

Airborne particulates

Monitoring and characterisation

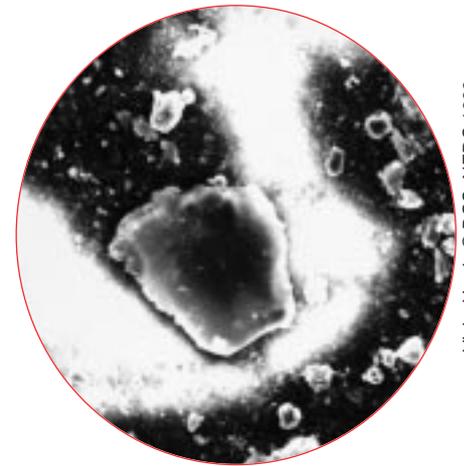
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Many natural processes as well as human activities generate fine particulate aerosols containing a wide range of components. The largest particles that can be maintained in suspension by air currents and eddies are about one millimetre (1000 microns) in size. These aerosols can affect the rural and urban environments, both close to and at great distance from source. They include mineral grains, biological particles, soot, salts, fragments of metals and alloys, etc. The mineral (i.e. inorganic) component is derived both from natural processes (sea spray, forest fires, volcanic activity and deserts — red dust from the Sahara is regularly deposited over Europe) and man's activities (traffic, civil engineering, exposing soil to wind abrasion through agricultural practices, and industries such as mineral extraction, quarrying and cement works).

Increasing concern over air quality worldwide has accelerated research into the field of particulate monitoring and characterisation. In the UK, the 1990 Environmental Protection Act empowered authorities to prosecute polluters; section 79(1)(g) allows pre-determined limits to be set for 'any dust arising from industrial trade or business and being prejudicial to health or a nuisance'. Dust is not only a nuisance in the domestic setting, there are also concerns about its impact on business, vegetation and public health. World-wide, recent high-profile natural disasters, such as the eruptions of Mount Pinatubo and the Soufriere Hills volcano in Montserrat, have raised the question of the health implications of fine volcanic ash for the local inhabitants. In the UK, asthma is on the increase, especially among children, and there are increasing numbers of successful compensation claims by former miners suffering the effects of coal dust inhalation (such as silicosis), and those exposed to asbestos or other harmful or toxic particulates in the course of their work.

Particles below 100 microns may not be visible to the naked eye, but may be inhaled and those smaller than 10 microns may penetrate deep into the lungs. The need for monitoring has therefore been recognised, and many networks put in place to monitor PM10 (particulate material less than 10 microns in aerodynamic diameter; a nominally respirable fraction). Sampling may be by active or passive means, either relying on wind and precipitation to bring particulates to the dust gauge or drawing air through a filter by means of a pump. Passive deposit sampling systems have the advantage of being relatively inexpensive, although requiring long periods of exposure, typically one month.

The BGS now owns a set of the favoured 'Frisbee-type' dust deposit gauges. These consist of a collecting bowl resembling an up-turned Frisbee with a foam insert to prevent collected particulates being blown back out. Dust dispersion from a potential source (such as a quarrying operation) may be established using clusters and/or traverses of deposit gauges to establish both the rate of drop-off and to collect samples for 'fingerprinting' to confirm provenance. This may be done through methods of analysis commonly applied to geological materials. X-ray diffraction analysis is used to examine the mineralogy of crystalline samples, the ratios of the various components may be used to measure the drop-off of inputs from individual sources. Both Scanning Electron Microscopy (SEM) and Energy Dispersive Spectrometry (EDS) may be used to determine size, sphericity, form and chemistry of discrete particles. Typically, a marked drop in average particle size is observed with increasing distance from source. Sensitive chemical analytical techniques such as Inductively Coupled Plasma Mass Spectrometry are also available to further characterise the bulk composition.



Above: Secondary electron SEM image, showing angular particulate materials collected using a dust deposit gauge on the margins of a working limestone quarry. The large grain in the centre of the field of view is an alkali feldspar.

Below: 'Frisbee-type' dust deposit gauge in use. It is positioned within one of Derbyshire's working limestone quarries, in close proximity to the crusher, a potential source of fine particulates.

