Research sheds new light on coal-cleaning chemicals found in the 2014 Elk River spill

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A collaboration between the U.S. Geological Service and West Virginia University has resulted in a better understanding of the chemicals that spilled into the Elk River in 2014, affecting the drinking water of 300,000 Charleston-area residents.

Scientists in the organizations examined river and tap samples at several locations impacted by the spill. The results, which were recently published in the journal *Chemosphere*, are the first to report concentrations for each of the two chemical forms of the primary spill component (4-methylcyclohexane methanol, or 4-MCHM) in water samples.

Kung Wang, Eberly Distinguished Professor in the C. Eugene Bennett Department of Chemistry at West Virginia University, and doctoral student Haresh Thakellapalli used a nuclear magnetic resonance spectrometer to establish the concentrations of the two distinct chemical forms in the spill sample. Their measurements of the low concentrations of the chemicals were a key contribution to the study.

Among the U.S. Geological Survey findings, some of which informed other recently published studies:

- The primary spill component, 4-methylcyclohexane methanol, or 4-MCHM, was still present in the Elk River at low concentrations six days after the spill began.
- The spill plume traveled at least 390 miles downriver from the

spill location to the Ohio River at Louisville, Kentucky. This distance represents a larger geographic area and population than the Charleston area that experienced many of the reported impacts of the spill.

- 4-MCHM was present in Charleston tap water more than six weeks after the spill began. Concentrations decreased throughout the testing, but were always present at some level.
- Another component of the spilled material (a form of methyl 4-methylcyclohexanecarboxylate)—previously unreported—was detected in Ohio River and Charleston tap water samples. This component has a pungent, somewhat sweet/fruity odor unlike the licorice-like odo characteristic of 4-MCHM, and likely contributed to the tap water odor complaints of Charleston residents.

Knowing how to identify the unique properties and odors of the chemicals, researchers say, will inform other studies examining other potential impacts of the spill.

"This spill represented a huge challenge for all of the entities who responded to it, as the behavior of these specific components in water environments was largely unknown before the spill," said Bill Foreman, a U.S. Geological Survey research chemist and lead author of the study. "Researchers had little information on how the spilled chemicals moved through water, their stability or toxicity, or even how to measure them, as published information was either limited or non-existent."

The method used by the Geological Survey and WVU scientists to identify the chemicals was able to determine both chemical forms of 4-MCHM to concentrations less than 0.5 part-per-billion. Measurement at these low concentrations is critical to understanding 4-MCHM behavior in the environment and in drinking water systems, and because Crude MCHM, part of the spill material, has a low odor threshold that

people can smell at less than 1 ppb.

More information: Foreman, W.T., Rose, D.L., Chambers, D.B., Crain, A.S., Murtagh, L.K., Thakellapalli, H., and Wang, K.K., 2014, "Determination of (4-Methylcyclohexyl) methanol isomers by heated purge-and-trap GC/MS in water samples from the 2014 Elk River, West Virginia, chemical spill:" *Chemosphere*, dx.doi.org/10.1016/j.chemosphere.2014.11.006.

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