Expeditionary Science: Conflicts of Method in Mid-Nineteenth-Century Geographical Discovery', in *Geographies of Nineteenth-Century Science,* ed. by David N. Livingstone and Charles W.J. Withers (University of Chicago Press, 2011) pp.255–78.

[17] Sorrenson, 'Expeditionary Science'; *New Spaces of Exploration*, ed. by Simon Naylor and James R. Ryan (London: I.B. Tauris, 2010).

[18] George E. Hemmen, 'Royal Society Expeditions in the Second Half of the Twentieth Century', *Notes and Records* 64 (2010) 89–99; Wolfgang U. Eckart, 'The colony as laboratory', *History and Philosophy of the Life Sciences* 24 (2002) 69–89.

[19] Thomas F. Gieryn, *Truth-Spots: How Places Make People Believe* (University of Chicago Press, 2018).

[20] Natalie Cox, 'Armchair Geography: Speculation, Synthesis, and the Culture of British Exploration, c.1830-c.1870' (PhD thesis, University of Warwick, 2016).

[21] Simon Naylor and Simon Schaffer, 'Nineteenth-Century Survey Sciences: Enterprises, Expeditions and Exhibitions', *Notes and Records: The Royal Society Journal of the History of Science* 73, (2019) 135–147 (p.5).

both through itinerant observation and the expansion of networks of fixed observatories.

The field station has therefore attracted increasing attention in science studies, as a space defined by both fixity and motion, by carefully regulated boundaries and an openness to surprise and happenstance, and where struggles for authority play out through global assemblages of circulating knowledge, bodies, instruments and ideas, and across gradients of colonial and postcolonial power.[22] Field stations can involve what Kohler labelled residential science: 'a generic type of intensive or "residential" field practice, which involves knowing a research locale as intimately [as] its human or animal residents know it, but also as generally as do cosmopolitan scientists'.[23] Yet field stations can also be more temporary affairs, erected to observe transitory phenomena, or to allow the regular circulation of scientists. Here, we contend that episodes of volcanic crisis throw into relief the tensions between expeditionary, field and observational science, with different spatial practices assumed to yield differently authoritative and useable knowledge.

The liminal spaces of volcanic crises

The field station is a liminal space; a portal between science's networked institutions and the more-than-human unruliness of the field. The language of liminality has recently been adopted from assemblage theory to describe the wider characteristics of volcanic crises too. Amy Donovan has emphasised the liminal nature of science-policy assemblages during volcanic crises, emphasising leaky boundaries and the 'diffusive' processes by which information, norms and values circulate between science, society and policymakers.[24] Donovan has positioned volcanoes themselves as 'complex assemblages', incorporating 'not only earth materials but also cultures, ideas, economies, and politics'.[25] We can reflect too on how volcanism exerts agency in broader 'geopolitical assemblages', within which elements (such as states, polities and earthly matter) interact in complex ways with emergent and unpredictable effects.[26] McConnell and Dittmer observe that the 1990s eruption exerted decisive agency over political subjectivities among the 'liminal polity' of Montserrat; subjectivities built around notions of political viability (of an independent island nation), of dependency and responsibility, long histories of colonial rule and political economy, and, if we follow Donovan, around diverse framings of risk.[27]

Yet volcanoes should not just be understood just as singular, 'evental' actors within liminal geopolitical assemblages.[28] Volcanic crises themselves produce conditions of liminality - 'a state in which a person, place or thing is unsettled, teetering on a threshold with micro-scaled dynamics threatening to tip them/it into a different state of being'.[29] Crisis conditions are conditions of liminality, demanding anticipatory action amidst scientific uncertainty. They therefore function as 'vectors of assemblage' for science, knitting together 'places, bodies, voices, skills, practices, technical devices, theories, social strategies and collective work that together constitute technoscientific knowledge/practices'.[30] Vectors of assemblage see local infrastructures of science woven into an 'international science system' which 'monitors, coordinates, authorizes, legitimates, classifies, and situates the flow of observational and experimental information'.[31]

Below, we explore how volcanic knowledge was assembled and made mobile in twentieth-century Montserrat, in whose interests, and how *trans*-local assemblages of science and politics were remade under the liminal conditions of volcanic crisis. We draw primarily on archived scientific reports and governmental correspondence held by organisations such as the UK National Archives, Royal Society, Carnegie Corporation and the Montserrat Public Library (MPL). This transnational approach allowed us to trace complex networks of correspondence, and to reconstruct tensions, disagreements, and assumed knowledge hierarchies. To our knowledge, the extensive collections of the MPL have yet to be used in work on the volcanic history of Montserrat, and we are currently engaged in ongoing work with Montserratian collection-holders to support the sustainable preservation, promotion and use of these important collections. As we illustrate below, questions of what is archived and committed to memory, and where, is deeply consequential for living with volcanic risks.

1933-1935: Anticipating disaster

Although long known to be volcanic in origin, no written records exist of volcanic eruptions on the island of Montserrat between European colonisation in the 17th century and the early 20th century. There is some geological evidence of an eruption around the time of European settlement – much of which was revealed by the eruption in the 1990s – but the lack of corresponding written evidence remains a mystery.[32] By the 1930s Montserrat was not considered prone to volcanic hazards in London (see below), but locally officials and the wider public were painfully aware of recent eruptions in nearby St Vincent (1902) and Martinique (1902, 1929). With a population of around 12,000, Montserrat formed part of the federal Crown Colony of the Leeward Islands, overseen by a Governor in neighbouring Antigua. Montserrat was administered by a Commissioner, T.E.P. Baynes, a small Executive Council and a larger Legislative Council which included both *ex officio* members (from the Agricultural, Medical and other Departments), and unofficial and unelected councillors including estate owners and managers, many descended from the planter oligarchy.[33]

Periodic volcanic activity attracted governmental attention, such as 'soufrières' discharging steam, boiling water and sulphurous gases, most notably between 1897 and 1902, when new vents

[22] P Wenzel Geissler and Ann Kelly, 'A Home for Science: The Life and Times of Tropical and Polar Field Stations', *Social Studies of Science* 46 (2016) 797–808; Amy Donovan and Clive Oppenheimer, 'At the Mercy of the Mountain? Field Stations and the Culture of Volcanology', *Environment and Planning A* 47 (2015) 156–7.

[23] Robert E. Kohler, 'Paul Errington, Aldo Leopold, and Wildlife Ecology: Residential Science', *Historical Studies in the Natural Sciences* 41 (2011) 216–254 (p.216).

[24] Amy Donovan and Clive Oppenheimer, 'Modelling Risk and Risking Models: The Diffusive Boundary between Science and Policy in Volcanic Risk Management', *Geoforum* 58 (2015) 153–65.

[25] Amy Donovan, 'When the Vertical Becomes Horizontal: Experiencing Exploding Mountains in Borderlands', *Annals of the AAG* 110 (2020) 1040–1058, p.1043.

[26] Jason Dittmer, 'Geopolitical Assemblages and Complexity', *Progress in Human Geography* 38 (2014) 385–401.

[27] Fiona McConnell and Jason Dittmer, 'Liminality and the Diplomacy of the British Overseas Territories: An Assemblage Approach', *Environment and Planning D* 36 (2018) 139–58.

[28] Ian G.R. Shaw, 'Towards an Evental Geography', *Progress in Human Geography* 36 (2012): 613–27.

[29] McConnell and Dittmer, 'Liminality and the Diplomacy', p.142.

[30] David Turnbull, 'Local Knowledge and Comparative Scientific Traditions', *Knowledge and Policy* 6 (1993) 29–54 (p.33).

[31] David Wade Chambers and Richard Gillespie, 'Locality in the History of Science', *Osiris* 15 (2000) 221–240 (pp.231–32).

[32] See J B Shepherd et al., 'Precursory Activity to the 1995 Eruption of the Soufrière Hills Volcano, Montserrat', conference paper, *Beyond Walls: Multi-disciplinary Perspectives*, Montserrat: School of Continuing Studies, UWI, 2002.

[33] Howard Fergus, *Montserrat: History of a Caribbean Colony* (London: Macmillan Caribbean, 2004).

opened and earthquakes caused some material damage. This activity declined shortly after the catastrophic eruptions on Martinique and St. Vincent in May 1902, but an uptick in such activity early in 1933 caused renewed anxiety in Montserrat. Government officers were dispatched to investigate conditions around the soufrières and the distinctive smell of hydrogen sulfide was periodically detected in the capital Plymouth. The first earthquakes were reported by a schoolteacher, F.E. Peters, in March 1933, and while some recalled similar but ultimately inconsequential occurrences a few decades earlier, popular fears began to mount. C.A Gomez, Curator of the Grove Botanical Station and head of the Agricultural Department, led a visit to Gages Soufrière and noted, with noses and lead acetate tests, the presence of both hydrogen sulfide and sulfur dioxide – indicative of changing subsurface conditions and of possible volcanic unrest. In September 1933 the first notable earthquake was detected at the Grove and from January 1934 there was a marked increase in seismicity. Gomez led another visit to Gages in March 1934, with a team consisting of a guide, the Agricultural Assistant H.L. Manning, and two officers from *HMS Dragon*. They detected similar smells, so Gomez began compiling records of felt earthquakes and passing them onto the Commissioner. By the following month Gomez had assembled a team of estate owners, forest officers and other keen observers who together kept a watchful eye on the soufrières and reported weekly to Commissioner Baynes.

Popular and official nerves were increasingly frayed by the sound of 'detonations' in the south-eastern part of the island which recalled those heard before the devastating 1902 eruption of Mt Pelee on Martinique, and officials began looking more widely for information and assistance.[34] Cables to neighbouring islands inquired into seismicity there, reflecting the by-then quite commonly held understanding of geological connections along the island chain. Meanwhile, the Governor suggested that the Secretary of State in London might like to despatch a scientist to investigate. But the Governor also reported that he had been informed 'that there is a volcanic scientist at present camping in a hut some 2000 ft up on Mount Pelee, Martinique, and that he has microphones inserted in the mountain at intervals'.[35] Despite reservations about enlisting a 'foreign expert', the request found its way up the mountain.[36]

Frank A. Perret was an American engineer, inventor and volcanologist who had travelled to Martinique in 1929. He installed monitoring equipment on the volcano and opened a museum to the devastating 1902 eruption, reflecting his signature commitment to both monitoring volcanoes' physical behaviour and to creating spaces for dialogue between volcano science and wider publics. Originally an electrical engineer, Perret worked for Thomas Edison in New York before setting up his own motor and elevator company. He sold his company to Otis in 1906, having begun to seriously pursue his interest in volcanology on the slopes of Vesuvius, where he witnessed and documented the eruption of 4-9th April 1906.[37] There followed visits and fieldwork on other European volcanoes, Sakurajima in Japan, and Kilauea in Hawai'i, where he was an influential advocate for the establishment of a permanent observatory.[38]

Perret made a brief stop in Montserrat on May 13, 1934 while *en route* from Martinique to the US by steamship. He reported that 'the odour of H_2S was strong at 2 miles out. In the town of Plymouth it seemed to me almost unendurable'. After conversing with the Commissioner, Perret reports that he 'went up the soufrière, nearly rupturing my old heart, had 12 min there for investigation, before running nearly all the way down to catch the boat - the safety of 12,000 co-nationals being of little importance to a steamship company'. Perret felt the situation to be 'extremely disquieting, though perhaps not yet alarming', and expressed regret at having to leave the island rather than stay-on to monitor and advise.[39]

On leaving, Perret warned that that night, with its new moon, might see an uptick in seismic activity. Sure enough, the island experienced the 'most severe shock experienced [in] thirty odd years', and newspapers relayed the 'panic' which reportedly gripped the island.[40] This gave extra credence to his additional suggestion that a period in two weeks' time could also see increased activity, driven by astronomical movements and the full moon. Perret's interest in astronomical influences on volcanic and seismic activity was shared among others at the time,[41] although Perret was among 'the first scientists to argue for predicting eruptions by observing them at close range'.[42] He understood that eruptions occurred when gaseous and magmatic pressure built up to such a degree that only a small physical change might be required to unleash an eruption. Perret was a theorist of volcanic liminality, observing in Montserrat a volcanic system 'teetering on a threshold with micro-scaled dynamics'- such as the gravitational pull of the moon - 'threatening to tip' the system into 'a new state of being'; an eruptive state.[43]

Perret wasn't offering a *prediction* that such a threshold was about to be crossed - he simply wanted to be informed if the pattern continued. But *prediction* is what was heard, most notably by the panicked Commissioner, and calamity is what others started to expect, with an eruption expected to tip the colonial society into a state of disorder too. While Perret and the Commissioner supposedly agreed to keep Perret's claims secret, the Commissioner subsequently complained that Perret proceeded to tell 'everyone his opinion', plunging 'the whole island' into 'a state of alarm.[44] The administration therefore invited a Royal Navy warship to take up position in the harbour, to assist with relief efforts and to quell any 'disorder' that might arise in the event of disaster.[45] Even if 'her services may not actually be required', authorities hoped that 'her presence alone will have a calming effect on the people'.[46] A parade on the cricket ground was scheduled to coincide with the 'critical day', in a further public performance of the state's disaster readiness.[47]

The colonial authorities - uneasy both about the prospects of worse to come, and about the reliability of Perret - sought a second opinion from Kew Observatory in London. Kew obliged with reassuring readings of the available seismic data and with

[34] Baynes to Colonial Secretary, Antigua, 9th April 1934, Montserrat Public Library (hereafter MPL) 82/158-175.
[35] Johnston to Cunliffe-Lister, 14th April 1934, MPL 82/158-175.
[36] Baynes to Colonial Secretary, Antigua, 14th April 1934, MPL, 82/158-175.
[37] Frank A. Perret, *The Vesuvius Eruption of 1906* (Washington DC: Carnegie Institution, 1924).
[38] Adam Bobbette, 'The Sound of Magma: Geographies of Infrasound, Vibrating Bodies, and Representing the Earth', *DMJournal–Architecture and Representation* 1 (2022) 1–23.
[39] Perret to Day, 22 May 1934. Geophysical Laboratory General Files, GL-2005-01, Carnegie Institution Archives.
[40] Pacific Cable Board telegram to CANAPRESS (unknown author), 14th May 1934, MPL, 82/158–175. 'Quakes rock Montserrat', *New York Times*, 15 May 1934, p10.
[41] Gianluca Sottili, Sebastien Lambert, and Danilo Mauro Palladino, 'Tides and Volcanoes: A Historical Perspective', *Frontiers in Earth Science* 9 (2021) 10.3389/feart.2021.777548.
[42] Bobbette, 'The Sound of Magma', p.3.
[43] McConnell and Dittmer, 'Liminality', p.142.
[44] Commissioner to Colonial Secretary, Antigua, 19 May 1934, MPL, 82/672.
[45] Telegram, Governor to Secretary of State, 15th May 1934, MPL 82/158–175.
[46] Johnston to Cunliffe-Lister, 22nd May 1934, MPL 82/158–175.
[47] Capt. Knox-Little to Baynes, 24th May 1934, MPL 82/158–175.

scepticism about any links between Earthly geology and celestial bodies. The reassurances were passed onto the island's population via church pulpits and government notices, announcing loudly that:

> THE AUTHORITIES AT KEW OBSERVATORY HAVE EXPRESSED THE OPINION THAT, ON THE DATA FURNISHED TO THEM, THERE APPEARS TO BE NO GROUND FOR APPREHENSION OF SERIOUS EARTHQUAKES OR AN ERUPTION IN MONTSERRAT, AND THAT IT WOULD BE UNWISE TO ATTACH UNDUE IMPORTANCE TO THE PREDICTION THAT an eruption would occur on the occasion of the next full moon.[48]

The captain of the warship - *HMS Danae* - was similarly sceptical of the 'ill-advised prophesy of trouble, broadcast by the scientist from Martinique, who happened to be passing through'.[49] *Danae* was about to begin a five-month tour of the Pacific, and coming to Montserrat would mean missing a vital delivery of beef and potatoes. Attributing the lack of Perret's epistemic authority to his itinerant spatial practices, the captain offered some acerbic 'boundary work' which cast Perret as existing outside the limits of reasonable scientific practice and trustworthy advice, condemning the 'voodoo prophecy of the wandering astrologer'.[50]

The 'critical day' ultimately passed without incident, but the failed 'prophecy' didn't dent the Executive Council's wish for Perret to investigate further. In July the Council resolved to invite him back, and Perret agreed to come for free.[51] While he wouldn't reach the island until November, over the ensuing months Perret received updates from the Commissioner and from Gomez, with whom he had deposited instructions for setting up a pendulum for observing the magnitude and direction of seismic waves. Meanwhile, he sought funds from the Carnegie Corporation in New York for a programme of field observation, noting that 'the British government - as is not unusual - seems disinclined to take the matter very seriously', while the proximity of the 'fire-ring' of the Caribbean volcanic arc 'lays obligation upon American science' to investigate, for reasons of both scientific interest and humanitarian responsibility.[52]

Perret's diagnosis of the geopolitics of scientific responsibility in the region was persuasive, and the Carnegie Institution for Science, which already had a long history of supporting research and education in British colonies, agreed to support his plans. Perret was back on island by November 1934, staying for three weeks and submitting his first report on the seismicity on 12th December – a day on which he recorded 180 seismic shocks, many of which caused serious damage to buildings and frayed official and public nerves still further.[53]

Assembling subvolcanic knowledge: in place and in public

Perret began setting up his field station in December 1934, and by the time of a return visit in February 1935 the wooden structure had been completed. Although kitted out with a few home comforts it nonetheless reproduced the 'monastic austerity' that characterised what Adam Bobbette has called Perret's uniquely 'volatile empiricism': 'knowledge required witnessing, and this meant being present in extreme volcanic environments'.[54] Perrett equipped the field station with a Bristol thermograph, a mercury bath, a seismic pendulum, cameras, binoculars, and gas sampling tubes. He buried microphones to capture subterranean rumblings while his air microphone and pitch pipes would measure what he called the 'pressure note' of the gas vents, revealing telling variations from B♭ to F♯.

Bobbette emphasises Perret's dedication to sound as a means of revealing 'the occult conditions' of volcanic systems.[55] Enabled by geophysical insights that 'the earth was in fact not solid but a giant medium for waves travelling through it', Perret positioned first his own resonant body and then his electro-acoustic instruments as amplifiers, arranging them carefully in space so that they might resonate with the vibrations of the earth and make those movements legible through automated inscriptions or written testimony. During the build-up to the 1906 eruption of Vesuvius, Perret had recalled 'an increasingly deaf Edison' in his New Jersey factory 'searchingly biting on to objects' to hear their mechanical vibrations 'more clearly'. At his lodgings in the shadow of Vesuvius, Perret noticed that his pillow was amplifying the mountain's rumblings, and so 'bit his bedstead and amplified the tremors through his skull. Hearing became material … sound was feeling, and Perret's body became a medium that collapsed the distance between his bed and the volcano'.[56]

The Montserrat hut itself became an amplifier and instrument too, collapsing what distance remained between Perret's body and the centre of volcanic activity. The hut's own vibrations offered clues about the directions and wavelengths of tremors, and a wall was painted with a zinc white paint whose discoloration might give insight into the make-up of the venting gases. Perret also put great emphasis on soufrière temperatures as indicators of activity, and his assembly of acoustic resonators was joined by a Bristol Recording Thermometer which 'rendered valuable service' as a 'watchdog', alerting Perret to 'the greatly feared increase of heat at the surface'.[57] When that watchdog began to bark in Spring 1935 by showing temperatures of 145 °C evacuations began to be considered – both of single estates and of the entire south of the island.[58] It was eventually worked out that the thermometer had succumbed to gaseous corrosion. Apparently a more reliable indicator of dangerous gases than temperatures, Perret re-purposed the instrument as a gas monitor and installed it at the Grove Botanic Station.

'Volcanologists require a great deal of their instruments', Perret later wrote; they also require a 'great deal … of themselves'.[59] Perret intended to stay in his field station for half a week at a time, but gaseous corrosion began to affect his body as much as his instruments. On one occasion he was hospitalized after a 40-hour stay in the fumigated hut led to serious respiratory damage. But the bodily toils of Perret's volatile empiricism became a key part of his public performance as a scientist. He regularly appeared both on the mountainside and at government receptions in goggles designed to protect his injured eyes, and welcomed visits to his field station from colonial officials and passing naval personnel who were curious about the results and implications of his work. Perret would put on quite the show, enrolling the volcano itself

[48] Government Notice no. 13/324/33, 22nd May 1934, MPL 82/158–175. Original emphasis.
[49] Capt. Knox-Little to Johnston, nd., MPL 82/158–175.
[50] Capt. Knox-Little to Baynes, 23rd May 1934, MPL 82/158–175. On boundary work see Thomas F. Gieryn, 'Boundary-Work and the Demarcation of Science from Non-Science', *American Sociological Review* 48, (1983) 781–95.
[51] Acting Commissioner to Perret, 11 July 1934.
[52] Perret to Keppel, 15th Sept 1934, GL-2005-01, Carnegie Institution Archives.
[53] 'Earthquakes rock British Island', *Daily Mail*, 15 December 1934.
[54] Bobbette, 'The Sound of Magma', p.4.
[55] Perret to Merriam, 10th Oct 1934, GL-2005-01, Carnegie Institution Archives.
[56] Bobbette, 'The Sound of Magma', p.4.
[57] Frank A. Perret, *The Volcano-Seismic Crisis at Montserrat, 1933–1937* (Washington, D.C.: Carnegie Institution, 1939), p.65.
[58] Commissioner to Governor, 15 April 1935, MPL 82/158-175.
[59] Perret, *Volcano-Seismic Crisis*, p.27.

into his performance of the 'well-known experiment' of shining a torch through the escaping gases, which would encourage condensation – making the gases newly visible to his audience – as well as potentially creating vacuums which would draw out even more of the 'eye stinging' substances.[60]

Through these public spectacles of human-volcano intra-action,[61] and of the bodily costs of generating reliable knowledge, Perret performed the work of not just studying the volcano's behaviour but of calming the nerves of the wider population; working for, as he put it, 'the greater tranquillity of the people'.[62] The field station became a hub and stage for a very public science. In addition to his mountainside performances, he gave regular public addresses in which he tried to calm popular fears. But these 'frontstage' performances of scientific rationality were joined – as so often in crisis advisory processes – by 'backstage' practices away from the public eye.[63] He wrote confidential letters to the Governor where he was more frank about 'the dread possibilities' of an eruption; 'anxiety is for those who know'.[64] Nonetheless, through his public work he became something of a celebrity, was made godfather to a child born locally during the crisis, and conversations with archivists during our research in Montserrat in 2023 revealed that he remains a core part of the cultural memory of the 1930s crisis.

Nonetheless Perret was far from alone in monitoring the volcano's vital signs. The Agricultural Department continued to make visual and instrumental observations, particularly during Perret's periods of absence. And alongside Perret's own resonant, gas-detecting hut, the 'light bungalow' inhabited by T. Savage English similarly made the direction of passing shockwaves conveniently visible. English himself, an amateur scientist, historian and former colonial administrator who had kept his own seismic records from the early days of the crisis, became a corporeal seismograph too. During one notable shock, English, 'having been seated in a low canvas chair, suddenly found himself standing upright, groping for equilibrium'. The telephone at the Gages Estate provided another measure of vertical movement, with a thrust of at least 2 inches required to throw the apparatus off its spring hook. Elsewhere, 'water fell back into basins, and tea into cups', denoting for Perret strong vertical but weak horizontal movements.[65]

Perret encouraged detailed record keeping at Gages Estate after Mrs Howes 'gauged very correctly the coming of strong conditions by the household silver turning an olive color'.[66] He enthusiastically compiled and studied others' observations of earth tremors, which helped him piece together the origin and direction of underground shock waves. He entrusted others with instruments, closely observed the behaviour of plants and animals, and enthusiastically embraced those who claimed to have identified signs of impending trouble.

The construction and maintenance of his field station was likewise a product of many people's labour. In Fig. 1 we see the faces of those who ferried materials and supplies, erected buildings, and installed, maintained and read scientific instruments. But in most instances where such contributions were made by black Montserratians, the archives are silent about who they were and

Fig. 1. 'View of field station and head of gorge, Gages Soufrière, Montserrat B.W.I.', by C.E.E Browne, March 4, 1935. Item P536991, Archibald MacGregor Archive. Reproduced with permission from British Geological Survey. © Natural Environment Research Council.

what exactly they did. Despite Perret's signature approach to volcanology as a fundamentally humanitarian endeavour,[67] like so much colonial science, it proceeded on the back of unacknowledged contributions of marginalised communities.[68] Tellingly, in Fig. 1 it is Perret alone who has crossed the threshold into the scientific interior of the hut, while others stand physically and symbolically outside.

By the end of 1935 Perret had assembled a monitoring network that could be maintained and utilised by the Curator and staff of the Grove Botanical Station, while a large, damaging earthquake on 4th November had underscored both the need for continuing close attention to the volcanic system, and the ongoing potential for greater disaster. Nonetheless, all of this took place amid a background of doubt and incredulity in the imperial metropole where serious questions were raised about the nature of the crisis, and even whether Montserrat was home to an active volcano at all.

Metropolitan doubt and the 'strain of uncertainty'

It wasn't until May 1935, with its crescendo of several months of damaging tremors which again made the international press,

[60] Perret, *Volcano-Seismic Crisis*, p.29.
[61] Karen Barad, *Meeting the Universe Halfway* (Durham NC: Duke University Press, 2007).
[62] Perret, *Volcano-Seismic Crisis,* p.19.
[63] Steven Hilgartner, *Science on Stage: Expert Advice as Public Drama* (Stanford, CA: Stanford University Press, 2000).
[64] Perret, *Volcano-Seismic Crisis*, p.28.
[65] Perret, *Volcano-Seismic Crisis*, pp.51-52.
[66] Perret to Baynes, 18th Sept 1935, MPL 82/158–175.
[67] Clive Oppenheimer, *Mountains of Fire* (London: Hodder & Stoughton, 2023).
[68] See Armston-Sheret, *On the Backs of Others*, University of Nebraska Press, 2024.

that the UK Government began to consider substantive action.[69] The Colonial Office forwarded a series of dispatches to the National Geodesy and Geophysics Committee (NGGC), seeking advice on the best course of action. Frank Whipple, Superintendent at Kew and member of the NGGC, put before his colleagues the question of whether the information Perret and his local assistants were supplying was adequate, and whether it would be worth the expense of sending a UK expedition. Whipple interpreted Perret's reports as the work of an 'enthusiastic' and 'capable observer', albeit one with a penchant for unusual instrumentation: 'He has not set up a seismograph … he seems to be content to trust to the blurs on the trace of a thermograph as the only instrumental record of earthquakes'.[70] Carnegie's Arthur Day tried to reassure Sir John Flett, Director of the Geological Survey of Great Britain, of Perret's reliability and of the need for financial support from London, but left Flett with the impression that Perret was 'rather an ingenious and imaginative person, and that possibly some of his reports are not to be taken too literally'. Flett thought this 'a common propensity with American scientists who study volcanoes'.[71]

British unease about excitable American volcanologists in general, and about the reliability of Perret and his eclectic network in particular, was not restricted to Flett. A July 1935 Admiralty report dubbed Perret a 'pseudo-scientist' and related that:

> the 'Volcanologist' Dr. Perret, whose activities and prophecies have done so much to keep the island in a state of anxiety has now fortunately returned to Martinique. It is understood that his recent visits have been at the request of authorities but it is sincerely to be hoped that he is not asked to come again. It is difficult to see what good his presence or prognostications achieve, while the harm they do in keeping the island in a state of apprehension is obvious.[72]

It wasn't the volcano maintaining a 'state of apprehension', but Perret's public readings of it. And the Admiralty's boundary work around who counted as a reliable interpreter of volcanic systems extended to a more foundational question. For the NGGC, volcanological assistance would hardly be required if there wasn't even an active volcano in Montserrat. Serious doubts were raised about the existence of a volcanic crater, which would indicate a recently active volcano. While some nineteenth century maps of the island used the word 'volcano' to denote geothermal vents,[73] others – including Admiralty charts – were ambiguous about a crater in the Soufrière Hills. T. Savage English was the chief proponent of the idea that a crater was in existence, but Flett was again sceptical about volcanological claims from the region: 'Mr. English's report that he has discovered a crater in Montserrat is interesting, but as many such reports come from the West Indies and few of them have proved reliable, it would be valuable to know on what evidence Mr English has founded his opinion'.[74]

In September 1935 the Secretary of State conveyed that 'expert scientific opinion' in London considered that the 'probability of volcanic outburst in Montserrat where no crater has been preserved must be regarded as too small to justify any alarm'.[75] The publication of these words as a Government Notice on 2nd October prompted Gomez to write to Commissioner Baynes, relaying English's testimony on the existence of a crater. Baynes visited English to discuss his observations. Back in March Baynes had told a press agent that 'there is no active volcano here', but by the autumn he was advocating for contrary positions.[76] He testified to the Colonial Secretary that English, having 'resided in Montserrat for some years' and having 'been over that part of the Island himself', could be trusted. As a practitioner of a kind of residential science, English carried the authority of intimate acquaintance with the local physical environment. English had furnished Baynes and Perret with sketches of the crater wall, and with maps of the island with the crater overlain (see Fig. 2). Baynes thereafter reported that:

> The public here are not reassured by the scientific opinion communicated by the Secretary of State for the reason that a preserved crater is believed to be in existence, and the fact that earthquake conditions have definitely been getting worse, with more continuous vibrations and tremors, seems to indicate that it is all leading up to something of a serious nature.[77]

Metropolitan scientific reason chafed against both local, embodied experience of the worsening seismic crisis, and against local knowledge of the geomorphological archive of recent volcanic activity. This 'local knowledge', as expressed in the surviving archives, aspired to inclusion in the body of Western scientific knowledge about Montserrat, and was not drawn from the kind of competing cosmological traditions whose interactions with Western earth sciences are increasingly well documented.[78] Nonetheless it was seemingly held by a broad cast of administrators, citizens, European settlers and amateur naturalists, and on October 22, 1935 a party consisting of S.A. Schouten, Assistant Agricultural Officer, two Cotton Inspectors and two estate managers mounted an expedition to English's proposed crater. In their report the party confirmed, in underlined all-capital type, 'THE POSITION OF ENGLISH'S "CRATER WALL" and 'ENGLISH'S 'CENTRALLY PLACED CONE", and stressed their agreement 'WITH MR. ENGLISH THAT THIS SPOT WAS AT ONE TIME THE SEAT OF GREAT VOLCANIC ACTIVITY'.[79]

This further raised the level of alarm among both the population and local officials. Conversations began to be had about supporting Perret's activities, owing both to his 'frequent absences' from the island and his perceived 'inability owing to age to conduct active investigations'.[80] A petition from 'some of the leading inhabitants of the island', including business owners, planters, schoolmasters and clergymen, relayed the population's growing anxiety.[81] Shocks were growing in frequency and intensity, and the data being collected under Perret's instruction pointed 'to some pending major calamity'. An investigation was needed, 'in collaboration with Perret', into 'whether there is any danger of eruption,

[69] E.g. 'Montserrat Fears Volcanic Outburst: People Suffer from Bad 'Case of Nerves''. *New York Times* 22 March 1935, p19.
[70] Whipple to Flett, 31 May 1935, The UK National Archives (hereafter TNA), BJ 1/270.
[71] Flett to Whipple, 2nd July 1935, BJ 1/270, TNA.
[72] Report of proceedings of HMS Dragon, 15 June to 11 Aug 1935. CO 152/455, TNA.
[73] See for example 'This plan of the island of Montserrat … ', C-8102, John Carter Brown Library, Providence RI.
[74] Flett to Whipple, 27 Nov 1935, BJ 1/270, TNA.
[75] Copy of Telegram, Secretary of State to Governor, 30 Sept 1935, MPL 82/158-175.
[76] Baynes to Pacific Cable Board, 13 March 1935, MPL 82/158–175.
[77] Baynes to Colonial Secretary, Antigua, 9 Oct 1935, MPL 82/158–175.
[78] See Alison Bashford et al., eds. *New Earth Histories*. University of Chicago Press, 2023.
[79] S.A. Schouten, *Report on visits made by the Department of Agriculture to the Roaches-Chances Mountain Group for the purpose of identifying 'a preserved crater'*, 24 Oct 1935, MPL 82/158–175.
[80] Copy of Telegram, Governor to Secretary of State, 23 Sept 1935, 82/158–175, MPL.
[81] Baynes to Colonial Secretary, Antigua, 12 Oct 1935, 82/158–175, MPL.

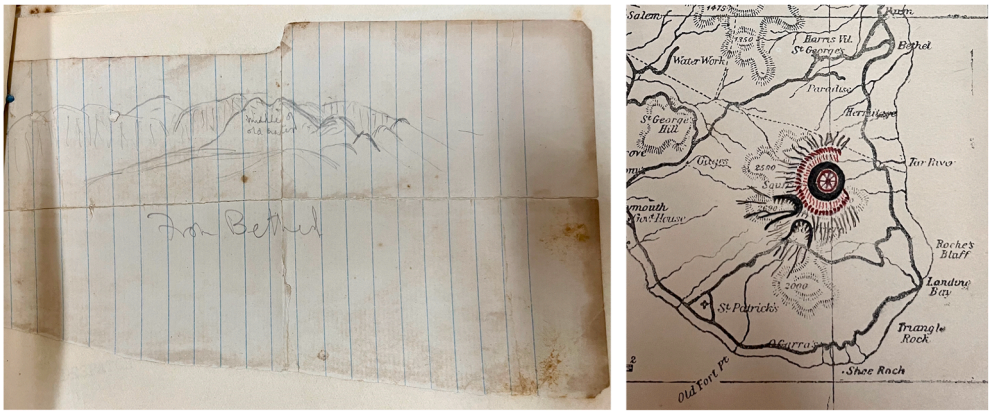

Fig. 2. (a) sketch map of the apparent crater wall, possibly by English himself. (b) Detail from map of the island showing southeastern corner, with the volcanic crater prominently overlain. Source: Montserrat Public Library, MPL 82/158–175. Reproduced with permission.

immediately or otherwise', and whether the sulphurous fumes might be as 'detrimental to the health of the community' as the nervous states being generated by the possibility of an impending eruption.[82]

The petition demanded the appointment of an officer who could assist with the long-term, close monitoring to which Perret aspired. The appointment would be 'a sort of observation officer', as Commissioner Baynes sheepishly described it to Perret, who would continue Perret's work in his absence, and work for him when he was on-island.[83] The American wasn't wholly in agreement. He argued that 'if our investigation is lacking in any detail which might be needed for the safety of the presidency - this detail is only that which results from the lack of apparatus which does not exist (though I have been preaching its creation for fifteen years)'.[84] His regular absences, he explained, were partly attributable to the time-consuming work of personally visiting instrument makers and Carnegie laboratories in the US to commission and tinker with the instruments that, in his view, would do more to understand and foresee the behaviour of the volcano than an extra scientist would.

1936-1937: expeditionary science and metropolitan reason

While Perret and the 'leading' islanders politely disagreed on the need for metropolitan scientific assistance, they were united in the view that a permanent scientific presence, embodied in a resident, sensing scientific body and carefully designed instrumentation, was required. Nobody wanted a short-lived expedition.[85] But on December 12, 1935, one year after Perret submitted his first report, the newly constituted Montserrat Committee of the Royal Society resolved to prepare an expedition of a geologist and seismologist, with the aims of investigating the island's geological structure and the sources of recent seismic disturbances, and of getting to the bottom of the volcano question by investigating the regional geophysical context and determining 'whether the report of the existence of an old crater there is well-founded'.[86] The rationale for the expedition did not share the language of crisis of the islanders' petition, but of sober investigation and fact-finding; of putting local theories to the test of metropolitan reason.[87]

The Royal Society would contribute £300, and the Colonial Office £1700, to support salaries, expenses and the purchase of instruments. Those were to include including 4 Jaggar horizontal shock recorders, 1 Kew vertical shock recorder and one 200 kg Wiechert 2 Component Seismograph, along with the salaries and expenses of the two scientists who, after a few rejections, agreed to go: Archie MacGregor of the Geological Survey, and University of Bristol physicist Cecil Powell. MacGregor was to evaluate the geology of the island with respect to past and possible future volcanic activity, while Powell was to install new monitoring equipment and to investigate the pattern of seismic disturbances.

MacGregor and Powell sailed for Montserrat on 19th February and 6th March respectively, with Sir Gerald Lennox-Conyngham - Cambridge geodesist, Fellow of the Royal Society, and former head of the Survey Branch in India - due to join them towards the end of their stay. Lenox-Conyngham was to offer further oversight of the seismological investigations and to make arrangements for the handover of responsibility for the instruments from the Royal Society to the local authorities. The expedition became an international attractor. Lenox-Conyngham's visit was planned to coincide with that of Thomas and Isabel Jaggar from the US, who also received funding from the Royal Society. Thomas Jaggar was the founder and director of the Hawaiian Volcano Observatory, a longtime correspondent of Perret, and an experienced observer of degassing volcanoes in Hawaii and Japan. Isabel Jaggar was likewise an experienced volcanological fieldworker, most notably in Hawaii.

Although seemingly equipped for long periods in the field (the expedition arrived with tents and other camping equipment), MacGregor and Powell lodged at the Cocoanut Hill Hotel. Both became integrated into elite circles, enjoying regular dinners with government officers and estate owners, and tennis matches with prominent members of both European and Afro-Caribbean

[82] Petition to the Secretary of State for the Colonies, 18 Sept 1935, 82/158–175, MPL.
[83] Baynes to Perret, 28 Sept 1935, 82/158–175, MPL.
[84] Perret to Baynes, 3 Oct 1935, 82/158–175, MPL.
[85] In one letter Perret refers to the Royal Society expedition as an 'occupation'. Perret to Day, 26 June 1936, GL-2005-01, Carnegie Institute Archives.
[86] Minutes of the Montserrat Committee p. 289, 12 Dec 1935, CMB134(L), Royal Society archives.
[87] We take the term 'metropolitan reason' from Lance van Sittert, 'Fighting spells: the politics of hysteria and the hysteria of politics on Tristan da Cunha, 1937–1938', *Journal of Social History* 49 (2015) 100–124.

communities. While Powell concentrated on establishing a new network of monitoring equipment, MacGregor took to the hills with Gomez and various guides and porters. Both kept detailed records of their social interactions and from notebooks we learn the names of a number of Montserratians who assisted the expedition's work in the field or by providing transport, such as Mr. Mead of Galway's, Mr R.E.D. Osborne of Tar River, Earnest Chambers and William Davy. Numerous others who helped (e.g. by driving cars or rowing boats) go unnamed, however, and contributions in the form of volunteered knowledge of the local environment are largely not remarked upon.[88]

MacGregor eventually came to accept English's theories, confirming the existence of a crater in his preliminary report for the Royal Society which was written on the boat home.[89] MacGregor thanked English 'for placing his extensive local knowledge at my disposal',[90] and formalised the name 'English's Crater' for the feature to the east of the island's highest point, which English had argued was the volcano's youngest crater. Perret's assistance was acknowledged too, albeit again in the category of local informant rather than fellow scientist. Perret's initial misgivings about the expedition (at one point referring to it as an 'occupation') gradually gave way to personal warmth, although his scepticism of the expeditionary style remained, and was shared by Jaggar (see below).[91]

MacGregor was reasonably sanguine about the likelihood of an explosive eruption in the near- or medium-term, and was less attuned than others to the ongoing seismicity.[92] In his notes and diaries he reports tremors felt by other hotel residents or by expedition partners, but which he himself did not feel. The tremors were more Powell's domain, and the physicist quickly set about distributing instruments and training observers. By the time he left the island on 26th July, Powell had set up a seismic monitoring network with Jaggar shock recorders under the care of estate- and home-owners across the island: at Paradise (Miss Griffin), Bethel (Mr Pencheon Jr. and later Mr Barzey), at St John's (in the house of schoolmaster Mr Daniels), and one on a concrete column which Perret had permitted to be installed inside his field station.

At both Olveston and O'Garro's, seismic instruments would be under the care of Mr Shand, Attorney and General Manager of the Montserrat Company. Shand regularly accompanied and served as a guide to MacGregor, and was sceptical of Perret's warnings, considering him an alarmist. When the Grove Botanical Station was chosen as the best site for the installation of the Wiechert seismograph - despite its unstable volcanic subsoil - Shand and Mr Maloney were chosen as 'the most suitable persons to be entrusted with the care of the instrument'. Powell noted that Shand, a trained surveyor, was 'intelligent and reliable' and had an 'aptitude for mechanics'. Mr Maloney, meanwhile, being a 'capable dentist', was 'good with his hands'.[93]

Thus was constituted an island-wide observational network whose extent would not be matched again until the 1990s.[94] Lenox-Conyngham's chief interest was arranging for the continuation of observations, and statements about the need for continuous monitoring were a common refrain of the various reports produced by the visiting scientists. Jaggar was particularly forceful, arguing that 'a mere "expedition" will accomplish nothing but a report of hearsay', and that British volcanic islands like Montserrat and St Vincent needed to be 'harnessed' with 'resident physicist brains' who would 'direct local talent', be supported to live as close as possible to the centres of volcanic action (Perret-style), and publish 'incessantly'. In so doing, they would not only help to anticipate and ameliorate possible crises through the empirical intimacy of residential science. Rather, scientific volcano monitoring would also perform a 'public service to the Empire' by publicly modelling a commitment to scientific rationality, 'freedom from superstition, careful work, sober judgment', self-sacrifice, and 'trained readiness for a crisis' - all qualities, Jaggar argued, which were 'lacking in tropical peoples'.[95]

Jaggar's racialised vision of locally-attuned scientific colonialism did not materialise in Montserrat. Instead, earlier themes of subjecting local claims to metropolitan reason were reprised, with the chair of the Royal Society's Montserrat Committee arguing that 'it was no good continuing observations unless they could be sent back to England and properly examined here'.[96] Nonetheless, seismic activity began to decline during 1936–7, and by the end of 1937 the Montserrat Committee disbanded and requested that data be sent directly to Powell in Bristol. In 1938, an emerging seismic crisis in Dominica saw several of Montserrat's instruments despatched there, while the Leeward Islands Governor consulted the Presidencies on the establishment of a regional monitoring network. Not all would commit financially, and monitoring in Montserrat slowed significantly during the war years. In 1946 the Wiechert seismograph was sent to St Vincent to help monitor an uptick in seismic activity there; the instrument arrived, but no records of its use survive.

As the observation system was dismantled, so too were the datasets. When records of seismicity for 1938–1945 were later requested from the Royal Society by the newly founded Seismic Research Unit in Trinidad (see below), the cost of posting the voluminous records was considered prohibitive, so they were apparently 'carefully cut … into postage-stamp-sized pieces each containing a single earthquake record'.[97] Fragmented, these seismograms, having been 'written by the Montserrat earthquakes', lost their narrative thread of a volcano stirring gradually but inexorably into life.[98]

1945-1995: the disappearing volcano

> *The eruption … which began in July 1995 … was probably the most long-expected and clearly-signalled eruption to occur anywhere in the world in the twentieth century.*[99]

[88] SA 368.01, Archibald Gordon MacGregor Archive, British Geological Survey.

[89] A. G. MacGregor, 'Royal Society Expedition to Montserrat, B.W.I.: Preliminary Report on the Geology of Montserrat', *Proceedings of the Royal Society of London. Series B* 121 (1936) 232–52.

[90] MacGregor, 'Royal Society Expedition', p.233.

[91] Perret to Day, 26 June 1936, GL-2005-01, Carnegie Institute Archives.

[92] A. G. MacGregor, 'The Royal Society Expedition to Montserrat, B. W. I. - The Volcanic History and Petrology of Montserrat, with Observation on Mt Pelé, in Martinique', *Philosophical Transactions of the Royal Society, Series B* 229, (1938) 1–90.; A. G. MacGregor, 'Prediction in Relation to Seismo-Volcanic Phenomena in the Caribbean Volcanic Arc', *Bulletin Volcanologique* 8, (1949) 69–86.

[93] Powell to Secretary, Royal Society Montserrat Committee, draft letter, 30 July 1936. DM 517/F/193, Cecil Powell – Montserrat Notebooks, 1936, University of Bristol Special Collections.

[94] Authors, 'The First Seismo-volcanological Observatory on Montserrat', under revision, *Volcanica*.

[95] 'Report from Dr Jaggar to Sir Gerald Lenox-Conyngham, FRS, 5th May 1936', MacGregor Archive, BGS.

[96] Minutes of the Montserrat Committee, 24 June 1936, CMB 134 vol 1, Royal Society Archives.

[97] Shepherd et al., 'Precursory activity', p.10.

[98] J.B. Shepherd, J.F. Tomblin, and D.A. Woo, 'Volcano-Seismic Crisis in Montserrat, West Indies, 1966–67', *Bulletin Volcanologique* 35 (1971) 147.

[99] Shepherd et al., 'Precursory activity', p.1.

Why, then, did the eruption come as such as surprise?

The quotation above opens a 2002 conference paper given by four volcanologists of the SRU (Seismic Research Unit, now Centre) of the University of the West Indies, founded in the 1950s following repeated arguments about the need for long-term volcano monitoring in the region. They position the 1990s eruption as the outcome of a long period of 'precursory activity' stretching back to the earthquakes and degassing of the 1890s, the 1930s crisis analysed above, and a subsequent 'volcano-seismic crisis' another three decades later which saw 700 earthquakes recorded between May 1966 and December 1967. At the start of 1966 there was no seismograph in Montserrat, but within a few months SRU installed a four-seismograph network with funding from the Government of Montserrat, which confirmed the shakes' volcanic origins and told a story of magma rising into the upper crust before subsiding again.

In late 1966 an eruption at short notice was considered a real possibility. However, members of the SRU team report that they, like Perret at times before, 'were under strict instructions by the Administrator not to discuss what we were doing with local people', and public statements by the Administrator played down the volcanic risks and emphasised that Montserrat was in no greater danger from volcanic activity than other islands.[100] Nonetheless, each new Administrator and Governor was briefed by SRU scientists, and several subsequent publications presciently mapped the geography of volcanic risk. However, in 1990 the Government of Montserrat withdrew financial support for SRU. This hampered efforts to rebuild the monitoring network following the devastating impacts of Hurricane Hugo in 1989, and communication channels between the SRU and the Government appear to have become challenging in the ensuing years, caused in part by rapid personnel turnover on both sides and, testimonies suggest, a lack of willingness to engage with volcanic risks in light of pressing economic development needs.[101]

As such, when the Soufrière Hills Volcano began to stir again in the early 1990s, with swarms of earthquakes intensifying from January 1992 onwards, there were again few monitoring instruments on the island and no governmental plans in place for how to deal with an eruption.[102] Instead, the island's disaster risk management protocols focused almost exclusively on hurricanes.[103] Furthermore, the relative fragility of the knowledge-making assemblage - its evident vulnerability to disassembly by governmental disinterest or destructive storm - meant that the basic question of the existence of an active volcano on the island was still not entirely settled when the eruption began in 1995. At this point, 'all the relevant governmental authorities stated that they were ignorant of the island's volcanic status'.[104] SRU scientists recount that:

> All three people most closely concerned with disaster preparedness in the island - Governor, Chief Minister and Chief of Police - are on record as stating that they did not know that the island was volcanic let alone that there was a dangerous live volcano within four kilometers of the capital town and that this had been showing increasingly obvious signs of an impending eruption for almost one hundred years.[105]

While the earlier disagreement over the existence of a crater pitted local observers and officials against counterparts in London, by this point the existence of an active volcano was recognised in the scientific community but not, it seems, in governmental circles in Plymouth or Whitehall. A 1987 paper detailing the risks of an eruption[106] 'apparently made no impression on those responsible for disaster preparedness'. A 1993 National Disaster Action Plan received little scientific input and only one sentence referred to volcanic risks, despite the possible links between the ongoing earthquakes and volcanic activity being by then discussed in public. One week into the eruptive crisis in July 1995, Governor Savage telegrammed his astonishment to the Foreign & Commonwealth Office that the recommendations of the 1987 report 'had never been followed'.[107]

As the volcano began to forcefully make itself known, as in the 1930s the local government quickly sought out new sources of scientific assistance and advice.[108] Experts from the SRU and from the US were the first on the scene and together instituted the first manifestation of the Montserrat Volcano Observatory in a row of Nissen huts which had previously been used as a school. UK scientists soon arrived on the scene too, but interactions between different groups of scientists were 'fraught' in the early days of the crisis, with some of the themes of the 1930s crisis reprised in tensions between local and visiting observers, and differing advice being given to the Governor and to the various departments of the UK government who had some share of disaster management responsibility: 'prognostications varied from the view that the volcano would go back to sleep to the prospect of a whole-island evacuation'.[109]

As in the 1930s, it took several months for 'the seriousness of the situation' to dawn on the Foreign Office. Savage's predecessor as Governor, David Taylor, recounts that 'It was not till after 19 people had died in pyroclastic flows from the volcano on June 25, 1997 that minds in Government in [the UK] began to focus on what was going wrong'.[110] The full complexities of the science-policy and disaster management practices in the early years of the eruptive crisis are beyond our scope, but have been well documented.[111] What is perhaps most striking, when viewing the 1930s and 1990s crises together, is how a volcano which (with the benefit of hindsight at least) had been 'clearly signalling' an eruption for a hundred years, had become one of the most watched volcanoes in the Western Hemisphere, and inspired 'classic works of the volcanological literature',[112] could nonetheless not be recognised as a volcano by so many of those charged with protecting those living in its shadow.

Accounts of scientists involved in monitoring the volcano between the 1960s and 1990s suggest there was no shortage of effort

[100] Shepherd et al., 'Precursory Activity', p.3.
[101] Shepherd et al., 'Precursory Activity'.
[102] Fergus, *Montserrat*.
[103] Amy Donovan, Michael Bravo, and Clive Oppenheimer, 'Co-Production of an Institution: Montserrat Volcano Observatory and Social Dependence on Science', *Science and Public Policy* 40, (2013) 171–86.
[104] Katherine Haynes, 'Exploring the Communication of Risk during a Volcanic Crisis: A Case Study of Montserrat, W.I.' (PhD thesis, University of East Anglia, 2005), p.27.
[105] Shepherd et al., 'Precursory Activity', p.2.
[106] G. Wadge and M.C. Isaacs, 'Mapping the Volcanic Hazards from Soufrière Hills Volcano, Montserrat, West Indies Using an Image Processor', *Journal of the Geological Society* 145 (1988) 541–51.
[107] Haynes, 'Exploring the Communication of Risk', pp.28-29.
[108] Amy Donovan and Clive Oppenheimer, 'Science, Policy and Place in Volcanic Disasters: Insights from Montserrat', *Environmental Science & Policy* 39 (2014): 150–61.
[109] Donovan et al., 'Co-Production of an Institution', p.173.
[110] David G. P. Taylor, 'British Colonial Policy in the Caribbean the Insoluble Dilemma—the Case of Montserrat', *The Round Table* 89 (2000) 337–244, p.340.
[111] See e.g. the various works by Donovan and colleagues cited herein.
[112] Shepherd et al., 'Precursory Activity', p.9, referring to the papers produced by the 1930s Royal Society scientists.

to make the volcano and its risks known; instead those knowledge claims, through a combination of direct political pressure and competition with other political priorities, appear to have not travelled smoothly through the liminal spaces linking the realms of international volcanology and colonial governance. Alongside disintegrating observation networks and the enforced secrecy of the 1960s, the complexity of Montserrat's colonial constitution offers an explanation. A number of investigations concluded that the complexity of Montserrat's relationship to the UK in the 1990s, with its constitutional arrangement that was intended as a step towards independence but which had become ossified as a complex hierarchy and patchwork of responsibilities, seems to have actively mitigated against successful governmental disaster preparedness.[113] This complex institutional web, we contend, mitigated against the official recognition of the existence of an active volcano on the island. The earlier recognition of English's crater was a product of the combined labours of local officials, observers and members of the public. But the crater became a scientific artefact, archived in journal articles and technical reports. It failed to become a part of the geopolitical assemblage of Montserrat, disappearing from governmental view both in Plymouth and London until the moment in 1995 when it was no longer possible to ignore it as a fundamental shaper of Montserratian life.[114]

The political geology of crises fast and slow

The 1930s volcanic-seismic crisis in Montserrat is revealing of a number of key features of crisis science: the emergence of new networks and forms of communication; the transformation of scientific spaces into arenas of public deliberation and contestation; the contestation of boundaries between reliable and unreliable knowers; tensions between expeditionary, field and observational science; and the rapid construction of scientific infrastructures and, often, their equally rapid deconstruction. In the case narrated here, these geographies were 'synoptic' in scale, linking one field site with imperial and global networks of circulating scientists, instruments, data, funding, and ideas.[115] Nonetheless, this assemblage was shaped in consequential ways by the hierarchies of colonial rule, and by its ambiguities and contradictions. While the relationship between science and empire has often been narrated in a fashion which implies an all-knowing imperial brain, the decades-long process of establishing the Soufrière Hills Volcano as a geological fact and as an object of governance is further evidence of the often slow and deeply political processes by which facts come to be collectively held, and of how colonised environments were often, in practice, objects of ignorance among those who presumed to rule them.

In offering insights into the geographies of crisis science with this case, we therefore propose that science studies scholars avoid *a priori* assumptions about the timescales of crisis situations. While the space-times of crisis are often defined by urgency and sometimes panic - affective states which are evident in the archives of the crisis moments narrated here - crises can also be understood on much longer timescales. We can read (as volcanologists have done) the 1990s Montserrat eruption as the outcome of a political-geological 'crisis' lasting almost a century.[116] This was a crisis which unfolded according to the inhuman temporalities and agencies of upwelling magma and the accretion and release of seismic forces. But that unfolding was also shaped by the slowly changing forms of colonial rule and practice which profoundly influenced how the volcano was made known by (and to) different actors. Knowledge of the volcanic system built up during the 1930s crisis slowly dissipated as wires were cut, instruments were removed and their graphs - supposedly science's 'immutable mobiles' - were dismembered precisely in order to make them mobile again.[117] Scientific reports were deposited in scientific archives, tacit knowledges built through embodied experience of crisis management disappeared from use as government officials rotated to other posts, and warnings of possible future volcanic crises receded from governmental interest, in both colony and metropole. All of this shaped the now well-documented confusion of the authorities' early response to the 1990s eruption, both in Plymouth and Whitehall.

Conditions of liminality, both in politics and geology, can be long-standing - at least according to human timescales. As such, crises can be both fast and slow.[118] Either way, they function as vectors of assemblage, 'plugging' scientific spaces into wider networks — to paraphrase Finnegan — and rearranging relationships between scientists, institutions, instruments, populations, environments and governments in ways which can be both fleeting and enduring. Attending to the geographies of crisis science in a way which accounts not only for the 'local' politics of expertise but also for transnational and enduring assemblages of knowledge and power is a vital task for geographers of science to take up. In an age of 'poly-crisis',[119] shaped by the intersecting agencies and temporalities of human and earthly forces,[120] and by ongoing struggles to decolonise global knowledge systems,[121] we suggest that studying past crises as vectors of assemblage can reveal the persistence of practices and power dynamics across space and time, in a fashion which can inform efforts to remake scientific and governmental practices in the present.

Data availability

The authors do not have permission to share data.

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[113] Edward Clay et al., 'An Evaluation of HM Government's Response to the Montserrat Volcanic Emergency Volume I' (London: DFID, 1999); Taylor, 'British Colonial Policy'; Donovan and Oppenheimer, 'Science, Policy and Place'.

[114] Peter McGowran & Amy Donovan, 'Assemblage theory and disaster risk management', *Progress in Human Geography* 45 (2021) 1601–1624.

[115] Lehman, 'Making an Anthropocene Ocean'.

[116] Shepherd et al., 'Precursory Activity'.

[117] Bruno Latour, *Science in Action* (Cambridge, MA: Harvard University Press, 1987).

[118] Ben Anderson et al., 'Slow Emergencies', *Progress in Human Geography* 44 (2019) 621–639.

[119] Edgar Morin and Anne Brigitte Kern, *Homeland Earth* (New York: Hampton Press, 1999).

[120] Kathryn Yusoff, *Geologic Life* (Durham, NC: Duke University Press, 2024).

[121] Jazmin P. Scarlett, 'The Harmful Legacy of Colonialism in Natural Hazard Risk', *Nature Communications* 13 (2022) 6945.

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Some of these digitized materials are now available through the Curating Crises Omeka Website: https://curatingcrises.omeka.net/collections/show/2.

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