Aerosol particles as viewed using transmission electron microscopy

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Air quality and climate change affect us all and are strongly influenced by airborne particles. The atmospheric burden of such aerosol particles is large and highly variable in space and time. They are major contributors to degradation of visibility, and also have important influences on human health. Most atmospheric scientists study aerosol particles in bulk or, if they are interested in the individual particles, by first destroying them with energetic beams before feeding their fragments into mass spectrometers. In both cases, important information such as coatings, agglomeration, shapes, and the information they can provide about their history is lost. However, transmission electron microscopy (TEM) can be used to measure the 2D and 3D shapes, sizes, compositions, coatings, intergrowths ('mixing states'), hygroscopicity, and crystallinity of materials of interest at the micrometer to nanometer scale. Thus, the techniques of mineralogy, suitably modified, can be applied to great advantage to the study of atmospheric aerosol particles, including dust, the name atmospheric scientists use for minerals. A special problem is presented by the occurrence of heavy metals in atmospheric nanoparticles. It is well established that heavy metals can cause severe health problems, and because of the small sizes of nanoparticles they can travel deeply into the lungs and other parts of the body, but little is known about their occurrence in and transport through the air. TEM is well suited for the study of such tiny materials. Examples will be presented of a range of TEM techniques applied to samples collected from various parts of the U.S., Mexico, southern Africa, the Middle East, China, Japan, and perhaps a few other regions, each to illustrate specific aspects of airborne particles and atmospheric issues.

Climate change impacts on acid sulfate soil landscapes

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The anticipated impacts of climate change are warmer conditions, an increasing proportion of rainfall to occur from heavy falls, increasing occurrence of drought in many regions, increasing frequency of intense tropical cyclones, rising sea levels and frequency of extreme high seas (e.g. storm surges). All of these predicted impacts have direct relevance to coastal acid sulfate soils landscapes, through either exacerbating sulfide oxidation by drought, re-instating reductive geochemical processes or changing the export and mobilisation of contaminants. The interaction of specific land management factors such as man-made drainage will also have a significant role in how the predicted impacts of climate change affect these landscapes.

Understanding the potential impacts of climate change for coastal lowland acid sulfate soils is particularly important, given the utility of these areas for agriculture and urban communities, their unique capacity to cause extreme environmental degradation, and their sensitivity to climatic factors such as temperature and hydrology and susceptibility to sea-level inundation.

There is a strong and expanding fundamental knowledge of processes in coastal acid sulfate soils, but limited studies to date that consider the impacts of climate change. Using data from our research group this paper examines some of the key issues of climate change of relevance to acid sulfate soil. We investigate the hydrogeochemical consequences of seawater inundation of an 800 Ha acid sulfate soil wetland and study of current drought triggered broad-scale oxidation (i.e. 20, 000 Ha of exposed soils) of lake bed sediments in the lower Murray-Darling River Basin, South Australia.