Increase in metal concentrations in Rocky Mountain watershed tied to warming temperatures

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(Phys.org)—Warmer air temperatures since the 1980s may explain significant increases in zinc and other metal concentrations of ecological concern in a Rocky Mountain watershed, reports a new study led by the U.S. Geological Survey and the University of Colorado Boulder.

Rising concentrations of zinc and other metals in the upper Snake River just west of the Continental Divide near Keystone, Colo., may be the result of falling water tables, melting permafrost and accelerating mineral weathering rates, all driven by warmer air temperatures in the watershed. Researchers observed a fourfold increase in dissolved zinc over the last 30 years during the month of September.

Increases in metals were seen in other months as well, with lesser increases seen during the high-flow snowmelt period. During the study period, local mean annual and mean summer air temperatures increased at a rate of 0.5 to 2.2 degrees Fahrenheit per decade.

Generally, high concentrations of dissolved metals in the Snake River watershed are primarily the result of acid rock drainage, or ARD, formed by natural weathering of pyrite and other metal-rich sulfide minerals in the bedrock. Weathering of pyrite forms sulfuric acid through a series of chemical reactions, and pulls metals like zinc from minerals in the rock and carries these metals into streams.

Increased sulfate and calcium concentrations observed over the study period lend weight to the hypothesis that the increased zinc concentrations are due to acceleration of pyrite weathering. The potential for comparable increases in metals in similar Western watersheds is a concern because of impacts on water resources, fisheries and stream ecosystems. Trout populations in the lower Snake River, for example, appear to be limited by the metal concentrations in the water, said USGS research biologist Andrew Todd, lead researcher on the project.

"Acid rock drainage is a significant water quality problem facing much of the Western United States," Todd said. "It is now clear that we need to better understand the relationship between climate and ARD as we consider the management of these watersheds moving forward."

Warmer temperatures and earlier snowmelt runoff have been observed throughout mountainous areas of the western United States where ARD is common, but it is not known if these changes have triggered rising acidity and metal concentrations in other "mineralized" watersheds because of lack of comparable monitoring data, according to the research team.

CU-Boulder Professor Diane McKnight, a collaborator on the project, has generated much of the upper Snake River data through research projects conducted with her students since the mid-1990s. McKnight said students in her environmental engineering and environmental studies classes like Caitlin Crouch—a study co-author who received her master's degree under McKnight—are highly motivated to understand ARD problems.

"Students can see that their research will have direct applications to addressing a critical issue for Colorado," said McKnight, professor in the civil, environmental and architectural engineering department and a

fellow in CU's Institute of Arctic and Alpine Research.

In cases where ARD is linked directly with past and present mining activities it is called acid mine drainage, or AMD. Another Snake River tributary, Peru Creek, is largely devoid of life due to AMD generated from the abandoned Pennsylvania Mine and smaller mines upstream and has become a target for potential remediation efforts.

The Colorado Division of Reclamation Mining and Safety, in conjunction with other local, state and federal partners, is conducting underground exploration work at the mine to investigate the sources of heavy metals-laden water draining from the mine entrance. The new study by Todd and colleagues has important implications in such mine cleanup efforts because it suggests that establishing attainable cleanup objectives could be difficult if natural background metal concentrations are a "moving target."

A study on the subject was published in the journal *Environmental Science and Technology*.

Provided by University of Colorado at Boulder