

Acid Rock Drainage and the Effects on Water Quality



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Overview

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- ▶ Introduction
- ▶ Chemistry of acid rock drainage
- ▶ Drainage into water systems
- ▶ Impacts
- ▶ Remediation and treatment
- ▶ Future considerations



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Introduction

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- ▶ Acid rock drainage (ARD)
 - ▶ Acidification of water that occurs when it interacts with rock.
 - ▶ Natural process.
 - ▶ Often called acid mine drainage (AMD) because it is common near mines.



ifraserlab.wordpress.com



Introduction

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- ▶ Gilt Edge Mine Superfund Site
 - ▶ Opened in 1930's, worked for ~20 years.
 - ▶ In 1986, re-opened by Brohm Mining Company (BMC).
 - ▶ In 1992, site started leaching acid.
 - ▶ By 1998, BMC was overwhelmed.
 - ▶ In 2000, declared a superfund site.
 - ▶ 150 million gallons of untreated water (more every day).
 - ▶ Millions of cubic feet of cyanide-heap leach piles.
 - ▶ So far, \$60 million spent in cleanup, an estimated \$100 million needed.



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Chemistry of ARD

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- Sulfides oxidize into acids when they interact with water and oxygen.



↑
Pyrite

↑
Oxygen

↑
Water

↑
Yellow Boy
(Rust)

↑
Sulphate

↑
Acid



geology.com



wikimedia.org

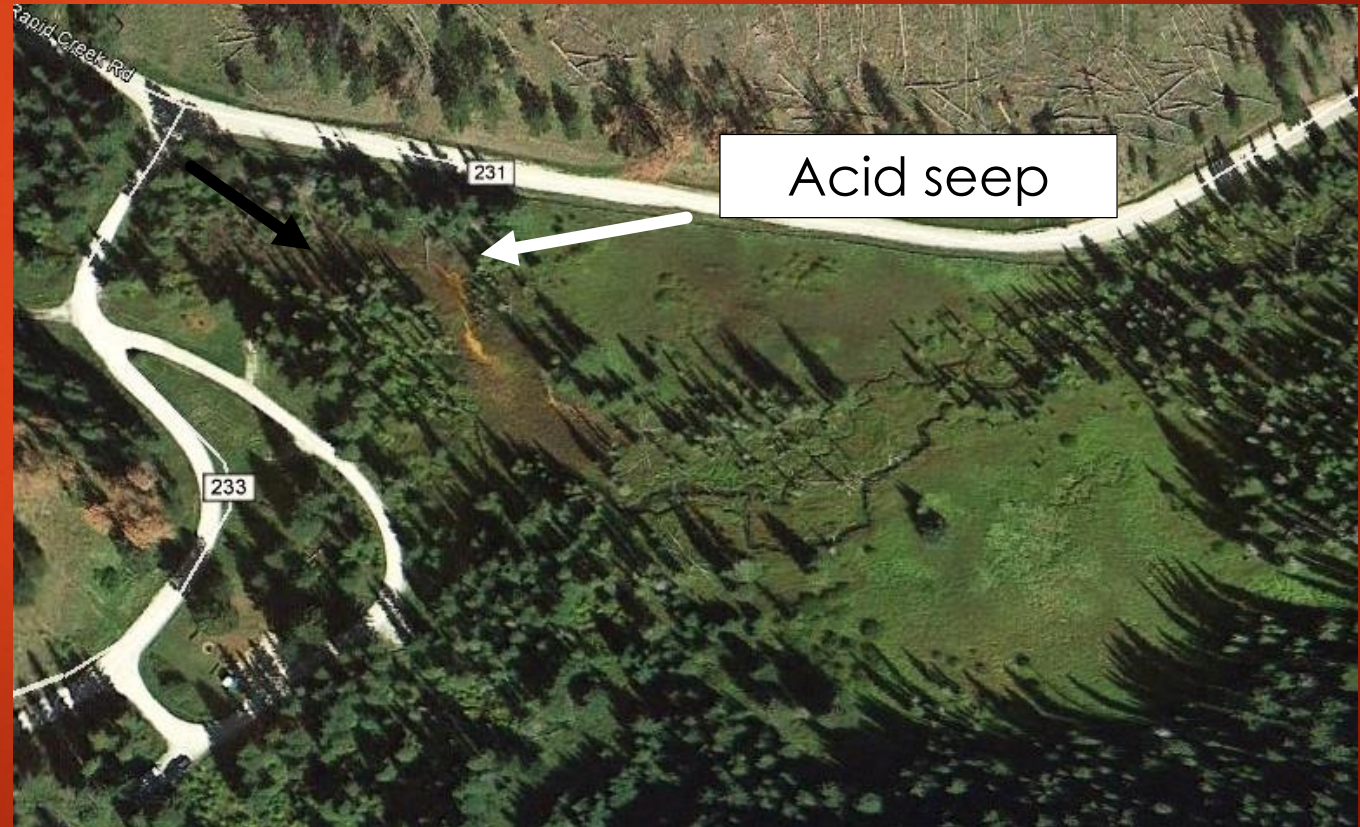


Drainage into water systems

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- ▶ Water moves through deposits and into ground and surface water.

- ▶ Black Fox Campground
Rochford, SD



Google Earth



Drainage into water systems

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► Mining

- Many sulfide deposits are mined for metals.

| Sulfide | Chemical Formula | Extracted Product |
|--------------|------------------|-------------------|
| Chalcopyrite | CuFeS_2 | Copper |
| Cinnabar | HgS | Mercury |
| Galena | PbS | Lead |
| Molybdenite | MoS | Molybdenum |
| Pyrite | FeS_2 | Iron |
| Sphalerite | ZnS | Zinc |



Drainage into water systems

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- ▶ Mine shafts and pits.
 - ▶ Increased surface area and allow more interaction with groundwater.



911metallurgist.com



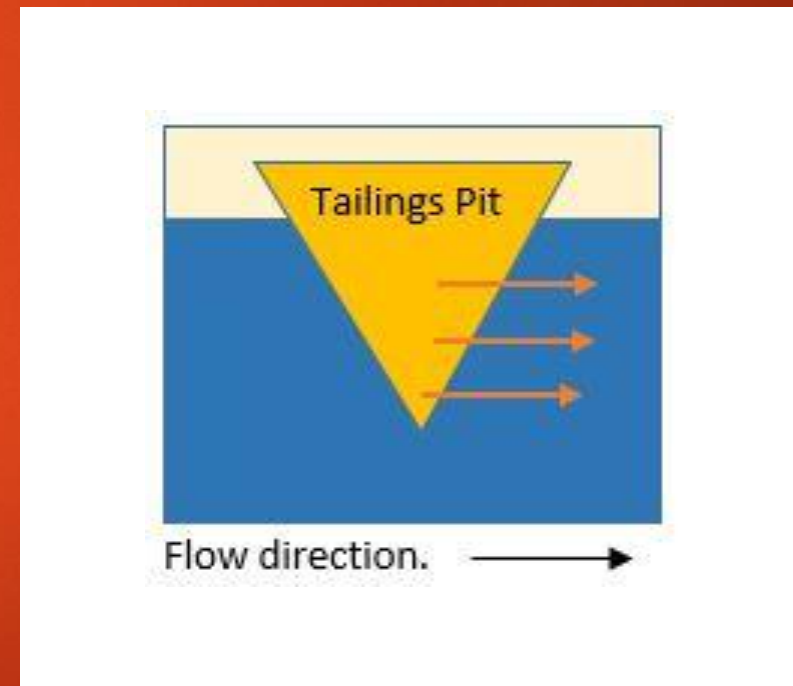
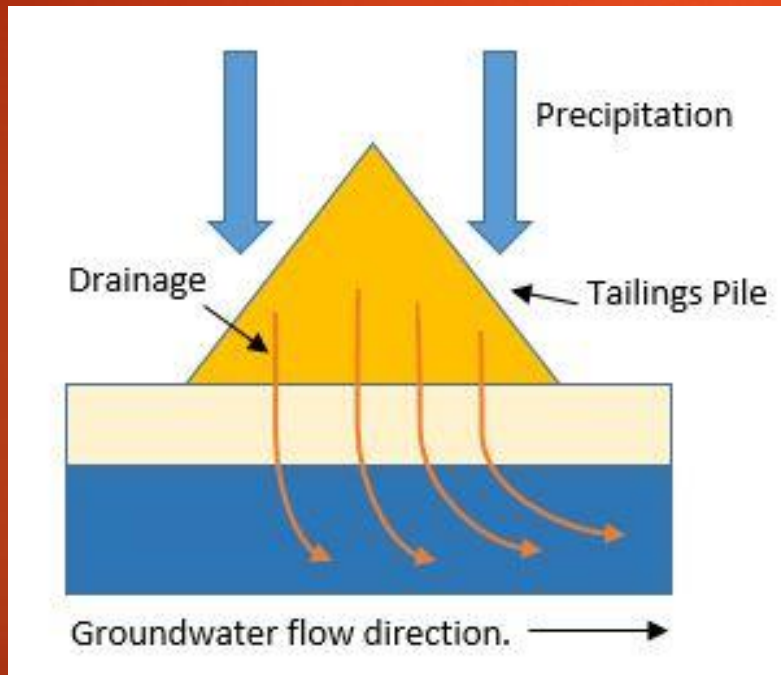
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Drainage into water systems

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- ▶ Mine tailings
 - ▶ Exponentially increased surface area plus leaching chemicals.



Impacts of ARD

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- ▶ Water discoloration
 - ▶ From rust precipitation
- ▶ Increased water temperature
 - ▶ Increased pathogens
 - ▶ Less dissolved oxygen
- ▶ Increased acidity
 - ▶ Harsher for fish and plants (if livable at all).
- ▶ Increased heavy metals
 - ▶ Acidic water mobilizes heavy metals.
 - ▶ Heavy metals lead to neurological issues.



wvu.edu



Impacts of ARD

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- ▶ Impacts on drinking water
 - ▶ More need for treatment to meet standards.
 - ▶ Increased pathogens
 - ▶ Increased heavy metals
 - ▶ Discoloration (secondary)
 - ▶ Damage to water treatment systems due to corrosion.
 - ▶ Ruptures
 - ▶ Clogged plumbing



latimes.com



borderhi.com



dcwater.com

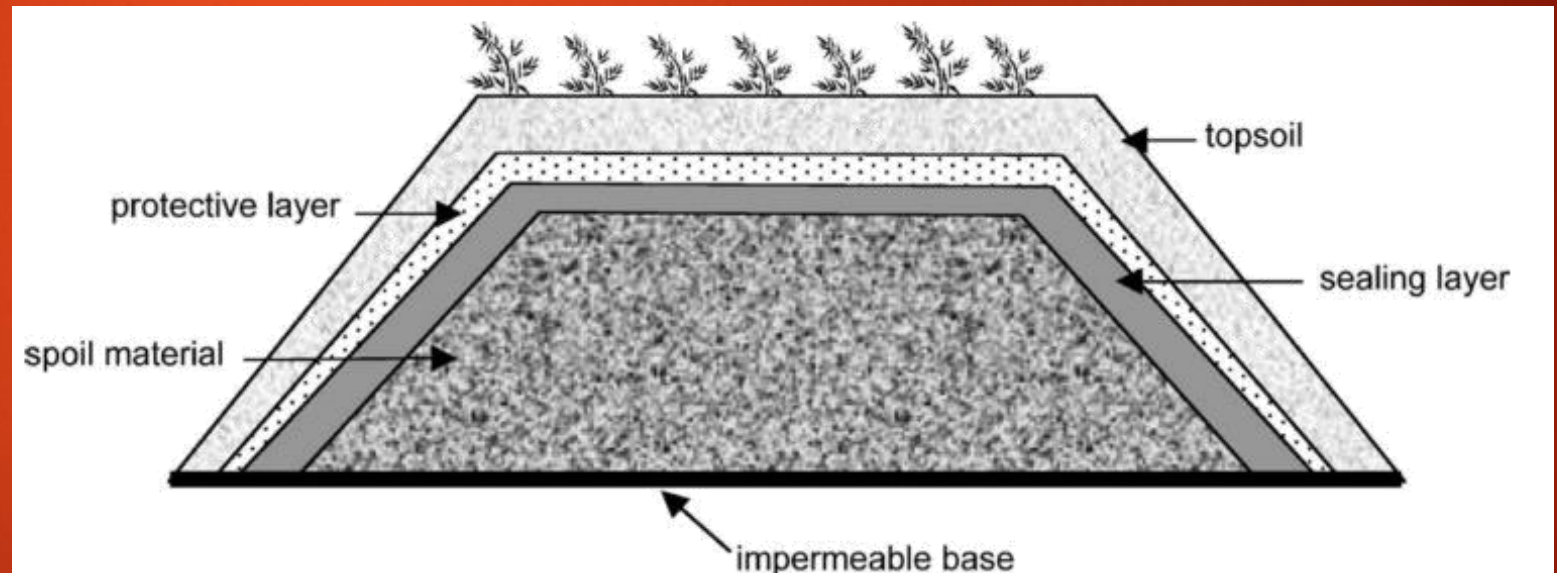


Remediation and Treatment

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► Prevention

- Sealing underground mines
- Underwater storage
- Sealed waste heaps
- Microencapsulation
- Anionic treatment
- Blending waste materials



Johnson, et al.,
2005



Remediation and Treatment

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- ▶ Treating affected water
 - ▶ Lime treatment
 - ▶ Raise pH to neutralize and precipitate heavy metals.
 - ▶ Expensive
 - ▶ Requires lime supply



Remediation and Treatment

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- ▶ Emerging treatment methods
 - ▶ More natural-based
 - ▶ Aerobic wetlands
 - ▶ Anoxic limestone drains
 - ▶ Bioremediation
 - ▶ Reactive barriers



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Future Considerations

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- ▶ Problem can still occur
 - ▶ Hidden mines
 - ▶ Groundwater travel time
- ▶ Developing countries
 - ▶ Economy outweighs safety
- ▶ Improved remediation methods
 - ▶ Affordable and deployable
- ▶ Regulations and mining practices
 - ▶ Prevention



environment.co.za



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