Acid Rock Drainage

What is acid rock drainage?

Some rock naturally contains sulfide minerals. Sulfides are made up of sulphur that is bound to another metal, such as iron, copper or nickel.

Weathering or oxidation occurs naturally or it can result from mining. When it occurs, water that comes in contact with the sulfide rock may then contain higher levels of acidity and dissolved metals. When not managed properly, this water can then drain away in storm water runoff, snow melt or groundwater. This is called acid rock drainage (ARD).

What are the risks associated with ARD?

If not properly managed, prevented or treated, ARD can have serious environmental impacts to surface and ground water quality and surrounding wildlife and vegetation.

Prior to modern practice, damage was done in some cases to the environment by mining because ARD was not properly managed. Due to better understanding of the environmental risk of ARD and the need to reduce those risks, significant strides in understanding, preventing and controlling ARD have occurred worldwide in the past 20 to 30 years.

Typically, mining ARD results from surface storage of sulfide-containing waste rock piles, which are then exposed to the elements without proper mitigation measures in place. Similarly, ARD can be caused if the tailings that are produced are high in sulfide content and are not properly contained.

A well planned mine that adheres to accepted mining best practices can prevent the formation of ARD and allow for safe management and containment or trigger treatment methods to ensure water quality standards are met.

Key Terms

Sulfide minerals: Some sulfide minerals like copper sulfide and nickel sulfide are mined and are critical components of other products

Oxidation: The effect oxygen has on exposed minerals over time (i.e. iron turns rusty from air)

Neutralization: The process of reducing or buffering the level of acidity caused by ARD

How does the mining industry manage ARD?

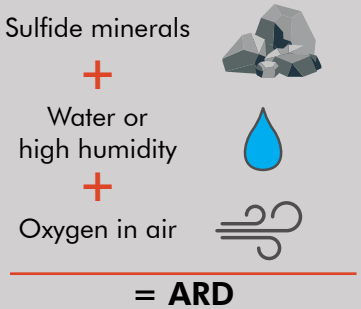
There are a number of ways to reduce the risk of formation of ARD or safely manage it. The potential for ARD is established before a mine becomes operational and is planned for in the design of the mine.

The three essential ingredients necessary in the formation of ARD are:

- Sulfide minerals
- Water or high humidity
- Oxygen in air

If you remove any one of those elements, ARD will not form. The risk of ARD forming can either be reduced, by isolating the mined material from exposure to air or water, or managed, by neutralizing ARD as it forms.

Acid Rock Drainage requires three essential ingredients to form:



Remove any one of these ingredients and ARD will not form:

Twin Metals Minnesota Project site

The level of sulfide in rock can vary greatly from one part of a mining area to another. For the Twin Metals Minnesota (TMM) Project, the ARD potential of the area to be mined has been measured as low because of where the mining would occur and the engineering controls that would be used. Continuing studies of the TMM Project deposit and the sulfide recovery process show that tailings produced by TMM from the Maturi Deposit would be non-acid generating.

Based on TMM research and data collected, tailings produced after extraction of minerals would contain sulfur at very low levels. Research conducted by the Minnesota DNR has shown that similar material within the Duluth Complex (where the Maturi Deposit is located) is non-acid generating.

At the TMM Project site, nearly all of the sulfides would be removed during mineral processing. Therefore, the tailings would have very low sulfur content and would not create a risk of ARD.

Twin Metals Minnesota Project ARD control measures

Above ground

Material brought to the surface for processing would all be ore from which copper, nickel and other minerals would be separated. The Project design eliminates the need for surface waste rock piles. Copper, nickel and other minerals shipped from the site in containers would bear the vast majority of sulfides initially present in the ore.

Underground

Water would be removed from the mine during operations for beneficial use in ore processing. Once mining activities are complete, the exposure to air would virtually be eliminated.

Up to half of the tailings would be mixed with cement and used as underground backfill. The backfill would help stabilize the mine during and after production.

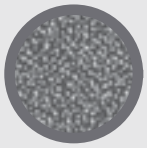
The Maturi deposit in the Duluth Complex TMM would mine is well contained within a specific band thousands of feet below the surface. The rock around the deposit is almost completely free of sulfides. As the ore is processed, the sulfides would be removed.

Above ground

Tailings would be dry stacked

The Project design eliminates the need for surface waste rock piles.

Below ground



Up to half of the tailings would be mixed with cement as backfill

Once mining is complete, the exposure to air would virtually be eliminated

Links to Acid Rock Drainage Resources:

TMM website
www.twin-metals.com

USEPA
https://www.epa.gov/nps/abandoned-mine-drainage

International Council on Mining and Metals
www.icmm.com/

Acid Drainage Technology Initiative Metal Mining Sector
https://community.smenet.org/adti-mms/home?ssopc=1