Old Man River's unique chemical signature

13 June 2018

Human activity greatly impacts the natural chemistry of the largest river in North America—the Mississippi River. In a new, large-scale study, geologists at Louisiana State University in Baton Rouge have identified a unique chemical signature in the river.

Materials containing carbon, oxygen, nitrogen and sulfur build up, break down and transfer between the atmosphere, freshwater, the ocean and rocks. Dissolved sulfate is a key chemical compound in this process and can be found nearly everywhere including rivers, lakes, the ocean and drinking water. To better understand how sulfate transfers between rocks and the ocean, the geologists extracted and analyzed 135 Mississippi River water samples for dissolved sulfate. They compared the ratios of the heavier versus lighter forms of sulfur and oxygen, or their isotopes, which provided them with a unique signature to trace. They found that 75 percent of the sulfate in the Mississippi River comes from the rusting of pyrite minerals in rocks, which is a naturally occurring process that is also greatly enhanced by human activities such as coal mining.

"While increased Mississippi River sulfate and its isotope signatures do not directly impact people, they are certainly symptoms of, and another way to gauge, the magnitude of our impact on natural chemical cycles," said Bryan Killingsworth, the lead author of the study, who conducted this research for his Ph.D. with Huiming Bao, the Charles L. Jones professor in the LSU Department of Geology & Geophysics. Killingsworth is currently a post-doctoral researcher at the European Institute for Marine Studies in Plouzané, France.

The process of pyrite rusting, or oxidation, that produces sulfate also generates acid. The acid can make rocks, such as limestone, dissolve at a faster rate, which can release carbon dioxide into the atmosphere. The acid also increases the amount of dissolved chemicals from rocks into rivers, and may contribute to ocean acidification.

The study conducted over four years between 2009 and 2013 captured a unique time period for the Mississippi River when it experienced historic levels of both flooding and drought. While sulfate was impacted surprisingly little by the historic floods, the process of pyrite oxidation was affected during drought.

This study was published in the journal, *Environmental Science & Technology*. The scientists are continuing to investigate the sources and processes that affect sulfate in rivers and rocks.

More information: Bryan A. Killingsworth et al, Assessing Pyrite-Derived Sulfate in the Mississippi River with Four Years of Sulfur and Triple-Oxygen Isotope Data, *Environmental Science & Technology* (2018). DOI: 10.1021/acs.est.7b05792

Provided by Louisiana State University