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Imagine being an engineer and planning for the death of your construction before it is even born. The leftover waste from mines is so dangerous that mining companies figure out what to do with it decades in advance, even before they start digging. What happens to mines when they are no longer in use? They become abandoned. The government has identified roughly 46,000 abandoned mines on public lands. Other estimates predict there are as many as half a million abandoned mines in the US.

Acid mine drainage, or AMD, is one of the many hazardous issues posed by abandoned mines. AMD is the byproduct of geo-chemical and microbial reactions that occur when mine water reacts with oxygen. When groundwater seeps into an abandoned mine, it reacts with oxygen and pyrite to form sulfuric acid, which dissolves metals from the surrounding rocks. The water, now holding sulfuric acid and the metals once within the rocks, drains out of the mine. The dissolved metals react when exposed to oxygen and fall out of solution, turning a bright yellow/orange color. A few options for remediating AMD are currently in use and include chemical or biological mechanisms. Both mechanisms contain options that can be classified as “active” or “passive. Active systems usually involve an attempt to increase the speed or efficiency of natural bioremediation, whereas passive systems can be much slower.

While AMD contaminates freshwater ecosystems and creates uninhabitable conditions for various organisms, it is an ideal home for a select community of microbes. These microbes actually increase the rate at which AMD is formed. Iron-oxidizing prokaryotes catalyze ferrous iron oxidation, and thus influence the rate of pyrite dissolution. This metabolic activity and mineral dissolution can decrease the pH down to values less than 2. This extreme acidity selects for a community of microbes optimized for acidic lifestyles.

“Yellowboy”, a byproduct of AMD.

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Various studies have been done to identify the specific microbial organisms that live in raw AMD discharge. One study conducted in Clinton County, PA evaluated the spatial distribution of microbial

communities throughout a passive treatment system. Sediment and water samples were collected, and water samples were filtered on site. Back at the lab, nucleic acid extractions from both the sediment and water samples were completed and Polymerase Chain Reactions (PCR) were performed. High-throughput sequencing of the 16S rRNA gene and shotgun metagenomics were used to analyze the samples. Metagenomics is a scientific field in which researchers study genetic material that has been extracted directly from the environment and high-throughput sequencing is a technique in which many DNA molecules can be sequenced together, greatly enhancing the speed and accuracy of sequencing. After sequencing the samples, the scientists were able to understand the dynamics of the sediment and aquatic environments of the treatment system and neighboring stream. The researchers found that microbial communities varied between the various sections of the entire system. For example, microbes living in raw AMD waste were mostly Firmicutes, while Proteobacteria dominated most of the community within and downstream of the passive remediation system. More about this study can be found here.

The influence of acid mine drainage on surrounding watersheds has become a highly studied topic. Bioremediation of these systems should be investigated further, because the problem will not solve itself and AMD can harm the surrounding wildlife while contaminating our drinking water. The state of Pennsylvania has more acid mine features polluting waterways and surrounding land than any other state in the country, and some of these mines are a century old. How close is the nearest abandoned mine from your backyard?

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