

# **ASSESSMENT OF THE HAZARDS AND RISKS ASSOCIATED WITH THE SOUFRIERE HILLS VOLCANO, MONTSERRAT**

## **23<sup>rd</sup> Report of the Scientific Advisory Committee on Montserrat Volcanic Activity<sup>1</sup>**

Based on a meeting held between November 4<sup>th</sup> and 8<sup>th</sup>, 2018 at the Montserrat Volcano  
Observatory, Montserrat

### **Part I: Summary Report**

Issued on December 18<sup>th</sup>, 2018

- There has been no significant surface activity at the volcano during the last year and the current pause has extended to eight 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. Observations of ground deformation and a steady SO<sub>2</sub> flux indicate that the volcano remains in a state of internal unrest and that pressurisation of a deep reservoir is still ongoing.
- Our estimates regarding the risk to the people of Montserrat due to potential hazards from the volcano remain at the same level as last year. For people living or working in Zone A we estimate the odds of an individual's death due to volcanic activity in the next year at about 1- in-13 million. For Zone B we estimate those odds at about 1-in-1.5 million, and for Zone C at about 1-in-180,000.

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<sup>1</sup> 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. Temperatures of volcanic gases derived from the deep magma reservoir and escaping through fractures and fumaroles in the lava dome have remained high, with the hottest fumaroles maintaining 500°C over the years since the last major activity. SO<sub>2</sub> flux measurements have been conducted regularly using the helicopter, as well as the re-deployed network of spectrometers, revealing fluxes in the range 100- 400 t/d, in line with gas observations during previous eruption pauses. These figures are also in line with satellite-based estimates.

When gases are trapped somewhere in the volcano 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. Thirteen VT strings have been detected over the last year, however none of these was accompanied by ash venting, nor showed any correlation with strain 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 7 years, however, we see for the first time a reduction in the rate of deformation. Pressurisation through magma cooling and crystallisation, migration of gas from a deeper reservoir, or new magma influx could explain these observations. New computer simulation will be carried out to take the reduction in the rate of deformation into account.

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 20% probability that magmatic surface activity, such as lava extrusion or explosions, will resume at some time during the next 12 months.

## **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.

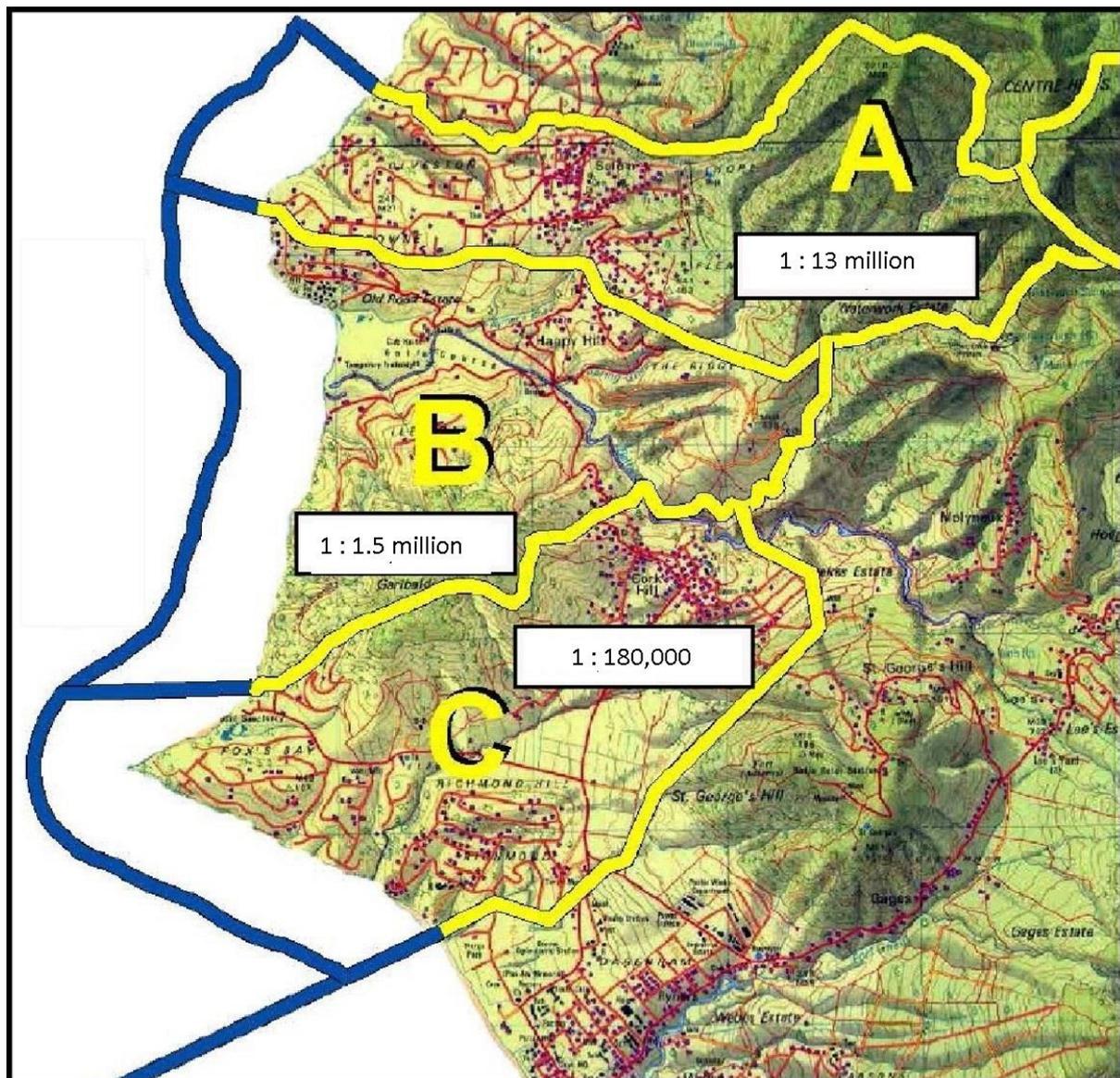
A resumption of lava extrusion would require magma to rise within the dome, likely producing an initial period of surface activity, such as ash venting, rockfall and small explosions. This initial activity is unlikely to be hazardous to Zones A, B and C but ash fall might reach these areas. Such hazards 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.

### Risks during the Next Year

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 consider the individual risk levels unchanged with respect to last year. 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.



*Fig. 1 Map of Hazard Level boundaries for Zones A-C together with estimated, rounded annual risks from volcanic hazards of death for an individual full-time resident, averaged over zones A, B and C, respectively.*

We assessed the current overall risk of death from volcanic hazards for the population of Montserrat to be similar to last year. For a full explanation of how these values are derived, see the Full Report.

### **Risks in Zones A, B & C**

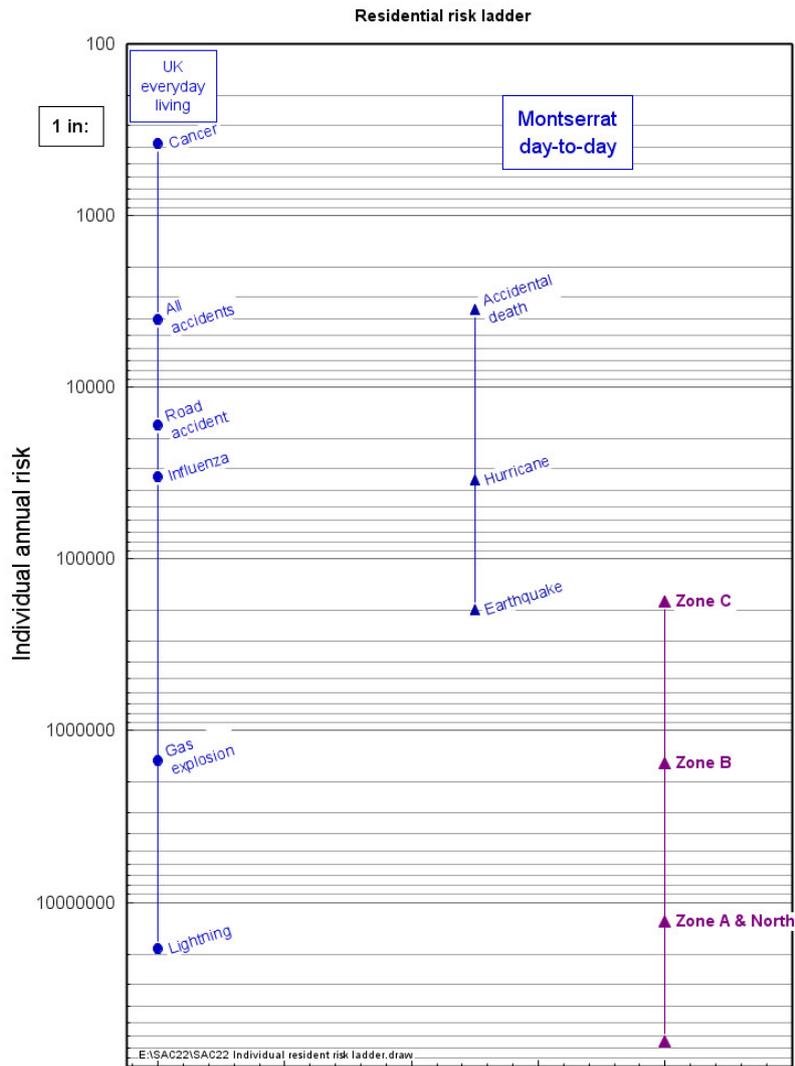
The average annual risks of a full-time resident individual being killed by volcanic activity have decreased to lower levels in all Zones (Figs 1 & 2) over the last years. These values are expressed as ‘odds’ rounded to the nearest 1000, and compared with the estimates from the previous years:

Zone	SAC22/23	SAC21	SAC20
A	1 in 13 million	1 in 50 million	1 in 4 million
B	1 in 1.5 million	1 in 1.7 million	1 in 17,000
C	1 in 180,000	1 in 110,000	1 in 8,000

For residents of Zone A, B and C this exposure to volcanic risk remains less than that for hurricanes. For Zones A and B the calculated risk values vary slightly between 2015 (SAC20) and 2018 (SAC23), however, the differences are not significant and simply illustrate the challenge of quantifying very small likelihood numbers.

### **Risks in Zone V**

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. Risk levels within Zone V do vary strongly from location to location and going forward we consider it more appropriate to subdivide Zone V into smaller areas where risk levels could be determined on a case by case basis, rather than using the same risk level throughout Zone V. In co-operation with the MVO, we suggest compilation of a map of Zone V that allows for identification of the risk to certain activities depending on the actual location within Zone V. This future project will provide a more flexible management of activities in the exclusion zone.



*Fig.2 Relative individual annual risk from the volcano for full-time Montserrat residents compared with other non-volcanic risks in Montserrat (centre) and everyday risks in the UK (left).The scale of risk is logarithmic, increasing upwards and expressed numerically.*