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New Contamination Concern for Colorado Streams

Abandoned hardrock mines and climate change cause metals and other elements to leach into streams. They also put rare earth elements into the water; a new study finds.

By Nancy Averett

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This junction in Colorado's Snake River is tinged with orange due to acid rock drainage. Credit: Garrett Rue

Cutthroat trout were once abundant in Colorado's Snake River, but water runoff contaminated with zinc and other minerals from abandoned mines along the tributary rendered much of the waterway uninhabitable to fish and other native species. This runoff and its effects on the Snake River—which drains into Dillon Reservoir, a major water supply for Denver and its surrounding regions—came to light in the early 1960s after scientists measured the river's water quality and found high levels of aluminum, iron, and manganese. Scientists now have found yet another problem making the situation worse: Closed mines and climate change are also causing **rare earth elements** (REEs)—a set of 17 metallic elements that are essential to many of today's electronic devices—to leach into the river, according to **a new study** published in *Environmental Science & Technology*.

Researchers found that current concentrations of REEs in streams range from 1 to 100 micrograms per liter. “Typically, the concentrations [of REEs] in surface water would be 3–5 orders of magnitude lower, so these concentrations are very high,” said [Diane McKnight](#), an engineering professor and fellow at the Institute of Arctic and Alpine Research at the University of Colorado Boulder and coauthor of the study.

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McKnight has been studying acid mine runoff in the Snake River watershed for decades. This problem isn't limited to the Snake River system, though, she said. There are about half a million abandoned hardrock mines across the Rocky Mountains, many dating back to the mid to late 19th century when boomtowns sprung up in Colorado, Montana, Wyoming, and other states in the West.

Mining and Climate Change Sped Up Natural Processes

“So much of Colorado was settled on mining.... [Miners] were just trying to get as much out of the mountains as they could, and once they stopped being able to do that, they just moved on to the next one,” said [Garrett Rue](#), lead author of the new research who collected the study's data while he was a master's student at the University of Colorado.

Because the Rocky Mountains have high concentrations of [pyrite](#), otherwise known as fool's gold, they naturally leach metals; when pyrite comes into contact with air and water, it forms [sulfuric acid](#), which, in turn, dissolves other metals in the rock and soil. Those metals then drain into nearby streams and rivers. Mining speeds up this process—it exposes more of the rocks and sediment to air than would have occurred naturally. Climate change does the same thing, although in a different way. As temperatures rise, the ground dries out faster and the [water table](#) drops, making the layer between the ground and the water table more arid, allowing more oxygen to circulate there, thus starting the pyrite oxidation process.

An Opportunity for These Emerging Contaminants

REEs are starting to be recognized as emerging water contaminants because they have recently become such a large part of everyday products—they are used in cell phones, light-emitting diodes (LEDs), and solar panels, and they are even in the contrasting agent that patients drink to improve the clarity of their organs during an MRI scan. Patients later excrete those REEs through their urine, and studies have found higher levels of the REE gadolinium, which is used in the contrasting agent, in the surface water of aquatic environments near hospitals.

While traditional water treatment plants can remove some harmful elements such as lead and cadmium, currently there are no removal treatments in place for REEs (although there are some [techniques to recover REEs](#)). In fact, scientists know little about how they might affect living organisms. There's no easy answer to dealing with the problem of acid mine runoff or climate change-induced REE runoff. Abandoned mining sites litter the Rocky Mountain West, and no one has found the best solution for cleaning them up. The original mine owners are long dead, and the EPA estimates that a government-funded cleanup would cost tens of billions of dollars.

But McKnight and Rue noted that their findings present a potential opportunity for investing in technologies to recover REEs from waters and recycle them to be used in electric vehicles, smartphones, and more. [Rare earth recycling](#) separates REEs and recycles them for use in modern technologies, many of which require REEs for their creation—for example, rare earth magnets, used to power electric vehicles, usually contain neodymium. Rather than get REEs imported from China, which is the United States' current process, techniques such as ion exchange, biosorption, adsorption, solvent extraction, and precipitation can be applied to recover REEs from waterways.

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Rare earth element recycling is potentially a cost-effective answer to our growing demand for technology products that use REEs and are currently outpacing our supply of them. But first...investment and infrastructure are necessary.

because this is such a hard nut to crack.”

—Nancy Averett ([@nancyaverett](#)), Science Writer

Rare earth element recycling is potentially a cost-effective answer to our growing demand for technology products that use REEs and are currently outpacing our supply of them. But first, according to McKnight and Rue, investment and infrastructure are necessary.

[Robert Runkel](#), a research hydrologist with the U.S. Geological Survey who was not involved in the study, said he sees a glimmer of hope in the idea of recycling REEs. “Maybe the fact that there [are REEs] in the water now will help with the cleanup because people will see a way to pay for some of it by reclaiming those REEs,” he said. “That’s the optimistic way to look at it. The pessimistic way to look at it is that those (contaminated) sites will still be there another 20 years from now

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