Human Health Considerations Associated with Sulfide Ore Mining: A brief overview

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Although physicians' primary ethical obligation is to individual patients, they also have a responsibility to protect and promote public health.
What we hope to convey today

- Briefly highlight important characteristics of iron ore and sulfide ore mining
- Identify negative human health effects associated with sulfide ore mining
- Introduce how sulfide ore mining may contribute to increased methylmercury
- Review the medical voice of concern raised regarding sulfide ore mining
- Review regulatory tools to evaluate and protect human health: workers and local and downstream communities
Sulfide ore Mining

Desired metals in a mining operation, such as copper, nickel, palladium group metals, can be bound to sulfur in rock. Because of this sulfur bond, they are described as sulfide minerals. There are many chemical compounds within this category.

Mining these sulfide minerals is referred to as sulfide ore mining.

(millions of tons of rock are excavated to obtain a fractional amount of the desired product)

Iron Ore and Sulfide Ore General Characteristics

Iron ore (taconite) mining

- Rock containing iron-bearing minerals (includes iron oxides and iron carbonate) has less sulfur
- General reaction with air/water = rust
- Mining rock & waste less likely to produce acid (although still may increase mercury contamination of fish)

Sulfide ore (copper-nickel) mining

- Ore body contains sulfide minerals
- General reaction with air/water can produce acid, sulfate
- Potential for release of heavy metals in ore

Unique risk of Sulfide ore Mining:
ACID MINE DRAINAGE

Status and trends of the nation's biological resources.
Available at: http://www.nwrc.usgs.gov/sandt/.
What experience shows us:

- Abysmal track record of sulfide mining elsewhere coupled with our geography: WATER-WATER-WATER=WATER=creation of acid mine drainage and release of toxic metals
- Once we option this door, we can never close it
- Examples:
  - Kuipers et al (2006) studied 25 operating hard rock mines and their EISs: all predicted compliance with water quality standard within their EISs however pollution from 85% of mines near surface water and 93% of mines near ground water exceeded water quality standards. 89% had inaccurately predicted that they would not create AMD.
  - Earthworks article studied fourteen operating copper mines representing 89% of the US copper production. 100% had pipeline spills or accidental releases...
Major toxins associated with sulfide mining also on WHO list:

World Health Organization’s
Chemicals of Major Public Health Concern:

- (Particulate) Air pollution*
- Arsenic*
- Asbestos-like fibers*
- Benzene
- Cadmium*
- Dioxin & Dioxin-like substances
- Inadequate or excess Fluoride
- Lead*
- Mercury*
- Highly hazardous pesticides

In addition: Nickel, Manganese, Fluoride, Nitrates

Sulfide mining health considerations: Air Pollution

- **Airborne particulates including fugitive dust, silica dust**
- **Additional air pollution** (directly from mining activity as well indirect impacts from electrical power generation with fossil fuel source)
- Inhaled, small particles lead to oxidative stress and inflammation
- **HEALTH EFFECTS** are numerous:
  - Increased risk cardiovascular event
  - Long term increased risk of hardening of arteries
  - Increased risk of blood clots
  - Increased tendency toward metabolic imbalances
  - Emerging evidence if increased dementia risk

Sulfide mining health considerations: Asbestos & Elongate Mineral Fibers (EMF)

- Asbestos and asbestiform fibers
- HEALTH EFFECTS of asbestos include lung disease and mesothelioma
- HEALTH EFFECTS OF EMFs are being studied, complex
Sulfide mining health considerations: Heavy metals

- **Arsenic** Cardiovascular, skin, carcinogen
- **Lead** Nervous system, blood, cardiovascular, kidneys, probable carcinogen
- **Mercury** Nervous system, kidney, possible carcinogen
- **Cadmium** Respiratory, kidney, carcinogen (lung)
Sulfide mining health considerations: Nickel

- NICKEL

Respiratory, skin (allergy), carcinogenic soluble Ni compounds, possibly carcinogenic metallic Ni (lung)
Sulfide mining health considerations: Manganese

MANGANESE

- Small amounts required
- Larger amounts toxic
- Water limit < 400 mcg/Liter

- HEALTH EFFECTS include:
  - Toxic exposures lead to 'Manganism'
  - Neurotoxin (Parkinson-like symptoms)
  - Toxic to heart
  - Toxic to liver
  - Increased infant mortality
  - Cognitive impairment
Sulfide mining health considerations: Unanticipated failures

- unanticipated interruption of water treatment
- extreme weather event that overwhelms operation
- catastrophic event such as tailing dam breach
- Contamination and destruction of food sources, livelihoods
- death
Sulfide mining health considerations: Sulfate release

- Anthropogenic pollution of freshwater systems is an ongoing global issue
- Aquatic flora and fauna can be severely impaired by sulfate pollution
- Minnesota’s native wild rice stands are negatively impacted by sulfate and sulfide exposures
Manoomin, Psíŋ

- Seed of an aquatic grass
- Indigenous peoples have harvested for millennia
- Culturally very important
- Shelf stable, gluten free, offers food security
- Very favorable nutritional profile
Significant cultural considerations of wild rice:

- Data support the connection between participation in traditional practices and improved health (Sasakamoose et al. 2017).

- In addition to manoomin’s cultural and spiritual importance, it is a nutritionally advantageous grain, with a favorable cardioprotective profile offering omega-3 fats, B vitamins, and desirable levels of protein, fiber, carbohydrate, and total fat (Tim and Slavin 2014).

- Aqueous sulfates released into the ecosystem from anthropogenic sources like SOCN mining are converted to sulfides which are toxic to wild rice growth. Wild rice does not grow in waters with high levels of sulfate (Myrbo et al. 2017).

- Fond du Lac Band of Lake Superior Chippewa: Health Impact Assessment concluded that the persistent health disparities for tribal communities in Minnesota are directly related to the involuntary loss of traditional lands, subsequent disruption of traditional lifeways and the loss of traditional, health-sustaining foods such as manoomin.
Let’s talk about sulfates and methylmercury:

1. Release of sulfate into the environment from anthropogenic source (example: acid mine drainage)
2. Sulfate reaches wetlands where it can stimulate certain "sulfate-breathing" microorganisms that are capable of converting inorganic mercury to methyl mercury
3. Enhanced rates of mercury methylation can occur
4. Methyl mercury bio-accumulates in aquatic ecosystems, including fish species
5. Humans consume mercury-contaminated fish
Methylmercury Bioaccumulation and Biomagnification:
How these toxins can impact human health

The causes of neurodevelopmental disorders, including ADD, learning disorders, autism spectrum disorder, language disorders and intellectual disabilities are complex and multifactorial, but the connection to exposures to heavy metals, particularly methylmercury, is known.

Those most vulnerable:

- Developing fetus (pregnant women)
- Infants and children (lactating mothers)
- People dependent on local fish as quality food source and/or cultural practice
Why is methylmercury so toxic for the developing nervous system?

- Placenta is unable to filter out heavy metals
- Methylmercury and other heavy metals are then able to cross the blood-brain barrier in infants and children up to age 2-3 years of age
- Once heavy metals reach nerve or brain tissue the amount of damage is proportional to the rate of growth and cell division of the tissues (brain size doubles in the first year of life and by age 3 is approx. 80% adult volume)
- Lasting negative effects when fetuses are exposed to concentrations at levels that are only 10%-20% of toxic levels for adults
Minnesota Department of Health study

- Published 2011
- Heel cord blood from newborn babies in Western Lake Superior Basin (MN, WI, and MI)
- Significant elevations in mercury found in 10% of newborns
- Methylmercury exposure is already a public health issue in northeastern Minnesota
Lasting Effects of Neuro-developmental and other health impairments

- Individual costs
- Community costs
- Healthcare costs
Medical Voice of concern raised:

- Many medical and public health organizations
- Multiple letters from health providers and non-profits supporting human health
- Resolutions by MAFP/AAFP and petition to Minnesota’s Environmental Quality Board (EQB)
- Articles in medical literature
- Consistent ask for comprehensive Health Risk Assessment and Health Impact Assessments as part of EIS or EAW for sulfide-ore copper nickel mining projects
- These were not done...
Published Articles:

Sulfide Mining and Human Health in Minnesota

BY FLOYD WINTER, M.D. RICK ALLISON, M.D. STEVE BASS, M.D. THOMAS BECK, M.D. PH.D. MARGARET SANDBURG, M.D. RICK WILLIAMS, M.D. DOUGLAS WARRICK, M.D. M.P.H. AND JAMES MILLER, M.D.

Sulfide mining specifically copper-ore sulfide mining represents a significant departure from Minnesota’s iron mining tradition. Sulfide mining can produce toxic and deadly substances that not only pose a risk to workers but can also contaminate nearby water bodies, affecting the health of humans and wildlife. Nutrient-rich mining waters, when drained into lakes and streams, can cause significant harm to aquatic ecosystems.

The Duluth Complex is a geological formation that contains deposits of copper-ore sulfide mining, which is located on the eastern side of the Boundary Waters Canoe Area Wilders.

Risks and costs to human health of sulfide mining near the Boundary Waters Canoe Area Wilderness

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INTRODUCTION
Sulfide-ore copper mining (SOCN) mining is being considered in western Minnesota. Given pollution resulting from SOCN mining, including acidic runoff and heavy metals, it is crucial to assess the potential risk to human health.

METHODS
The Duluth Complex is a geological formation that contains deposits of copper-ore sulfide mining near the Boundary Waters Canoe Area Wilderness (BWCAW). Environmental assessments of the Duluth Complex have been performed by the Minnesota Pollution Control Agency (MPCA), but they have been limited to impacts on water quality and wildlife. The study also assessed the potential risks to human health.

RESULTS
The study found that SOCN mining poses significant risks to human health, including potential exposure to heavy metals and acidic runoff.

CONCLUSION
The study highlights the need for further research and regulatory oversight to ensure the safety of mining activities in the Boundary Waters Canoe Area Wilderness.

Published Articles:

Sulfide-ore mining and human health in Minnesota

WHERE ARE WE NOW?

For many years, Minnesotans have been raising concerns regarding the potential for sulfide-ore copper mining (sulfide-ore copper) to impact human health in Minnesota. Although the debate is not new, the landscape surrounding decisions regarding this type of mining within Minnesota’s borders is dynamic and constantly changing. As SOCN mining moves forward, new legislative and regulatory efforts are being implemented to mitigate potential health impacts.
Regulatory Tools to evaluate health risks: HRA and HIA

<table>
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<tr>
<th>HIA</th>
<th>HRA</th>
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<tr>
<td>▪ Focuses on the Social Determinants of Health</td>
<td>▪ Focuses on specific contaminants/hazards</td>
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<tr>
<td>▪ Primarily qualitative</td>
<td>▪ Primarily quantitative (deriving specific values)</td>
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<tr>
<td>▪ Stakeholder engagement highly valued</td>
<td>▪ Expert-driven</td>
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*Note: Both have systematic processes & are based on science.*
HIA & HRA • What is a Health Impact Assessment?

Why HIA?

- Identify harms and benefits *before decisions are made*
- Identify *evidence-based strategies* and recommendations to promote health and prevent disease
- Support *inclusive and democratic decision-making* and increase transparency in the decision-making process
- Support *community engagement* in the decision-making process and foster community empowerment
- Advance *equity and justice*

*Note: There are many ways to insert health into decision-making. HIA is one way.*
Physician Advocacy for Health Impact Assessments

October 2016 MAFP members and leadership advocate for MAFP’s request for a MN Rule change to require Health Risk and Health Impact Assessments as part of the Environmental Review process. Pictured, left to right: John Ipsen MD, Jennifer Pearson MD, Maria Huntley MAFP Executive Director, Dania Kamp MD, MAFP 2016 President, Emily Onello MD, Deborah Allert MD, and Kristan Wegerson MD.
Review: Core Concerns Regarding Sulfide ore Copper Nickel Mining

- At least 6 of the 10 toxins of major public health concern listed by the World Health Organization (mercury, lead, arsenic, asbestos, particulate air pollution, cadmium) are released from sulfide-ore mining.
- This type of mining also releases sulfates, which increase the amount of methylmercury in the environment.
- Abysmal track record of sulfide mining elsewhere coupled with our geography—WATER-WATER-WATER= creation of acid mine drainage and release of toxic metals.
- Once we open this door, we can never close it.
And again... A few key points regarding potential toxicity:

- Heavy Metals with many harmful affects to human health: cancer, heart and lung disease, neurodevelopmental disorders
- Methylmercury is a chemical with significant toxicity to humans
- Methylmercury exposure can occur by eating fish and other food sources contaminated via bioaccumulation and biomagnification within in the food chain
- Developing human brains are more susceptible to damage at much lower concentrations of methylmercury
- MDH study demonstrated mercury as already existing problem
- Neurotoxic damage from methylmercury can have significant impacts on individuals and society
- Health impacts of mercury exposure could be disproportionate, affecting people consuming local fish at higher rates- a justice issue
What can you do...?

• Educate yourself/others about this topic
• Continue to pressure law makers and regulatory agencies to mandate that human health be rigorously considered/studied before permitting toxic industries such as sulfide-ore copper nickel mining
• Support key local organizations fighting for our clean water
  – Tamarack Water Alliance
  – Water Legacy
  – Minnesota Center for Environmental Advocacy (MCEA)
  – Honor the Earth
ADDITIONAL READING:


ADDITIONAL REFERENCES:


THANK YOU FOR BEING HERE!!