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Editorial

Impacts of dust on environmental systems and human health

Increasingly, airborne particles emitted from geologic media pose threats to human health and the environment worldwide due to expansion of infrastructure development to serve increasing population. These particles which are commonly referred to as "dust", can range in size from 1 to 10,000 μM with a large percentage falling within the PM-10 particle size category [particles with aerodynamic diameter of 10 μm (microns) or less]. Dust can be generated through open-cast mining operations, civil construction operations, farming activities, and vehicle operations on un-surfaced roads. Upon generation, dust can be carried by wind into sensitive environments. Adverse health effects of respiratory "dust" on human health are well-documented. Love et al. [1] surveyed 1224 men and 25 women at 9 open-cast coal mining sites in the United Kingdom and found asthmatic symptoms in 5% of the men and chronic bronchitis symptoms in 13% of the men. In another report by Banks et al. [2] on the United States Public Health Service data, 38% of pneumoconiosis occurred in drill crew members. Occupational exposure to respirable quartz in dust can also lead to lung emphysema. Significant levels of anthropogenic quartz within PM-10 samples have been statistically tied to quarry operations in central California [3]. A review of data on the carcinogenicity of respirable quartz by the International Agency for Research on Cancer (IARC) led to the conclusion that evidence is sufficient to confirm the carcinogenic hazard posed by these materials to humans [4].

Apart from the intrinsic geochemistry of earthen dust materials, anthropogenic activities have introduced contaminants that sorb onto soil particles that are subsequently entrained into the atmosphere as dust. Recently [5], platinum group elements released through vehicle operation have been found in airborne dust samples in ring road areas of Madrid, Goteborg, Rome and Munich at levels of 17.7, 4.1, 8.1 and 4.1 pg/m^3, respectively. Lead and a variety of other metals from automobile exhaust have also been found to contaminate roadway and parking site dust sampled in Palermo, Italy [6], and Kayseri, Turkey [7]. Contamination of roadway topsoil material from which dust may be generated by vehicular and wind action is particularly prevalent in developing countries, where most roads are un-surfaced and in some cases, leaded gasoline has been in use. For example, Fakayode and Olu-Owolabi [8] and Onianwa [9] have found very high levels of lead on roadway and ambient soils in Western Nigeria. Within the past few years, analytical data have revealed the presence of disease-causing microbes on some earthen dust particles. Aspergillus, a fungus that can attack human sinus, ear, lung and central nervous systems has been found [10] to be responsible for 30% of fatal infections among patients with acute leukemia and lymphoma at the Northwest Memorial Hospital in Chicago, IL. Human health threats from airborne microbes, some of which ride on dust particles, caused the temporary closure of some operation rooms of Montreal's Royal Victoria Hospital in 2001 [11]. Similar concerns about microbes on dusts have arisen in California: where test data [12] have shown that as much as 5–10% of the allergenocity of the total suspended particulates sampled from the atmosphere along roadsides in Long Beach and Rubidoux is attributed to road dusts. Indeed, dust-borne pathogens, carcinogenic pesticides and toxic heavy metals derived from proximal and distal farmland, construction sites, roadways and other wind-exposed areas, constitute significant but inadequately mitigated health and ecological hazards in many cities and regions of the world. Global data on generation rates are uncertain but in the United States a 1997 estimate [13] puts annual emissions of fugitive dust at 25 million t.

A major rationale for improved effort in dealing with the dust problem is greater recognition of the spreading of ecological and human health damage risks through inter-regional and inter-continental transport of dust by wind. The most remarkable example of early large-scale generation and transport of dusts is the "dust bowl" of the 1930s in the United States. The dust bowl, which was caused by an extended drought and excessive tillage of land, greatly impacted the weather and ecology of the United States and eventually led to the creation of the Soil Conservation Service to institute control measures. Owing to advances in meteorology, analytical instrumentation, satellite technology and image interpretation, more precise information on source areas, travel patterns and depositional zones for dust are obtainable. Indeed, fungi on Saharan dust have damaged Caribbean corals; it has also been found [14] through the Puerto Rico dust experiment (PRIDE) that the major source of variability in the vertical profile of Saharan dust during trans-Atlantic transport is sedimentation and downward vertical winds. Using modern analytical techniques such as single-particle scanning electron microscopy and energy-dispersive X-ray analysis, Reid et al. [15] has derived elemental ratios of samples of Saharan dust. As chronicled by Jaffe and Snow [16], in mid-April 2003, as much

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as 1.1×10^5 metric t of PM-10 Asian dust was transported by wind across the Pacific Ocean into the atmospheric boundary layer of the United States. This resulted in increases of PM-10 concentrations ranging from 30 to 40 $\mu g/m^3$ above Tucson, AZ; Salt Lake City, UT; Aspen, CO; Savannah, GA; Atlanta, GA; Winston Salem, NC.

For region-sized contiguous sources of dust such as the Sahara Desert, mitigative actions at the anterior end are very limited. At the posterior end, receptors and associated impacts can be identified, monitored and controlled through a variety of policy and technical measures. For roadways, remediation/construction sites, mining sites and farmlands, both preventive and remedial policies and techniques have been used by authorities. Among them are regulations on atmospheric concentrations of dust derived from activity sites, traffic restrictions, wind fencing, dust palliation using physical and/or chemical methods such as aqueous polymers [17,18] and site vegetation. As reported by Wei et al. [19], China has promulgated national air quality standards that limit the annual average and 24-h average PM-10 concentrations to maxima of 100 and 150 $\mu g/m^3$, respectively. Local and regional organizations have also developed regulations and guidelines for dust control at various sites. For example, Indiana (USA) Department of Transportation (INDOT) limits fugitive dust concentrations to 67% in excess of ambient upwind concentrations (MADOS, 2003). In Hong Kong, the 1 h and daily total suspended particle limits are 500 and 260 mg/m^3, respectively.

Although many analytical, monitoring and control challenges still remain, research into the sources, characteristics, transport patterns, health and environmental risks, and control measures of dust have been intensified in the last few years. The results of such research fit within the scope of the *Journal of Hazardous Materials*. Dust is indeed hazardous to both human health and the environment. The *Journal of Hazardous Materials* deals with risk assessment and management as well as environmental control technologies. Specifically, this special edition on "*Generation and Control of Hazardous Dust from Geologic Media*" contains original articles on the issues outlined above.

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