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EDITORIAL

# The Aero-geochemistry of Cities and Regions

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It is convenient to assess the human health and environmental hazards posed by contaminants through analyses of intertwined processes inherent in contaminant generation, transport and deposition at sinks. Contaminant generation has attracted a lot of regulatory interest in many countries. Limits on emissions and standards on operational protocols of industrial facilities, waste disposal systems and various categories of vehicles have been developed and enforced. Contaminant deposition is at the posterior end of the process sequence and is usually of great concern to the public. A sink can serve as a contaminant source under the influence of transport processes. This is frequently the case with air pollutants such as dust that can be re-entrained in the atmosphere after deposition. As a medium for contaminant transport, air is more significant than water and soil in terms of contaminant dispersion from sources. Thus, with respect to environmental and human health risk assessment, pollutants that are present in the atmosphere tend to traverse more exposure pathways than those present in surface water or soil. Exposure pathways for air pollutants can be direct inhalation, dermal exposure, and oral intake, following deposition into exposed surface water and onto edible plants.

The presence of air pollutants in significant concentrations, poses serious health hazards to residents of cities and other densely populated regions (DPRs). This can be scaled in terms of the number of people per unit area of land that are exposed to contaminants of specific concentrations per unit of time. Furthermore, densely populated regions tend to attract a diverse set of sources for contaminant generation, e.g., fuel dispensing stations, automobiles, construction sites and industrial/municipal facilities with combustion systems. Thus, the aero-geochemistry of cities and DPRs requires an increase in analytical focus and hazard mitigation. The pollutants of concern are oxides of nitrogen ($NO_x$); volatile organic compounds (VOCs); sulfur dioxide ($SO_2$); particulate matter (PM), including those in soil dust, coal dust, tobacco smoke, fly ash and diesel exhaust; and air toxics such as heavy metals, dioxin, benzene, some pesticides and polychlorinated biphenyls (PCB). Under suitable physico-chemical conditions, air pollutants can interact to generate other new air pollutants and/or undesirable environmental conditions. Adequate heat and sunlight promote the interaction of $NO_x$ and VOC to form ground-level ozone which poses human health risks and damages vegetation. Particulates reduce visibility in many cities and cause both structural degradation and aesthetic deterioration of buildings in many regions. Regional haze is common

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in Eastern Europe, Eastern USA and Asia. For example, seasonal reduction in visibility in the USA is in the approximate range of 60–80%. Acid rain in the common pH range of 2.5–5.5, forms as a result of the reaction of emitted gases with water and their subsequent precipitation. It has damaged the ecology and aesthetics of cities, especially in old industrial regions, where many inefficient combustion engines are still used in factories, power plants and other facilities.

Within the past 15 years, monitoring of pollutant concentrations in the atmosphere within and above major cities has increased worldwide. These projects have been performed for contaminant source attribution, regulatory development and environmental impact assessment. A few specific examples are briefly mentioned herein. A three-month long monitoring of elemental composition and concentrations of PM-10 and PM-2.5 has been performed by Braga et al. (2005) in the Guaiba Hydrographic Basin of Brazil. The concentrations of inorganics were found to be higher than the daily and annual averages of 150 and 50 $\mu g\ m^{-3}$, respectively, specified as Brazilian standards. Facilities such as steel plants and coal-fired power plants along with hospital waste burning, and vehicular emissions, have been identified as the sources of monitored particulate matter. In a comparative analysis of one year-long PM-2.5 and PM-10 monitoring data on particle mass, water-soluble ions, trace elements, and carbon, at urban kerbside, urban background, near-city and rural sites in Switzerland, Hueglin et al. (2005) found that there was a gradual decrease in the concentrations of the inorganic substances monitored from urban to rural sites. Essentially, road traffic was identified as the causative factor for the observed differences. This implies that long-range atmospheric transport provided the background values while proximal impacts of traffic added to the background values. This observation and method of distinguishing between local and long-range sources should be applied in similar scenarios elsewhere. Isotope geochemistry can also be used more widely in source identification for air pollutants. Xiu et al. (2005) collected and analyzed size-fractionated particulate mercury in ambient air in Shanghai, People's Republic of China. It was found that coal burning contributed about 80% of the total mercury measured at the Shanghai site. In Brisbane, Australia, Lim et al. (2005) characterized elements and polycyclic aromatic hydrocarbons (PAHs) in urban air. The effects of the development and use of more efficient engines in cars were detected in the monitoring data. In India where economic boom has generated more facilities that can pollute the environment of cities and vice versa, Srivastava et al. (2005) have found excessively high levels of VOCs over Delhi. This circumstance has been attributed to the growth of mobile sources internal combustion diesel engines. Road dust emission is a major problem in many cities, especially in developing countries where a high fraction of roads and open areas are not paved. Inyang and Bae (2006) have presented a brief synopsis on the human health and environmental impacts of dust.

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