Manganese concentrations higher in residential neighborhoods than industrial sites, varies by region

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In residential neighborhoods near manufacturing industries, a breath of air may be more hazardous than refreshing depending on the location, finds a recent study involving a Kansas State University geologist.

Saugata Datta, assistant professor of geology at Kansas State University, along with researchers at Columbia University and Johns Hopkins Bloomberg School of Public Health and Department of Environmental Health Sciences, explored levels of the elemental metal manganese in airborne particulate matter -- a combination of dust, soot and other organic and inorganic particles suspended in a gas or liquid. Five counties across the U.S. were sampled as researchers characterized manganese and identified if manganese concentrations in the airborne particulate matter varied by geographic region.

"Manganese is an element that was originally thought to have a lot of nutritional aspects for humans and was relatively harmless health-wise," Datta said. "But more recently that thinking is changing. Manganese is a neurotoxin at certain levels when in water, so there is a question about if it's toxic in air, too."

Manganese can be introduced into particulate matter -- and consequently the air -- through vehicle exhaust; vapor emissions from power plants, manufacturing industries and smoke stacks; battery and electronics manufacturing; welding; and auto manufacturing, Datta said. Tests on

subways have also shown elevated levels of manganese in particulate matter because of abrasion from the steel tracks.

For the study the team analyzed samples of airborne particulate matter from Sacramento County, Calif.; Pinellas County, Fla.; Anoka County, Minn.; Harris County, Texas; and Maricopa County, Ariz. Samples were collected by Johns Hopkins Particulate Matter Center and examined using spectroscopy and other techniques at the National Synchrotron Light Source at Brookhaven National Laboratory in New York.

Air samples among the sites varied in total manganese, ranging from 0.01 micrograms/mg to 0.67 micrograms/mg. Samples' compositions also varied in types of manganese, which included manganese-2 oxide, manganese-3 oxide, manganese-2 acetate, manganese-2 pyrophosphate and manganese-2 sulfate at various levels at each location.

"Because the levels of manganese have not been monitored very much, it's hard to say whether these are high, low or average levels," Datta said.

Studies on manganese and human health, though, have shown the element to be problematic, Datta said. Toxicological studies have linked airborne particulate matter containing manganese to respiratory and cardiovascular health. Additionally, long-term inhalation of manganese has been attributed to manganism, an irreversible disease similar to Parkinson's.

Researchers also found that the samples of airborne particulate matter from residential neighborhoods near gas, electric and petroleum manufacturing and refineries showed the higher levels of total manganese than samples collected from around the industrial sites.

The researchers' study, "Use of X-Ray Absorption Spectroscopy (XAS) to Speciate Manganese in Airborne Particulate Matter from 5 Counties

Across the U.S.," was published in a recent issue of the journal *Environmental Science and Technology*. It is believed to be an important study to show that the particulate matter toxicity varies by location across the U.S., and one of the first to identify manganese oxidation states in airborne particulate matters.

The study was funded by the Environmental Protection Agency.

Datta is also conducting a study on India's groundwater, which contains manganese and arsenic. The study includes Sankar Manalikada Sasidharan, a master's student in geology, India, and Sophia Ford, a geology undergraduate student, Wilson, Kan.

The Kansas State University team has found that if arsenic is present in the groundwater, so is manganese, which turns the base platform around a well gray. The team also found that higher levels of arsenic might be occurring with lower levels of manganese and vice versa.

According to Datta, studies by research teams -- McArthur et al 2012 , ES&T and Biswas et al 2011, ES&T -- found that elevated levels of manganese in India's drinking water led to decreased intellectual function in children. However, the 2011 report from the World Health Organization does not include a guideline for manganese in water.

"These studies are a unique set of work that not many people are looking at," Datta said. "We're attacking manganese, understanding the toxicity levels and understanding its chemistry in both air and in water. Both are pathways to be ingested by humans. In air most of it is caused by vehicles and industries, but in water it is affected by sediments that leach out. We want to attack back."

Provided by Kansas State University

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