

24th Report of the Scientific Advisory Committee on Montserrat Volcanic Activity¹

Based on a meeting held between November 10th and 14th, 2019 at the Montserrat Volcano Observatory, Montserrat

Part I: Summary Report

Issued on December 29th, 2019

- There has been no significant surface activity at the volcano during the last year and the current pause has extended now to nine and a half years. The absence of any pyroclastic flow or major rock fall activity implies that the major part of the lava dome remains stable. However, temperatures of volcanic gases that escape through fractures and fumaroles have remained high.
- Seismicity overall has remained at a low level except for occasional short bursts of volcano tectonic earthquakes. Monitoring of ground deformation indicates a slow but continuous lengthening over the island, with a maximum uplift of about one centimetre over the last year. A small reduction in this rate of deformation is now evident.
- Our estimates regarding the individual annual risk to the people of Montserrat due to potential hazards from the volcano remain at the same low level as last year. For people living or working in Zone A and B we estimate the probability of an individual's death due to volcanic activity as minimal, and for Zone C comparable to the risk exerted by an earthquake.

¹ The information provided in both parts of this Report is advisory. It is offered, without prejudice, for the purpose of informing the party commissioning the study of the risks that might arise in the near future from volcanic activity in Montserrat, and has been prepared subject to constraints imposed on the performance of the work. While Committee members believe that they have acted honestly and in good faith, they accept no responsibility or liability, jointly or severally, for any decisions or actions taken by HMG or GoM or others, directly or indirectly resulting from, arising out of, or influenced by the information provided in this report, nor can they accept any liability to any third party in any way whatsoever.

Volcanic Activity

During the last year, volcanic surface activity has remained at a low level and no pyroclastic flows have occurred. Volcanic gases originating from the deep magma reservoir escape through fractures and fumaroles in the lava dome. Images of these fumaroles obtained by thermal camera indicate that the temperature of volcanic gases remains high. Measurements of SO₂ emissions have been carried out by helicopter or boat, as well as a network of spectrometers, revealing daily fluxes in the range of about 200 - 300 tonnes, in line with gas observations during previous eruption pauses.

When gases are trapped in the volcano, possibly in its hydrothermal system, and a certain overpressure is reached, short bursts of volcano tectonic earthquakes (so-called VT strings) signal the opening of cracks and escape routes for accumulated gas. Twelve VT strings have been detected over the last year, with varying duration and intensity. However, in contrast to previous years, none of these were accompanied by ash venting at the surface, nor showed any correlation with strain or gas measurements.

The monitoring of ground deformation shows a slow lengthening trend over the island with a maximum uplift of about one centimetre over the last year. These trends are consistent with the activity we have seen over the previous 8 years, however, a small reduction in the rate of deformation is now evident. Pressurisation through magma cooling and crystallisation, migration of gas from a deeper reservoir, or new magma influx could explain these observations. Taking the reduction of the deformation rate into account, we also consider now the possibility that part of the ongoing surface deformation could be a delayed response to previous magma intrusion that could have ceased several years ago. The explanation of the deformation pattern is subject to ongoing research.

Based on current observations and monitoring results we conclude that the volcano remains in a state in which lava extrusion is still possible at short notice. However, there is no indication that this is imminent. We think there is less than 13% probability that magmatic surface activity, such as lava extrusion or explosions, will resume at some time during the next 12 months, and the most likely scenario for the next year is a continuation of the current state.

Volcanic Hazards

The major part of the lava dome remains stable but continuing erosion has the potential to destabilize steep parts of the dome. Hazards from rock falls, pyroclastic flows of limited reach, minor explosions and mudflows remain a possibility over the next year, even without lava extrusion. A collapse of the dome, with more extensive pyroclastic flows, also remains possible but less likely.

A resumption of lava extrusion would require magma to rise within the dome, likely producing changes in the patterns of seismicity, ground deformation and gas emissions. An initial period of surface activity, such as ash venting, rockfall and small explosions is unlikely to be hazardous to Zones A, B and C but ash fall and, in more energetic explosions, small rocks might reach these

areas. Such hazards would affect some areas within Zone V, such as Plymouth and St George's Hill. If fresh magma pressurises the dome or reaches the surface, hazard levels could rise rapidly.

Assuming that all monitoring networks will be maintained and upgraded in the next year, we consider it very likely that signs of resuming lava extrusion or pressurisation would be detected by the MVO; however, renewed volcanic activity without precursors cannot be ruled out completely. Continuous monitoring of the volcano is essential.

Risk levels in Zones A, B & C

We have carried out our standard quantitative risk assessment using expert judgment on the probability of future events and we obtained essentially the same numbers as last year. Therefore, we adopt the individual risk levels in Zones A, B & C as unchanged from last year².

The average annual risks of a full-time resident individual being killed by volcanic activity have decreased to lower levels in all Zones from 2010 through 2017, and remained at a very low level ever since. For residents of Zone A, B and C this exposure to volcanic risk remains less than that for hurricanes.

Risks in Zone V

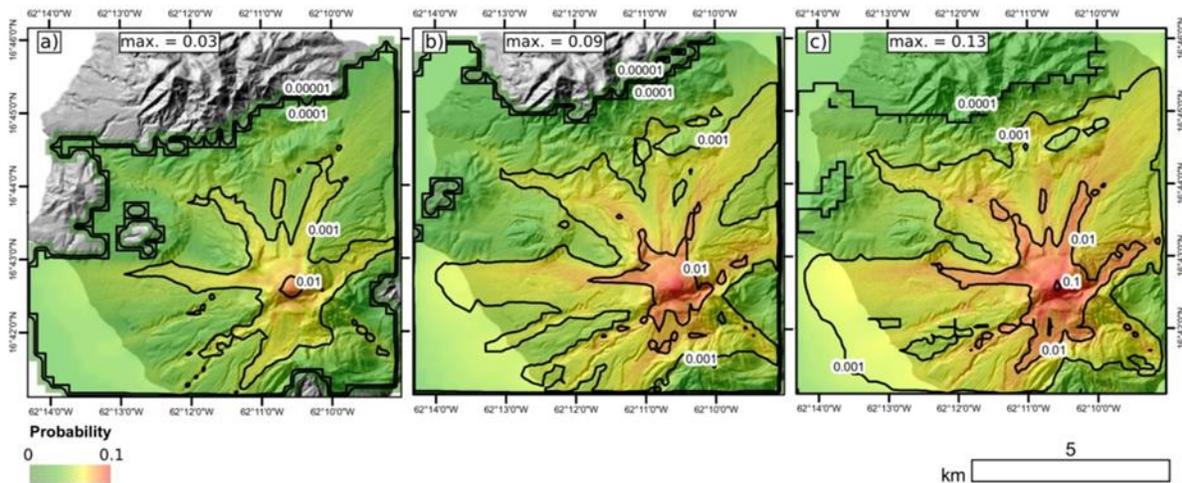


Figure 1 Probability of pyroclastic flow inundation for (from left to right) one, five and 20 years. Numbers represent the probabilities, e.g. $P = 1/100 = 0.01$.

Activities taking place in Zone V such as sand exports from the Plymouth jetty, geothermal work, police operations, animal projects, metal reclamation, filming and tourist trips need to be managed in co-operation with the MVO. Hazard levels within Zone V vary strongly from

² Note that the risk values will need to be re-assessed following any major change in behaviour, e.g. a resumption of lava extrusion or a significant increase in seismicity, ground deformation or gas emission.

location to location and we now consider it appropriate to develop, in collaboration with MVO, an approach to subdivide Zone V into smaller areas (micro zonation). This approach will, in turn, facilitate, a more detailed analysis of risk associated with specific activities in specific locations, and therefore provide a better use of the current “window of opportunity” for those activities in Zone V. Risk levels for certain activities will be determined on a case-by-case basis, and based on the short-term hazard assessment (e.g. the probability of pyroclastic flows being generated in the next year). This should not be confused with a long-term hazard map that is used for longer-term planning of infrastructure and investments in Zone V.

In co-operation with the MVO, we have therefore started to develop a map of Zone V that allows the identification of pyroclastic flow inundation probabilities from which we can then calculate risk to certain activities depending on their actual location within Zone V. This project will provide a more flexible management of activities in the exclusion zone.

Figure 1 shows one component of such a map depicting the hazard from pyroclastic flows only, compiled for three time windows of one, five and 20 years from now. The increasing probabilities of pyroclastic flow inundation as the time window lengthens can be seen in the growing extent of areas covered by yellow and orange colours. The probabilities for pyroclastic flow inundation are based on probabilistic flow modelling which takes into account the current situation of the volcano. A complete ‘operational’ hazard map would also include other hazards comprising explosions, lahars, and the exposure to gas plumes, as well as geographical references as coastlines, roads etc.