

### **Metal Isotopic Monitoring of Environmental, Extraction, Distribution of Metal Associated with Mine Practice**

**Adam Simon**<sup>1</sup>, Ryan Mathur<sup>2</sup>, Karr McCurdy, Lee Ann Munk

<sup>1</sup>University Of Michigan, Ann Ar, United States, <sup>2</sup>Juniata College, Huntingdon, United States,

<sup>3</sup>VectOres Science, Inc., Huntingdon, United States, <sup>4</sup>University of Alaska Fairbanks, Fairbanks, United States

Quantitatively determining the source(s) of metals in ground and surface water is important for monitoring the environment during mining, smelting, refining, and reclamation operations. We developed a hydrogeochemical technique that uses the isotopic composition of metals in water at parts per trillion concentrations to trace the source(s) of a given metal or metals and the minerals from which they were derived. The technique is based on the comparison of metal isotope ratios of, for example,  $^{65}\text{Cu}/^{63}\text{Cu}$ ,  $^{66}\text{Zn}/^{64}\text{Zn}$ ,  $^{56}\text{Fe}/^{54}\text{Fe}$ ,  $^{109}\text{Ag}/^{107}\text{Ag}$  and  $^{124}\text{Sn}/^{122}\text{Sn}$ , in environmental samples and from samples tied directly to mining activity, mine waste, ore, and tailings. The technique can be used by mining and other firms such as industrial, governmental, and agricultural companies to distinguish among multiple possible sources of metals when conducting environmental impact assessments. The technique has been used to demonstrate that 1) copper and zinc in stream water draining the Red Dog lead-zinc mine in Alaska were not sourced from tailings, 2) copper in stream water draining a copper deposit in China was most likely sourced from pyrite in tailings, and 3) silver in forest soils downwind of a smelter in the Czech Republic can be traced to smelter emissions. The technique has also been used to fingerprint the source(s) of metals in the supply chain. For this application, the isotopic composition of multiple metals including copper, lead, silver, tin and zinc, and metal concentrations, identify the geographic source of metals such as gold and tin in the supply chain. Application of this technology distinguishes gold sources within mining districts and possibly from individual deposits helping to detect illicit gold sources and sales.