Sulfide Mining: The Process & The Price

A Tribal & Ecological Perspective
**Introduction**

Mining, particularly sulfide mining, presents certain unavoidable ecological risks. Tailings, the slurry of mine waste and water, is a by-product of mining and represents a significant environmental concern. The Mining Company of White Pine, Michigan, has proposed in 1975 to mine portions of Wisconsin, Minnesota, and Michigan. This proposal has led to concerns over the potential environmental impacts of mining.

**The Sulfide Mining Process**

Mining is the process by which valuable minerals such as copper, lead, zinc, and gold are extracted from the earth. These minerals are essential to modern society and are typically found in their pure or native form, as components of other minerals. Copper, lead, and zinc ores are often treated to extract these minerals. Copper, zinc, and lead mining is often referred to as sulfide mining, and the release of various forms of sulfur is an inevitable byproduct of the mining process.

**Basic Geology and Exploration**

Copper, zinc, and lead are widespread in the rocks of the earth's crust, but in economically significant concentrations. Mining companies often survey large areas to identify potential ore bodies. These surveys may involve the use of geophysical techniques to detect variations in the earth's magnetic or electrical properties.

**Beneficiation: Milling and Concentration**

Today, mill operators in over half of the mining companies use various techniques to extract valuable minerals from the ore. Beneficiation involves crushing the ore to a smaller size before the minerals are separated from the gangue. Chemicals may be added to the ore to make the minerals more soluble or to change their properties. Tailings are the by-products of the milling process and represent a significant environmental concern.

**Development and Mining**

Development includes all the activities that must take place before the orebody can be mined. This involves construction of surface structures, access roads, power lines, and rail lines. Once the ore is extracted, it must be transported to a processing plant. Tailings are a significant by-product of mining and represent a significant environmental concern.

**Gravity Separation**

Gravity separation is the process of separating minerals based on their density. A high density mineral will sink to the bottom of a container, while a lower density mineral will float on the surface. This process is often used in the mining industry.

**Froth Flotation**

Froth flotation is a method of separating valuable minerals from gangue minerals. The valuable minerals are treated with a froth inhibitor, which prevents them from floating away. The froth is then skimmed off, leaving the valuable minerals behind.

**Benefits:**

- **Tailings:** The slurry of mine waste and water is a by-product of mining. Tailings are often stored in large impoundments and can be a significant environmental concern.
- **Water Management:** Beneficiation produces tailings and waste water as byproducts of mining. Tailings and waste water must be managed to minimize their environmental impact.
- **Leaching:** Beneficiation produces tailings and waste water as byproducts of mining. Tailings and waste water must be managed to minimize their environmental impact.

**Leaching:**

Leaching is the process of dissolving a valuable mineral from ore by contact with a suitable solvent. The solvent may be a chemical solution or a process fluid. The solvent may be used to leach the valuable mineral from the ore, leaving the gangue behind. Leaching is often used in the production of copper, gold, and silver.

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Smelting and Refining

Metals inside certain minerals are extracted. The metals may also be refined depending on their intended commercial use. Smelting involves three separate stages: roasting, smelting, and converting.

Roasting is required for high-sulfur concentrates. It oxidizes the iron in the concentrate and drives off sulfur dioxide. Roasting breaks most of the melting impurities in the beneficiated (sulfidic) ore into a molten slag, leaving the metallic sulfides in a solid state that can be removed before the metal is melted.

At the same time, the major metals combine with oxygen to form its usual oxides of metallic sulfides. Converting destroys the iron from the metallic sulfides, which is then removed before the metal is cast into final forms.

Wet or very pure metal is needed, such as copper for electronic applications, the exact metal content can vary as long as it is above 96%. Refining can be done in a number of different ways, including fire refining, electrolytic refining, vacuum-melting refining, or high-pressure electrolytic refining.

Reclamation

Reclamation of the mining activity, the rehabilitation and restoration of the project site or state as close as possible to its original pre-mining condition. The goal is to remove and eliminate all immediate or potential liabilities, to make the area usable and attractive again, and to restore the vegetation and stabilization of the site or area, there is no single way to accomplish such goals.

Each site will differ, and the choice of reclamation measures will be influenced by such factors as the nature and severity of the mine operating activities, the particular state where the mine is located, and the technical and economic feasibility of the reclamation project.

The Effects of Mining on Ecosystems

All mining has impacts on air, water, soil, and living organisms. Air pollution is often a problem when mining involves the burning of fuels or chemical processes. Water pollution occurs when mining and its associated processes is found in Figure 2.

An abundance of water makes it more likely that pollutants will encounter and contaminate that water, and less likely that pollution control measures will be completely effective.

A. Exploration

Mineral exploration poses a number of ecosystem threats. Drilling operations may pollute surface water. When a water source is contaminated with acid, it can be neutralized by adding lime to increase its pH. Acidification leads to a decrease in aquatic oxygen levels, which can kill fish and other aquatic organisms.

B. Development/Mining

An ecosystem can be threatened by sulfide mining operations when wastes contain poisonous sulfides that are leached by water from mining and its associated processes. The federal government is responsible for regulating and investigating mining and its associated processes. Mining's potential threats to ecosystems are discussed in this section.

1. Pollutants

Mining and its associated processes can produce acid drainage, heavy metal contamination, and sedimentation. These can cause a series of surface and groundwater problems. For example, acid drainage can kill fish and other aquatic organisms. Heavy metal contamination, such as copper, can contaminate surface and groundwater. Sedimentation can cover and kill invertebrates and other aquatic organisms.

2. Riparian Areas

The riparian zone is the area adjacent to a stream or river. It is a critical component of an ecosystem, providing habitat for a variety of plants and animals. Riparian areas are often referred to as the "cradle of biodiversity" because they support a wide variety of plant and animal life.

Major Ecosystem Threats of Sulfide Mining

- **Acidic conditions (low pH)**
- **Heavy metals**
- **Sediments/suspended solids**
- **Hydrogen sulfide production**
- **Kills fish and other aquatic organisms**
- **Enters via respiratory tissue and poison cells**
I pH the technology behind these systems is exposed to oxygen and required may not be well-controlled, the bacteria that speed up acid generating reactions; Bactericides or as fugitive dust. Groundwater new To be well-defined, an appropriate amount of proper buffering and its long term is prolonged, salt balance presents in tailings in small amounts. The threats of chemicals contained in tailings are to acidic levels, organ—

Sulfide mining can have devastating effects on local streams.

When tailing escape from tailings management areas or from underground mining workings, contamination occurs. Tailing contains acid-generating materials, toxic heavy metals, dissolved solids, sulfates, and acidity.

Acid Mine Drainage

Acid mine drainage comes when sulfide minerals that are exposed to oxygen and water produce sulfuric acid. Acidification occurs naturally within water bodies, but at a very slow rate. Mining causes the sulfide minerals to come into contact with oxygen and water, which accelerates this process. In acid mine drainage, the rate of reaction is speeded up dramatically. The bacteria Thiobacillus ferroxidans, common in acidic environments, acts as a catalyst in this process. Uncontrolled acid generation can result in soil and groundwater contamination. The damage caused by acid migration spreads over long periods of time, perhaps centuries. When the mine is abandoned, the damage continues. The bacteria Thiobacillus ferroxidans acts as a catalyst in this process. Uncontrolled acid generation can result in soil and groundwater contamination. The damage caused by acid migration spreads over long periods of time, perhaps centuries. When the mine is abandoned, the damage continues. The bacteria Thiobacillus ferroxidans acts as a catalyst in this process. Uncontrolled acid generation can result in soil and groundwater contamination. The damage caused by acid migration spreads over long periods of time, perhaps centuries. When the mine is abandoned, the damage continues. The bacteria Thiobacillus ferroxidans acts as a catalyst in this process. Uncontrolled acid generation can result in soil and groundwater contamination. The damage caused by acid migration spreads over long periods of time, perhaps centuries. When the mine is abandoned, the damage continues. The bacteria Thiobacillus ferroxidans acts as a catalyst in this process. Uncontrolled acid generation can result in soil and groundwater contamination. The damage caused by acid migration spreads over long periods of time, perhaps centuries. When the mine is abandoned, the damage continues. The bacteria Thiobacillus ferroxidans acts as a catalyst in this process.

Minerals can escape into the environment by chemical processes. As the potential exists for the development of several mines in proximity to one another, policy makers must consider how these cumulative impacts will be addressed in the future. The development of several sulfidemines in an ecosystem can pose special threats to that ecosystem. Human contact with heavy metal laden tailings poses health-threats. Perhaps the most severe health-threatening potential of some of the heavy metals found in tailings is their entry into the food chain. Fish are known to concentrate some of the heavy metals that are found in tailings. This concentration process is known as biomagnification, where the toxic substances are passed up the food chain. One of the metals that is of concern is cadmium. Cadmium is a heavy metal that is found in tailings. It is a known carcinogen and is known to cause cancer in humans. The United States Environmental Protection Agency has set a maximum level for cadmium in drinking water of 5 parts per billion. The presence of cadmium in drinking water can cause health problems, including kidney damage and cancer. The presence of cadmium in fish can cause health problems for humans who consume the fish. The presence of cadmium in the fish can cause health problems for humans who consume the fish. The presence of cadmium in the fish can cause health problems for humans who consume the fish. The presence of cadmium in the fish can cause health problems for humans who consume the fish.

**Chemical Process Pollution**

Beneficiation uses many chemicals. After one processing, some chemicals persist in the tailings where they can come into contact with water and be carried away from the site. In addition, tailings are often used to reduce the amount of stored chemical. This can contaminate groundwater, which can then move through underground aquifers and reach surface waters. Figure 5 shows the characteristics of some of the chemicals commonly used in beneficiation.

**E. Cumulative Effects**

Cumulative impacts occur when individual impacts, happening simultaneously or consecutively, effect greater than the sum of their parts. Individual impacts can multiply when placed in a setting where a cumulative effect occurs. The cumulative effect can be increased by the presence of different media. For example, when several metals are treated in the at the same site, they have the potential to react with each other and cause a cumulative effect. However, the presence of different media can cause a cumulative effect. For example, when several metals are treated in the at the same site, they have the potential to react with each other and cause a cumulative effect. However, the presence of different media can cause a cumulative effect. For example, when several metals are treated in the at the same site, they have the potential to react with each other and cause a cumulative effect. However, the presence of different media can cause a cumulative effect. For example, when several metals are treated in the at the same site, they have the potential to react with each other and cause a cumulative effect. However, the presence of different media can cause a cumulative effect. For example, when several metals are treated in the at the same site, they have the potential to react with each other and cause a cumulative effect. However, the presence of different media can cause a cumulative effect. For example, when several metals are treated in the at the same site, they have the potential to react with each other and cause a cumulative effect. However, the presence of different media can cause a cumulative effect. For example, when several metals are treated in the at the same site, they have the potential to react with each other and cause a cumulative effect. However, the presence of different media can cause a cumulative effect. For example, when several metals are treated in the at the same site, they have the potential to react with each other and cause a cumulative effect. However, the presence of different media can cause a cumulative effect. For example, when several metals are treated in the at the same site, they have the potential to react with each other and cause a cumulative effect. However, the presence of different media can cause a cumulative effect. For example, when several metals are treated in the at the same site, they have the potential to react with each other and cause a cumulative effect. However, the presence of different media can cause a cumulative effect. For example, when several metals are treated in the at the same site, they have the potential to react with each other and cause a cumulative effect. However, the presence of different media can cause a cumulative effect. For example, when several metals are treated in the at the same site, they have the potential to react with each other and cause a cumulative effect. However, the presence of different media can cause a cumulative effect. For example, when several metals are treated in the at the same site, they have the potential to react with each other and cause a cumulative effect. However, the presence of different media can cause a cumulative effect. For example, when several metals are treated in the at the same site, they have the potential to react with each other and cause a cumulative effect. However, the presence of different media can cause a cumulative effect. For example, when several metals are treated in the at the same site, they have the potential to react with each other and cause a cumulative effect.
The Potential Effects of Mining on Indian Tribes

Indian tribes in the northern portions of Wisconsin, Minnesota, and Michigan are profoundly affected by sulfide mining operations in ways that are different for different tribes. For example, one tribe may be significantly affected by smelting operations, while another tribe may be affected by the adverse effects of acidification and acid rain. These differences are due to a variety of factors, including the location of the mines, the type of mining operations, and the specific environmental impacts on the tribes.

For example, sulfide fragmentation can result from the large surface area created by mining operations. Land use and cultural practices on reservations may be impacted by mining activities. The presence of individual and tribal resources, including land and water, can be impacted by mining activities. The impact on the tribes may vary significantly depending on the location of the mining operation.

Tribal reservations and treaty rights are fundamental to the preservation of Indian culture and identity. Indian tribes use these resources to maintain their social and cultural traditions. Local customs and traditions, and the physical environment.

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The following is a summary of the primary threats from smelting and refining:

- Sulfuric acid is a component of acid rain, which lowers the pH of water and can cause damage to aquatic and terrestrial ecosystems.
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...court ruling, the Wisconsin legislature adopted a bill that the site constitutes a viable site (defined as a site that is suitable for mining and that will have a low probability that standards will be violated at the "compliance boundary," which may be 1200 feet, or about 4 football field lengths, from the minesite. Within the compliance boundary, the DNR may order the mining operator to backfill and/or restore the site, if it concludes that the site would be ready for the "compliance boundary," which is defined as the area referred to as a land disposal site, "...can begin to apply at the "compliance boundary," which is defined as the area referred to as a land disposal site, "...can begin to apply at the "compliance boundary," which is defined as the area referred to as a land disposal site, "...can begin to apply at the "compliance boundary," which is defined as the area referred to as a land disposal site, "...can begin to apply at the "compliance boundary," which is defined as the area referred to as a land disposal site, "...can begin to apply at the "compliance boundary," which is defined as the area referred to as a land disposal site, "...can begin to apply at the "compliance boundary," which is defined as the area referred to as a land disposal site, "...can begin to apply at the 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Exemptions must not violate any other law or rule and must be consistent with the overall policy that the regulations purport to implement. Exemptions or variances must not endanger public health, safety, or welfare, or the environment. The decision to grant or deny an exemption or variance will turn on an interpretation of the terms "endanger," "public health, safety, or welfare," and "consistent with," all of which can be construed narrowly or broadly depending on the circumstances.

Exemptions have been granted. Wisconsin's mining criteria prohibit mine siting within 300 feet of a navigable river or stream. However, an exemption was granted enabling a mine to be located only 140 feet (less than half a football field's length) from the Flambeau River in Rusk County. The DNR concluded that the variation would not create any additional threat to the surrounding environment.

Wisconsin's officials contend that the state's mining laws are among the toughest in the nation. Yet, the question remains how these laws, which appear so designed to encourage metallic mineral mining, can adequately protect against the many and inevitable ecosystem threats that such mining poses.

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Conclusion

Policymakers and regulators inevitably balance trade-offs in determining whether sulfide mining takes places in northern Michigan, Wisconsin and Minnesota. Mining will create jobs; it will also cause environmental damage. The number of jobs created can be predicted with some accuracy; the amount of environmental damage cannot.

Many communities in the United States are now paying the price of unwise policies with regard to sulfide mining: acid mine drainage, heavy metals contamination, and other environmental degradation.

Indian tribes with reservations and off-reservation harvest rights in northern Wisconsin, Michigan and Minnesota are particularly susceptible to the impacts of sulfide mining. Their cultures mandate respect for the earth, and humility and gratitude for the resources it provides. In the Indian view, the perpetuation of natural resources is tied to the perpetuation of humans. Loss or contamination of natural resources thus affects Indian culture in ways far beyond the loss of a food source.

New technologies intended to mitigate or prevent environmental damage from sulfide mining are being developed but remain untested. Thus, wisdom counsels a conservative course for mining policy and permitting decisions. Particularly in a region so abundant in water resources, the threat of sulfide mining is real and are potentially devastating.

In the case of the proposed Crandon mine in Wisconsin and similar sites elsewhere, policymakers must consider whether they wish irreplaceable watersheds to be testing grounds for these new technologies.

Ultimately, these decision makers must be prepared to bear the legacy should these technologies prove inadequate to prevent widespread environmental damage.

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References

Introduction


Chapters 1 and 2


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