high-volume liquid impinger is currently being tested in Barbados, collecting aerosol samples during African dust events. Over 100 bacteria and fungi (19 genera of bacteria and three genera of fungi) have been characterized from source region dust events. Most of the bacteria belong to genera found in soil or marine environments, including *Acinetobacter, Bacillus, Corynebacterium, Planococcus,* and *Staphylococcus*. Approximately 25% of the bacteria identified from Mali aerosols were potential pathogens of plants, animals, or immunocompromised humans. Several bacteria are very similar or genetically identical (by comparison of the 16S rDNA genes) to isolates obtained from African dust aerosols in the Caribbean. Characterization of dust-associated microbial communities is being expanded via the application of culture-independent methods (e.g. direct community DNA extraction followed by molecular techniques). This should increase the number of microbial taxa detected by removing culture bias. The transcontinental movement of microbes in African dust (as part of the global system of dust transport) has implications for ecosystem health (coral reefs), agriculture and livestock (safety of the food supply), and human health. While satellite images leave no doubt that desert dust particles are achieving intercontinental distribution, we are just beginning to address the questions relating to dust-associated biological particles--how many, how often, and even which types--also make this trip.

Key words African dust; Sahara dust; bacteria; fungi; microbiology

Natural siliceous dust and human health: Pathways, toxicity, and impact

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Fine atmospheric dust includes mineral particles and aggregates, fibrous minerals and fibrous organic material. Generation, dislodgement and transport (deflation) of natural dust with the finer (<4 microns) components suspended as silt-size aggregates, is widespread in and adjacent to the world's drylands, as well as deriving from volcanic vents. Silica is a highly fibrogenic agent in lung tissue. Long-term inhaling of siliceous dusts can lead to a number of fibrotic lung diseases, including natural (non-occupational) pneumoconioses (notably silicosis, but including asbestosis and others). Different polymorphs of silica show different levels of toxicity in interaction with lung tissue. Particles with highly active surfaces may release radicals, causing cell damage. Some types of inhaled particulates are degraded by macrophages, but many are highly resistant and persist in the lungs, some stimulating fibroblastic cells to deposit collagen. Silicosis is an inflammation of the lung commonly caused by silicate mineral particles, leading to fibrosis. Three types are recognized: nodular pulmonary fibrosis (simple or chronic silicosis), acute silicosis, and accelerated silicosis. Generally, finer particulates have greater oxidative capacity than the coarser fractions. They contain more reactive oxygen species, their greater bioreactivity making them more toxic to pulmonary tissue. Nevertheless, inhalation of large dust particles (>10μm) may constitute a health risk if the mineralogy is toxic, regardless of where the grains lodge in the respiratory system. Dust may absorb harmful gases, disease-generating bacteria and carcinogenic hydrocarbon compounds. Silica-related respiratory disease may also an exacerbate cardiac problem, and epidemiology suggests a link with tuberculosis. Quantification of dust loading and exposure requires study of spatial and temporal patterns, supported by meteorological analysis, airflow modeling and satellite-borne imagery. Some acute, short-term health impacts have been assessed using atmospheric and health records both before and after a dust storm or by comparison of populations within and outside such events. Analysis of the size, shape, mineralogy and geochemistry of ambient dust particulates provides information on natural dust sources, dust concentrations, and potential particulate toxicity, as well as providing a datum for assessment of human exposure levels. These and other aspects are illustrated in several case studies. It is concluded that non-occupational silicosis is barely recognized as a global public health problem, despite indications from epidemiology that several millions of people are likely to be at risk. In addition, the precise nature of the pulmonary response to crystalline silica needs to be better understood, particularly at the molecular level.

Key words natural dust; human health; silica; toxicity; silicosis

Factors controlling the spatial and temporal variability of dust emissions

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New field measurement techniques are allowing researchers to better understand how surficial properties affect the temporal and spatial variability of dust emissions. In this paper we review the current understanding of the dust emission process and present new field measurements that examine how three surface properties: roughness, crust strength, and temporal changes of surface properties affect dust emissions. These data were collected using three unique measurement systems developed by our team. Roughness exerts considerable control on the entrainment threshold and emissions of dust from a surface. We have carried out a series of experiments designed to quantify roughness effects on aeolian sediment entrainment and transport in a shear stress partitioning framework. Our results show that the model of Raupach et al. (1993) provides very good agreement with available data to predict the amount of shearing stress on the intervening surface among roughness elements, relatively independent of their size and distribution. However, element size affects the aeolian sediment transport process beyond that attributable only to the reduction of surface shear stress caused by the roughness. Additional interactions of the elements with the saltation cloud appear to reduce the transport efficiency and potentially dust emissions as well. The effect of crust strength on dust emissions was assessed using a newly-developed pin penetrometer, which can measure crust strength *in-situ*. Previous researchers suggested that variation in crust strength even within a small area could lead to considerable spatial variability in dust emissions. Our measurements showed that crust strength is highly variable over a scale of centimeters. This variability may help to explain some of the observed scatter in field measurements of dust emissions for what appear to be homogeneous surfaces. Variability of dust emissions in time and space was also evaluated using a new instrument, the Portable *In-Situ* Wind Erosion Lab (PI-SWERL) developed to measure dust emissions from soil surfaces. The PI-SWERL consists of a cylindrical enclosure containing an annular flat blade that rotates at different speeds, which generates shear stress upon the surface. The shear stress generated by PI-SWERL results in the entrainment of particles including dust. This instrument has been used to evaluate temporal changes in dust emissivity around the Salton Sea in southern California. We have observed that for the same surface dust emission potential can change by an order of magnitude in a year, driven largely by changes in crust strength and character with climate.

Key words dust emission; surface property

Mineral aerosol: Connections to climate and human health

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Mineral dust is a major component of the global aerosol, and the importance of dust for regional climate and biogeochemical cycles has become increasingly apparent. By scattering and absorbing radiant energy and through their effects on clouds, dust and other aerosol particles can cause climatic effects that affect ecosystem function and human health. Iron oxide minerals in the atmosphere are especially important in this regard because they absorb solar radiation and are involved in redox reactions. Furthermore, dust particles that settle out of the atmosphere provide nutrients, including iron, to marine ecosystems and other nutrients to terrestrial ecosystems. New technologies have shown that dust reacts in complex ways with other atmospheric constituents; indeed, this is one of the major revelations of recent dust research. Dust and other substances commonly occur in the same air parcels, but bulk chemical methods do not show whether the particles are internally mixed (multiple components mixed in single particles) or externally mixed (admixtures of different particles). Electron beam techniques have shown internal mixtures of dust and black carbon, but the implications of this for climate forcing are still unresolved. Studies conducted with an aerosol time-of-flight mass spectrometer suggest preferential reactions between dust, sulfur and nitrogen oxides, and chlorine. These reactions have important implications for particle formation and solubility, and for the particles' health effects. The activity of radionuclides, including Pu, co-vary with atmospheric dust loads, and while this is not a serious health concern, the emerging view is that pure dust is rarely sampled. While dust can affect ecosystems through climate, the production of dust also is influenced by humans, especially land-use practices that affect vegetative cover. Indeed, the issue of the relative importance of natural vs. anthropogenically-driven changes in dust budgets remains a subject of debate although several recent studies indicate natural variability dominates. Chemical methods and models are being applied to identifying dust sources, with the latter also being used to investigate future scenarios; for example, a recent simulation projects weaker winds, more moisture, and enhanced desert vegetation will lead to a worldwide decrease in dust by the end of this century.

Key words mineral dust; environment; new technique; climate; health