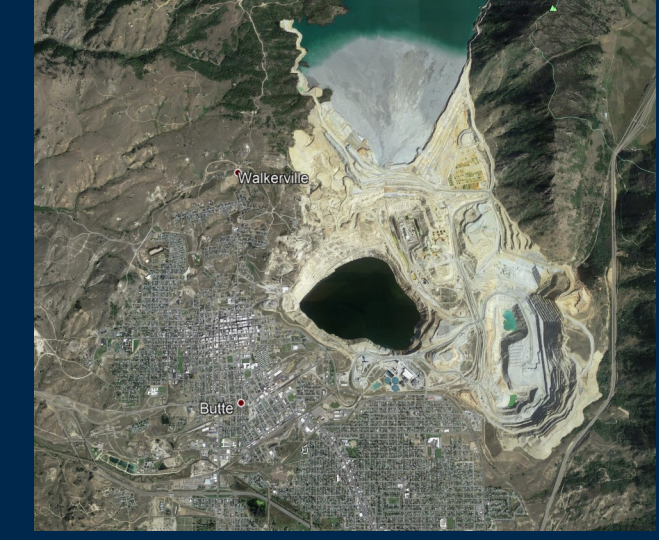


What killed 342 snow geese in Butte, Montana?¹

During their 1995 migration north to Canada, some geese rested on the shores of the abandoned Berkeley Mine in Butte, Montana. Days later, hundreds of geese corpses were discovered strewn around the area. Berkeley Mine was decommissioned in 1982 and left victim to the natural environment. Water accumulated in the open pit, creating a lake one mile long, half-mile wide, and 1780 feet deep.² The lake's water has leached into the cracks of the mine and weathered the exposed minerals, resulting in acidic, toxic water. In 1995, when these geese came to the lake, the hazardous waters caused a mass dying. If the lake continues to grow as it has over the past several decades, then it may overflow and contaminate the drinking water of the nearby town of Butte.



Depicted at right is a satellite image of the Berkeley Pit. The town of Butte, Montana is seen next to the pit. This image demonstrates the size of the contaminated lake that threatens the town of Butte.



Pyrite⁶
Fe₂S₃



Realgar
As₄S₄

Ingredients for Acid Mine Drainage

Sulfide minerals are exposed to the surface where they can be weathered. Such rocks include **pyrite (Fe₂S₃)**, **chalcopyrite**, and **realgar (As₄S₄)**.

Water provides the hydrogen necessary to create an acidic environment. Water can come from aquifers, rainfall, or local waterways.

Oxygen from the atmosphere and dissolved in water oxidizes the minerals.

Sulfide minerals



Water (H₂O)



Oxygen (O₂)

In open pit mines, sulfide minerals are exposed to the surface. If the mine is not remediated, acid mine drainage occurs.

Once the watery environment becomes acidic enough, the ferrous iron (Fe⁺²) produced from oxidation of pyrite becomes a better reactant than oxygen (O₂). Therefore, a feedback loop is created in which oxidation of pyrite produces its own oxidizing agent. Acid mine drainage is difficult to stop once it enters this level of acidity.

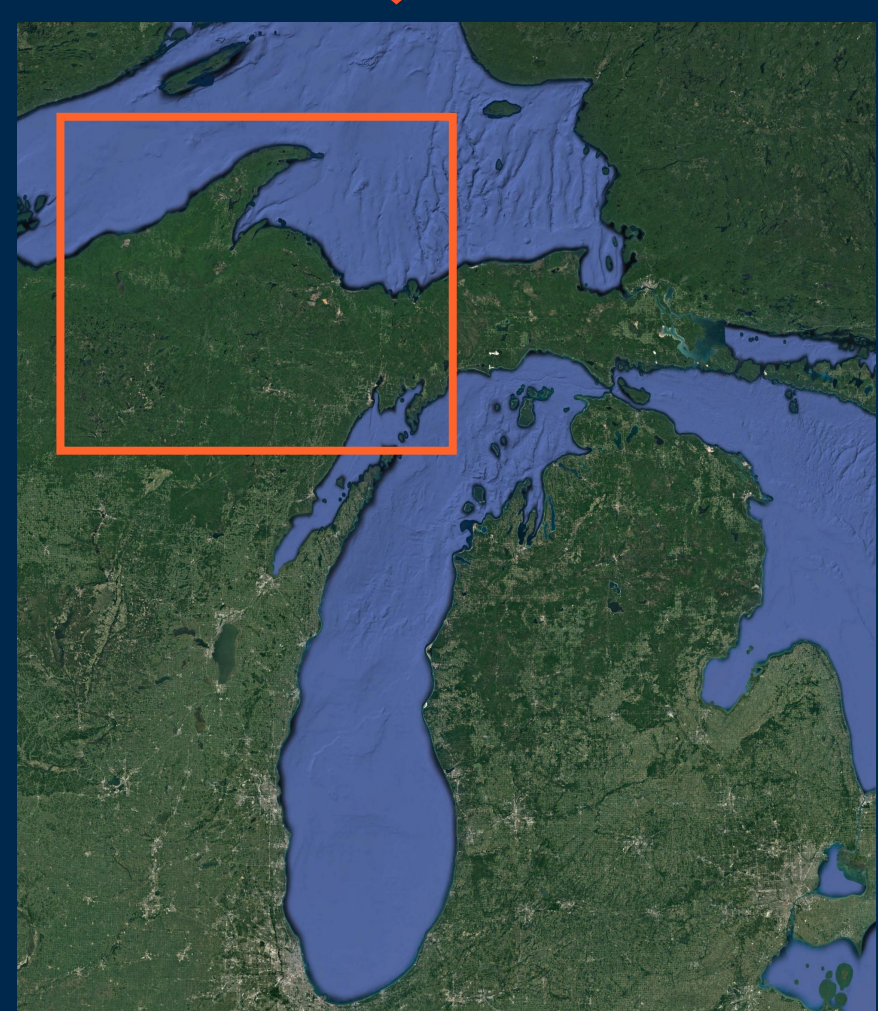
Into the surrounding environment,

acid mine drainage waste escapes from the pit mine.



Acidity + Toxic metals

Washed into the surrounding environment, including lakes, rivers, streams, and aquifers, all of which act as habitats for animals or sources of water for people.



Acid Mine Drainage in Michigan

The Upper Peninsula is a hotspot for mining in Michigan, producing lots of copper and iron. Consequently, there is a lot of opportunity for acid mine drainage. Iron River has been particularly affected with abnormally abundant toxic metals.³ In 1973, the Dober Mine in Iron County killed all aquatic life for miles downstream and continues to leach acidic runoff today.⁴

Acid Mine Drainage

Caleb Jelsma-Cale, Class of 2022

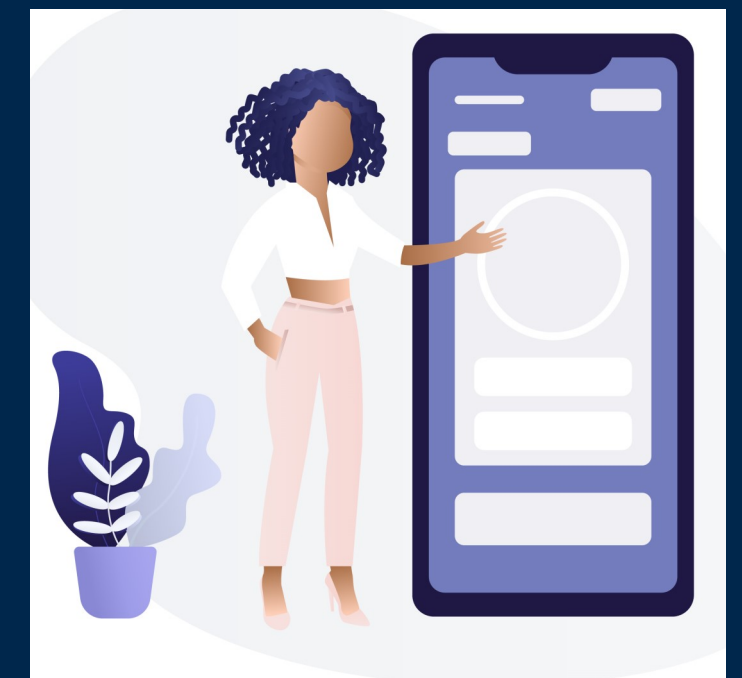
"I am an undergraduate student at the University of Michigan — Ann Arbor where I am majoring in Earth and Environmental Sciences. I first learned of acid mine drainage when taking EARTH 325 *Environmental Geochemistry*, taught by Dr. Jena Johnson. Something about it stuck with me and made so much sense. I had never considered this would be an environmental issue. When I took EARTH 380 *Natural Resources, Economics, and the Environment*, taught by Dr. Adam Simon, acid mine drainage was contextualized more in its environmental impacts and association with mining operations. I want to share my understanding of this environmental issue with the broader public to promote informed decisions about the future of technology and our relationship with our planet.



Mining is Essential

Metals exhumed from the Earth are essential to modern living. The copper in electric wires, the lithium in smartphone batteries, and the rare Earth metals that make computers run all needed to be mined

Avoiding all mining operations would only stunt societal development. Therefore, the effects of mining must be mitigated.



Water contaminated by acid mine drainage can be colored a rancid orange or red, indicative of the dissolved metals, like ferrous ions.

At right is a satellite image of a tailings pond, which collects and contains mine liquid mine waste, with the characteristic, orange color of acid mine drainage. This tailings pond is located outside of Marquette, Michigan.



What YOU can do to prevent acid mine drainage

Vote

The easiest way to prevent AMD is to vote for public policies and officials who will protect people and the environment. Government regulations are very effective at ensuring responsible management of decommissioned mines.

Recycle

Recycling metals reduces the need to mine more from the ground. Less mining means less risk of acid mine drainage. Recycle electronics responsibly. Contact your county's recycling department or private, recycling organizations.

Responsibly Source Metals

The power of the consumer's dollar can be used to fight acid mine drainage. Spend your money on products that source metals from responsible mining operations.



1. <https://www.bbc.com/news/world-us-canada-38239879#?text=Thousands%20of%20migrating%20snow%20geese%20dropping%20dead%20in%20the%20area>
 2. http://www.slate.com/blogs/atlas_obscura/2013/09/04/berkeley_pit_in_butte_montana_is_a_lake_of_toxic_waste_with_possible_ant.html
 3. <https://data.glfwc.org/archive/bio/AdminReport17-08.pdf>
 4. https://www.sosbluewaters.org/NWF_Acid_mine_drainage_factsheet11.pdf
 5. Satellite Images derived from Google Earth
 6. <https://www.esci.um.edu/courses/1001/minerals/pyrite.shtml>