REDOIL
Resisting Environmental Destruction On Indigenous Lands
An Alaska Native Grassroots Network

ACAT
Alaska Community Action on Toxics

Mining and Toxic Metals

A case study of the proposed Donlin Creek mine

Mining activities are known to release significant amounts of toxic metals into the surrounding environment.[1] Some toxic metals frequently associated with mining include mercury, arsenic and lead. These substances are present at low concentrations in soil, rock and water, but the process of mining may release quantities harmful to the health of people and the environment.

<u>How Mining Releases Toxic Metals</u>

Large amounts of waste rock and tailings contaminated with toxic metals can be produced by mine sites. In the case of the Donlin Creek mine, there are only 0.072 ounces of gold for every ton of ore, a figure that does not take into account the waste rock. Toxic substances contained within the rock and tailings are more easily released once these substances are processed/milled and left in mine pits, underground workings, waste rock piles, and tailings impoundments where they are exposed to the environment.

Mercury can be released from waste rock and mine tailings directly into the atmosphere even at normal environmental temperatures because mercury evaporates at a much lower temperature than other metals.[2] Once in the atmosphere, it can later be deposited in soils and waters miles from the mining site.[3]

Dust emissions from the mine site during blasting and mining operations could contain any toxic metals that occur locally. For example, dust emissions at Alaska's Red Dog mine are responsible for severely contaminating the surrounding environment with lead and cadmium.[4] Rain water leaches toxic substances from waste rock and mine tailings into soil and waterways. Additionally, rain can deposit toxic metals from the air, present as vapors or attached to dust particles, into waterways.[5]

One of the major sources of toxic metals associated with mining is acid mine drainage. When waste rock excavated from the mine is exposed to air (oxygen) and water, it chemically reacts to form several acids, including sulfuric acid. This acid leaches toxic metals from the rock and surrounding environment. Acid mine drainage is known to have very high concentrations of metals including iron, mercury, arsenic and antimony. Acid mine drainage may contaminate both surface and ground water. [6] Once acid mine drainage begins to form it is usually impossible to stop and is difficult and costly to remedy.[7] According the EPA, the variable size and mineral composition of waste rock makes accurate prediction of AMD difficult.[8]

The massive amounts of fossil fuels needed for large scale mining operations also contribute to the release of toxic metals into the atmosphere. Burning coal and petroleum releases toxic metals, specifically mercury, and other hazardous substances into the air. These toxic emissions are associated with cardiovascular problems, reproductive effects, cancer and other health problems.[9] It is estimated that mining consumes 7-10 percent of the world's energy production.[10]

Additionally, seasonal variations in precipitation and temperature can have a significant impact on the concentrations of toxic metals and the effects on wildlife. Snowmelt from or through a mine site can potentially introduce considerable amounts of toxic metals and acidic water into ecosystems in a short period of time. The increased stresses of an arctic winter make arctic organisms more vulnerable to toxic exposures.[11]

Effects of Toxic Metals

Different toxic metals produce different symptoms in the people and animals that are exposed to them. The following section provides a summary of the health effects of some toxic metals frequently associated with mining activities.

Effects in humans

Mercury is toxic to the central and peripheral nervous systems. Health problems associated with mercury include personality changes, deafness, changes in vision, loss of muscle coordination or tremors, loss of sensation, and difficulties with memory. Mercury can be passed from pregnant mothers to unborn children and also to babies through breast feeding. Because they are still developing, fetuses and children are especially sensitive to the harmful effects of mercury.[12]

Bacteria within the environment transform inorganic mercury into methylmercury, a more toxic form of mercury that is best known as being the form that accumulates in fish. Indigenous populations that rely on subsistence fishing are especially susceptible to the effects of methylmercury, because they are disproportionately exposed through their traditional diet.[13] One study found that prenatal methylmercury exposure due to consumption of marine mammals and fish by the mother resulted in attention, language, and memory deficits in children.[14] Not only does presence of methylmercury present a danger to health, it also presents a danger to the livelihood of anyone who relies on healthy stocks of fish.

Arsenic is known to cause cancer of the skin, liver, bladder and lungs. Mines can release arsenic into the air and breathing arsenic from the air near mines is known to cause lung cancer. Arsenic exposure may cause disorders of the nervous system and of the circulatory system. Arsenic exposure may interfere with fetal development. Arsenic can cross the placenta into fetuses and can be transported from mother to her child in breast milk. Unlike mercury, the naturally occurring forms of arsenic are the most toxic. [15] Chronic arsenic exposure has been associated with birth defects and still births.[16]

Lead is neurotoxic, which means it destroys brain and nerve cells. Children exposed to lead can suffer from abnormal and reduced physical and mental growth, and may also have lower intelligence. Lead can be passed from mother to child during pregnancy and breast feeding. Developing children are much more sensitive to lead exposure than adults.[17] There is evidence that lead can cause health problems at much lower levels than previously thought, and that no level of exposure to lead is safe for developing fetuses or children.[18] Lead exposure has also been associated with attention deficit hyperactivity disorder and antisocial behavior.[19] Lead has been determined to be a probable human carcinogen by the Environmental Protection Agency.[20] There is also evidence that lead is an endocrine disrupting chemical, with the potential to alter hormone function.[21,22]

Antimony has a number of adverse health effects. Antimony is a possible human carcinogen associated with the development of lung cancer. Breathing air contaminated with antimony can cause lung diseases, heart problems, and numerous gastrointestinal disorders.[23] The Occupational Safety and Health administration (OSHA) lists cumulative heart and lung damage as major health effects of antimony.[24] According to the EPA, these health effects can include antimony pneumoconiosis (lung damage), alterations in pulmonary function, chronic bronchitis, chronic emphysema, pleural adhesions, increased blood pressure, altered EKG readings and heart muscle damage.[25] Antimony accumulates in organs, especially in the liver and kidneys and also in the blood.[26]

Cadmium is a known carcinogen; some studies of workers exposed to cadmium found higher levels of lung cancer. Cadmium also causes kidney, lung, and intestinal damage. [27] Cadmium can pass from mothers to children through breast feeding. In animals, cadmium exposure during pregnancy has caused negative effects on behavior and learning, as well as abnormal fetal metabolism, low fetal weight and skeletal deformations. There is some evidence that cadmium causes reproductive problems in humans including low birth weight and reduced sperm count.[28]

Effects in Fish and Aquatic Organisms

In addition to having harmful effects on people, toxic metals can directly affect aquatic organisms including fish. Fish are known to accumulate toxic metals from the water, and fish living in close proximity to mine sites have been found with higher concentrations of toxic metal.[29] Salmon exposed to mining effluent (the wastewater released by a mine) had greater mortality rates, and were generally smaller than unexposed salmon.[30] Some toxic metals such as cadmium and copper can inhibit the olfactory response, the ability of the fish to smell. This is an important effect because fish rely on olfaction, or smelling, to find mates, locate food, and return to home streams.[31] Additionally, metal contamination may affect the food web causing indirect consequences for fish species.[32] Metals are known to accumulate in aquatic organisms used as food sources by fish, such as the caddisfly larvae.[33]

Donlin Creek Case Study

Nova Gold Resources proposes to develop Donlin Creek mine in the Kuskokwim River watershed in southwest Alaska. Both subsistence and commercial fisheries rely on the Kuskokwim River. Contamination of the Kuskokwim River system would have devastating affects on the health of the people, environment and economy in the region.

The Donlin Creek Mine deposit is characterized by "sheeted quartz, quartz–carbonate and sulphide-only veins characterized by a gold–arsenic–antimony–mercury geochemical signature." [34] Arsenic, antimony and mercury are all toxic metals with known adverse health effects. Mercury is of particular concern because it accumulates in aquatic organisms. It is estimated that even with protective measures in place the Donlin Creek mine would emit hundreds of pounds of mercury a year.[35] Mining operations at Donlin Creek are likely to contaminate the environment with the toxic metals.

Additionally, mercury from the Donlin Creek site would be released into the air and soil from waste rock and ore. Mining is the single greatest contributor of mercury to the environment, and gold mining produces more waste mercury than any other form of mining. Mercury is already a significant problem in the Arctic. Mercury from different areas of the world builds up in the Arctic, and accumulates in the tissues of fish and marine mammals used as traditional food sources.[36] Mercury levels in fish in the Kuskokwim River are already elevated due to contamination from abandoned mines. Further contamination could prove significant if not devastating. The Northern pike sampled downstream of former mine sites had higher concentrations of mercury than those above the mine sites.[37] Some Northern pike had concentrations of methyl-mercury above 0.3 ppm, the level the US EPA currently maintains is safe for consumption.

Releasing more mercury into the local Kuskokwim watershed would put vitally important fish populations at risk of mercury contamination. This presents a serious hazard for Alaska Natives in the area who rely on subsistence fishing for approximately 60 percent of their diet.[38] Disruption of traditional harvesting practices would have serious effects on the community health of Indigenous

Peoples.[39]

A major portion of the Donlin Creek mineral deposit is arsenopyrite, a compound made of arsenic, iron and sulfur, frequently found in and near gold deposits.[34] During gold mining, when arsenopyrite is exposed to oxygen in the air and water, it chemically changes into H_2SO_4 (sulfuric acid), H_3AsO_3 (arsenious acid), and H_3AsO_4 (arsenic acid).[6] This reaction and the actions of these contaminants usually causes the water surrounding the waste rocks and tailings to become extremely acidic, releasing toxic metals such as arsenic, mercury and antimony.

There is clear evidence that the geography of the Kuskokwim region is capable of producing acid mine drainage contaminated with toxic metals. The former Red Devil mine site releases acid mine drainage into Red Devil Creek, a small tributary located close to the mine site. The creek releases water that is significantly contaminated with toxic metals in to the Kuskokwim river. Although the average naturally occurring arsenic concentration in the Kuskokwim watershed is 1 ppb, the Red Devil Creek water has an average of 180 ppb arsenic. This is 18 times the EPA limit of 10 ppb for drinking water. This same tributary stream releases water with 281 ppb antimony, while the naturally occurring antimony concentrations in the region are below 1 ppb. The total mercury concentrations in Red Devil Creek have been measured at 243 ppb and 230 ppb, while measurements of mercury in the Kuskokwim and its other tributaries are all below 11 ppb.[40]

Donlin Creek mine could potentially contaminate the Kuskokwim river and delta with toxic chemicals including mercury and arsenic, and the development of acid mine drainage could devastate the Kuskokwim river ecosystem threatening subsistence food sources, commercial salmon fisheries, wildlife and people.

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