

SCIENTIFIC ADVISORY GROUP FOR EMERGENCIES (SAGE)

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VOLCANIC ASH DISRUPTIONS

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MINUTES of a Meeting held in 35 Great Smith Street  
on 19 May 2010 at 14:00

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**PRESENT**

Professor John Beddington  
Government's Chief Scientific Advisor  
and SAGE Chair

Dr David Thomson	Met Office
Professor Stephen Mobbs	Natural Environment Research Council (NERC)
Professor Stephen Belcher	University of Reading
Professor Hugh Coe	University of Manchester
Professor Adrian Simmons	European Centre for Medium-Range Weather Forecasts (ECMWF)
Dr Willy Aspinall	University of Bristol
Professor Alex Halliday	University of Oxford
Dr David Kerridge	British Geological Survey
Dr Sue Loughlin	British Geological Survey
Professor Marge Wilson	University of Leeds
Dr. Matt Watson	University Bristol
Professor David Spiegelhalter	University of Cambridge
Professor Brian Collins	Department for Transport and Department for Business, Innovation and Skills
Professor David MacKay	Department for Energy and Climate Change (DECC)

**OBSERVERS**

Susan Hamilton	Department for Transport
Dr Jordan Giddings	Department for Transport
Chris Bradley	Foreign and Commonwealth Office
Ian Williams	Home Office

Dr Penny Bevan  
Dr Hillary Walker  
Jeremy Clayton  
Sarah Brown  
John Perry  
Ben Alcott

Department for Health  
Department for Health  
Government Office For Science  
Defra  
MOD  
Civil Aviation Authority

**BY TELEPHONE**

Dr Thor Thordarson  
Dr Gudrun Larsen  
Dr Kristin Vogfjord

University of Edinburgh  
Institute of Earth Sciences  
Icelandic Meteorological Office

**SECRETARIAT**

Judy Britton (GO-Science)  
Chris McFee (GO-Science)  
Catherine McCloskey (GO-Science)  
Anita Friend (Cabinet Office)  
Elizabeth Moore (Cabinet Office)

**APOLOGIES**

Dr Jennie Gilbert  
Professor Bill McGuire  
Professor Steve Sparks  
Professor David Clary (FCO)  
Professor Mark Welland (MOD)  
Professor Julia Slingo (Met Office)  
Professor Bob Watson (Defra)  
Professor Bob Maynard (HPA)

## **Item 1 – Welcome and Review of actions**

Professor John Beddington welcomed Dr Thor Thordarson , Dr Kristin Vogfjord (Icelandic Meteorological Office) and Dr Gudrun Larsen (Institute of Earth Sciences) to the group.

### Review of Actions

**Actions 1 and 2** were complete. **Actions 3 and 4** were discussed as part of agenda item 4 and were complete. **Actions 5 and 6** were discussed as part of agenda item 2 and were complete. **Action 7** was discussed as part of agenda item 7 and was complete. **Action 8** (the aviation sub-group) had been superseded by other actions (see agenda item 5). **Action 9** was on-going and was discussed as part of agenda item 6. **Action 11** was on-going.

## **Item 2 – situation report**

### British Geological Survey (BGS)

BGS reported that the plume had reduced in height since the weekend (5000m compared to 6000 to 7000m). This along with the decrease in the number of earthquakes indicated a decline in activity. However, the depth of the earthquakes (most originated at 16-18km below the surface) was likely to indicate a continued magma supply. The Institute of Earth Sciences (IES) in Iceland continued to collect samples which would allow better definition of the source parameters.

The key points raised in the discussion were:

- the composition and particle size distribution of the ejected material varied daily and there had been significant pulses of sulphur dioxide;
- the particles collected 30km from the source on the 16/17 May were very fine (80% of them were under 90µm) indicating that there could be some interaction between magma and water, and
- there were many other volcanoes in Iceland which presented a risk to the UK.

BGS said that they had procured 6 seismometers from a UK manufacturer. These seismometers would be similar to the backbone formed by the IMO network and would provide real-time information. There were also a number of non-real time measurements undertaken by university groups from around the world. The group agreed that a wider agreement was needed to allow this information to be shared.

**ACTION 3.1: BRITISH GEOLOGICAL SURVEY to work with DR GUDRUN LARSEN** to produce a short paper which listed which volcanoes in Iceland were a current cause for concern, to clarify the reasons for this and to quantify the risk as far as was currently possible.

#### Met Office

The Met Office reported that there was currently a southerly (favourable) airflow over the UK. Conditions were expected to change at the weekend with northerly and easterly winds predicted early in the following week. The risk that this would pose to UK airspace was dependent on the size of the plume at that time (SAGE(10)(05)(16)).

Professor Adrian Simmons introduced a paper (SAGE(10)(05)(11) which analysed six-hourly data on airflow between Iceland and the UK and the likelihood of shifting weather regimes. He advised against over-interpretation of this analysis but reported that it indicated that climatologically there was a 28% chance of north-westerly (unfavourable) airflows over the UK at any one time. There was estimated to be only a chance of under 2% of being in unfavourable conditions that would last a further 5 days or more. In contrast there was estimated to be about a 30% chance of being in favourable conditions that would remain so for 5 or more days.

#### **Volcanic Hazards Sub-group update**

Dr Willy Aspinall reported that initial analysis showed a weak positive correlation between the preceding gap and the Volcanic Explosivity Index (VEI) of eruptions at Katla. Colleagues at the Institute of Earth Sciences reported they had noted a similar correlation between the VEI and the length of time following eruptions at Katla. Work was now needed to determine whether failed eruptions should be included in this analysis.

**ACTION 3.2: VOLCANIC HAZARDS ASSESSMENT SUB-GROUP** to look at data from Iceland to assess correlation between magnitude of eruption and the following repose time.

**ACTION 3.3: VOLCANIC HAZARDS ASSESSMENT SUB-GROUP** to consider building “failed eruptions” that didn’t reach the surface into model looking at possibility of Katla erupting.

### CAA

The CAA noted that they had held an industry briefing day on the 13<sup>th</sup> May and that this had been supported with presentations from SAGE members.

### **Item 3 – Feedback on Iceland visit**

Updates of the Iceland visit were provided by Dr Sue Loughlin, Professor Steve Mobbs, Dr Kristin Vogfjord and Dr Gudrun Larsen. Professor Mobbs tabled a paper describing the visit. (SAGE(10)(05)(18)).

SAGE members thanked Kristin and Gudrun and asked them to convey their thanks to their colleagues who had been very helpful on the visit. The group agreed that a memorandum of understandings between UK and Icelandic academics and Governments would be useful to ensure a collaborative approach was taken.

The key points raised during the discussion were:

- the Icelandic Meteorological Office (IMO) would have a second weather radar by the end of this year;
- there was still the need for additional lidars in Iceland;
- the IMO would appreciate assistance from SAGE colleagues on determining particle size from satellite data and to better understand and model the bent-over plume;
- a radio-sonde system to characterise the plume in more detail would be useful;

- a better understanding of the layers within the plume was required. Some SAGE members were working on a fluid dynamics model to look at this issue;
- seismometers, pressure sensors and strain gauges would be important to understand the internal dynamics of the eruption, improve predictability, early warning systems and improve the ability to determine when eruptions ceased; and
- although there were enough seismometers around Eyjafjallajökull more broadband instruments near Katla would help improve the sensitivity of measurements. More monitoring equipment was also required at other volcanoes in Iceland.

**ACTION 3.4: NATURAL ENVIRONMENT RESEARCH COUNCIL** to take forward the work agreed in their meeting with the Icelandic Met Office.

**ACTION 3.5: PROFESSOR JOHN BEDDINGTON** to contact Icelandic government to state his support and stress the benefits of funding the loan of Italian weather radar to the **Icelandic Met Office (SECRETARIAT** to draft letter).

**ACTION 3.6: DR MATT WATSON** to contact the **Icelandic Met Office** to offer his support on obtaining particle size distributions from satellite observations.

**ACTION 3.7: MET OFFICE** to talk to **Icelandic Met Office (IMO)** about how IMO's access to global satellite data might be improved.

**ACTION 3.8: BRITISH GEOLOGICAL SURVEY** and **INSTITUTE OF EARTH SCIENCES** to draw up paper detailing which volcanoes in Iceland are being extensively monitored; why these volcanoes are being focussed on; and which volcanoes need additional monitoring.

**Agenda item 4 – Sulphur Dioxide**

Professor Beddington introduced the discussion, which was summarised in the covering note (SAGE(10)(05)(19)).

The Department for the Environment, Food and Rural Affairs (Defra), and the Department for Health (DH) were asked to provide sulphur dioxide thresholds, which if exceeded would start to cause concern and consequently act as a trigger for contingency arrangements to be activated. Based on advice from the Health Protection Agency, DH proposed a threshold of  $1000\mu\text{m per m}^3$  averaged over a period of 15 minutes. This was the point beyond which those with underlying conditions might be expected to start experiencing more serious health affects and the point at which hospitalisation rates might start to rise. Defra agreed with this threshold and reported that currently fluoride and PM10 (the distribution of particles smaller than  $10\mu\text{m}$ ) levels were of greater concern to them.

Professor Steve Mobbs reported that old materials may have been a factor in the corrosive damage to the Dornier, as a result of sulphur dioxide. The CAA said that they were not so concerned with the impact of sulphur dioxide on planes at altitude and this was far less significant than issues surrounding ash effects. The DH said that most air in airliners was re-circulated, which would limit any exposure to pockets of gas, but that they didn't offer guidance on this issue.

The group was told that measurements indicated that in the initial phases of the eruption 500-600 mg of sulphur dioxide per kg of magma were currently being released. This had since increased to 1100 mg of sulphur dioxide per kg of magma. Steve Mobbs reported that measurements showed that there were a few parts per billion (ppb) of sulphur dioxide in the plume but that there were patches with up to 200 ppb. This was consistent with the modelling. This was still well below the DH defined threshold. The group was cautioned that experience from Montserrat showed sulphur dioxide could be emitted at variable levels and that the concentrations were not necessarily correlated with the amount of material being ejected.

The Met Office reported that although the NAME model could include sulphur dioxide as a passive material it did not currently have the capacity to include the potentially complex chemical reactions that would take place within the plume. These

were thought to be more complex than those that usually occur in the atmosphere and are well understood.

The group agreed that further work to determine how much sulphur dioxide needed to be ejected for the DH threshold to be reached, was required. This would include the use of:

- the model that Professor Wilson had developed based on the 1783 Larki eruptions;
- petrological<sup>1</sup> methods to estimate likely sulphur dioxide magma concentrations;
- microprobe measurements to estimate sulphur dioxide emissions from the source and estimated eruption rates;
- existing models on the dispersal of sulphur dioxide in the atmosphere; and
- work to define the complex chemical reactions that take place within the plume, owing to the wide range of chemicals in it.

In addition the group were reminded that satellite measurements have a good sensitivity to sulphur dioxide levels and could therefore help provide early warning of when triggers may be exceeded. Other options for early warning would be investigated.

**ACTION 3.9: NATURAL ENVIRONMENT RESEARCH COUNCIL** to involve **DR MATT WATSON** and his team at Bristol University in their work on high-resolution fluid dynamics modelling to investigate the complicated behaviour of the plume close to the vent.

**ACTION 3.10: PROFESSOR MARGE WILSON** to convene sub-group looking at the sulphur dioxide issue, including: monitoring and modelling capability; the predictability of sulphur dioxide emissions; determining the level of volcanic

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<sup>1</sup> E.g a petrological microscope examination of thin sections combined with microprobe information to determine chemical compositions and relative concentrations within a sample.

emission required for the 1000µg/m<sup>3</sup> threshold to be reached in the UK and the ability to provide early-warning for this threshold being reached.

### **Agenda Item 5 – Changes to the ‘no fly’ zones, and Indicative Scenarios**

#### New ‘grey zone’

The CAA introduced the paper they had placed on their web site outlining the process by which they had introduced a new ‘grey zone’ (SAGE(10)(05)(29)). This paper explained the rationale for the new zone and associated safety levels. Increasing the zone by a factor of two was part of a stepwise, pragmatic and safe approach to maximising the use of airspace. The Met Office confirmed that introducing a new threshold concentration a factor of two higher, did not affect the overall uncertainties of the model and that, despite concentration fluctuations and errors in predictions exceeding by a factor of 2, the change in threshold did imply a corresponding change in the risk.

Dr Willy Aspinall introduced his paper on probabilities on extreme events and told the group that it was important to consider a very rare incident where a number of low probability events could occur in conjunction (SAGE(10)(05)(27)). The group agreed that there needed to be further discussion around this paper.

**ACTION 3.11: BRIAN COLLINS (DEPARTMENT FOR TRANSPORT)** to form a sub-group to review the introduction of the “Time Limited Zone”, the NAME modelling of potential ash concentrations, and the approach of the aeroengine manufacturers to understanding engine tolerances.

Sub-group to include the **Civil Aviation Authority, Met Office, Matt Watson, Willy Aspinall, Government Office for Science** and others as necessary.

#### Indicative scenarios

The updated indicative scenarios were briefly discussed (SAGE(10)(05)(24)), and three papers from departments were tabled (Defra – SAGE(10)(05)(21), DH – SAGE(10)(5)(22), and DECC – SAGE(10)(05)(23)) which considered potential

impacts of these scenarios. Work was still in progress in understanding the impact of each scenario, and this would be informed by the output of the sulphur dioxide and volcanic hazard sub-groups. It was agreed that the scenarios paper would be updated accordingly.

**ACTION 3.13: GOVERNMENT OFFICE FOR SCIENCE, CIVIL CONTINGENCIES SECRETARIAT, MET OFFICE and BRITISH**

**GEOLOGICAL SURVEY** to update the Indicative Scenarios paper in light of the work of the **Met Office** and **Adrian Simmons** on the variability of atmospheric flow from Iceland to the UK and the Katla probability work.

**Agenda Item 6 – research funding**

The group noted the paper outlining potential research needs (SAGE(10)(05)(25) and SAGE(10)(05)(26). Professor Beddington reported that the secretariat was working on this and that it would be taken forward over the next few weeks.

**Agenda Item 7 – AOB**

The appraisal paper by Dr Willy Aspinall was discussed as part of Agenda item 3. There was no other business.

Professor Beddington thanked the SAGE members for their continued time and hard work. He said that work was progressing through the sub-groups, and he proposed to meet again in around one month. He also asked members of the sub-groups to keep the secretariat informed of meetings.

**ACTION 3.12: ALL SUB-GROUPS** to inform the secretariat of planned meetings, and provide agendas and outcomes of these meetings.

**SAGE Secretariat**  
**27 May 2010**