Concerns for air traffic during volcanic ash cloud were legitimate, say scientists

Tests have found that grains in the ash cloud were sharp enough to put aircraft at risk from abrasion and engine failure

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- guardian.co.uk, Monday 25 April 2011 20.00 BST
- Article history

Particles collected from the Iceland ash cloud were found to be sufficiently sharp to damage jet engines. Photograph: Brynjar Gauti/AP

An independent investigation into the volcanic ash cloud that caused travel chaos across Europe last year has vindicated the aviation authorities' decision to ground thousands of flights until the danger had passed. The drifting plume of ash contained fine particles that were hard and sharp enough to put aircraft at risk from abrasion on windows and airframes and, more seriously, to melt inside jet engines and clog up cooling ducts – something that could have caused engines to fail and planes to fall from the sky, scientists report.

Detailed tests on particles collected from the ash cloud found the grains were still sufficiently sharp to cause damage to aircraft two weeks after the violent eruption of the Eyjafjallajökull volcano in Iceland.

The ash cloud produced in April last year grounded aircraft over much of Europe for nearly a week. Some 100,000 flights were cancelled, leaving an estimated 10 million travellers stranded or delayed. The decision to close airspace cost European airlines and tour operators between €1.5bn and €2.5bn, according to estimates by EU transport officials.

The flight ban led to criticisms from the airline industry, with some carriers accusing the Civil Aviation

Authority (CAA) of overreacting. The chief executive of British Airways, Willie Walsh, said the prolonged ban was "scandalous". When more ash appeared over Britain a month later, Sir Richard Branson, head of Virgin Atlantic, called the closure of Manchester airport "beyond a joke". Neither airline responded to inquiries over the Easter bank holiday weekend.

"One of the important findings of our research was that the air-traffic authorities' decision to close airspace was absolutely the correct one," said Susan Stipp, leader of the nanogeoscience research group at the University of Copenhagen, who studied the ash cloud with colleagues at the University of Iceland.

The Eyjafjallajökull volcano spewed a vast cloud of ash high into the atmosphere when hot magma erupted beneath 300 metres of ice that lay on top of the caldera. When hot magma mixed with the ice, it produced a powerful steam explosion.

Fears over the dangers of ash clouds to aircraft come from an incident in 1982, when a British Airways 747 carrying 263 passengers flew through an ash cloud during the eruption of Mount Galunggung in Indonesia. The pilot saw sparks flying from the aircraft's windows and wings as the ash sandblasted the plane, and all four engines failed when melted ash coated the interior components. The pilot managed to restart three of the engines when they cooled during descent, and landed while looking through a two-inch strip in a side window that had been spared the worst of the sandblasting.

The CAA closed British airspace after consulting safety guidelines drawn up by the International Civil Aviation Organisation, a branch of the UN that sets global aviation standards. The guidelines stated that aircraft must avoid contact with ash clouds. The aviation industry knew of the requirement but had taken little effective action to draw up safe levels of ash in the air.

"I knew that they were sitting on a knife-edge dilemma: if they closed airspace needlessly, it meant losses of huge amounts of money and annoyance and hardship for stranded passengers, their families and businesses. But if they did not close airspace, and even one airplane went down, the results could be tragic," Stipp told the Guardian. "It seemed to me that the air-traffic authorities had to fly blind on making that decision and if anything, were erring on the side of caution."

Writing in the journal Proceedings of the National Academy of Sciences, the researchers describe a series of tests on ash collected during the powerful eruptions and afterwards. The studies revealed the ash cloud to be carrying finer particles, which could be more troublesome to aircraft engines than those released by typical eruptions.

The group measured the particle size, shape and hardness to judge whether they could cause dangerous sandblasting to aircraft. The particles clustered around two size ranges, from 25-thousandths of a millimetre to one-fifth of a millimetre, and were harder than the materials used to make the aircraft bodies. They melted between 900ºC and 1,400ºC, and so could easily clog up jet engines, which run at 1,500ºC to 2,000ºC.

"The very sharp, hard particles put aircraft at risk from abrasion on windows and body and from melting in jet engines," the scientists write in the journal. "Concerns for air transport were well grounded."

In further laboratory tests, Stipp simulated the wear and weathering of the particles from being in the atmosphere for two weeks. The particles remained sharp enough to cause damage, she concluded.

The scientists have drawn up emergency procedures to be used in future incidents when ash clouds threaten to close airspace. The tests can reveal in one hour whether the particles are toxic to people and

animals. In six hours, aviation officials would know whether the ash cloud posed a danger to aircraft, and in 24 hours, would have enough information to predict the size and density of the ash cloud and how it carried on the winds.