TOXICOLOGICALLY RELEVANT CHARACTERISTICS OF ATMOSPHERIC PARTICULATE MATTER FROM DIVERSE GEOGENIC, GEOANTHROPOGENIC, AND ANTHROPOGENIC SOURCES

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The air humans breathe, depending upon where they are, what they are doing, and many other factors, can contain a complex mix of airborne particulate matter (PM) derived from myriad sources. Over the past decade, our USGS project has collaborated with many colleagues in the earth and health sciences to measure toxicologically relevant mineralogical, physical, geochemical, biosolubility, bioaccessibility, and bioreactivity characteristics of diverse PM types or sources. These include a spectrum of geogenic (produced from the Earth by natural processes), geoanthropogenic (produced from natural sources by processes that are modified, enhanced, or contaminated by human activities) and anthropogenic (produced by human activities) PM and PM sources; all have either been shown or speculated to cause adverse health impacts. Our project's results help public health experts understand better the nature of diverse PM exposures, and therefore potential health impacts.

Diverse PM types (many desert dusts, glacial dusts, wildfire ash, volcanic ash, dusts transported between continents) can have abundant respirable particles (<2.5 μm, PM2.5) that may contribute to respiratory and related cardiovascular health problems due to their abundance, mineralogy, geochemistry, biosolubility, and bioreactivity. Some PM types can cause irritation of dermal, ocular, and respiratory tissues because they contain acutely bioreactive, caustic alkali minerals (wildfire ash, concrete particles in building collapse dusts, cement dusts, coal fly ash) or caustic acid minerals (soluble metal sulfate salts in coal dusts or weathering sulfidic mine wastes; volcanic ash; urban PM). Many PM types contain potentially toxic elements that are bioaccessible in simulated lung or gastric fluids, such as: wildfire ash and ash from burned buildings (Cr[VI], As, Pb, Sb, Mn, Cu, Zn); dusts from building collapse (Pb, Sb, Zn, Cu, Cr[VI]); coal fly ash (Pb, Tl, As, Cd, V, Cr[VI], Cu, Zn); dusts from metal mine wastes and PM from sulfide smelting, mercury ore roasting, or artisanal gold amalgamation (Pb, Hg, As, Cd, Cu, Zn, Mn, others); and volcanic ash (F, Mo, Mn, Cu, Zn). Oxidative stress and toxicity in the lungs may result from inhalation of PM that release Fe, Mn, and other redox-sensitive elements either acutely in high concentrations (ie biosoluble iron sulfates and bioreactive sulfides in mine wastes or coal dusts) or chronically in lower concentrations (biodurable volcanic ash, asbestos, etc.).

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