

## To Chairman Parker and Members of the Maine Board of Environmental Protection

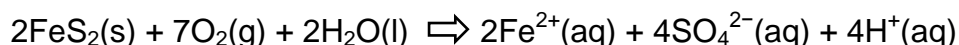
### Testimony Against Acceptance of Maine DEP Rules Chapter 200: Metallic Exploration and Mining

By Peter Garrett, PhD, 202 Eames Road, Winslow, ME 04901 ([peter.garrett@eggi.com](mailto:peter.garrett@eggi.com))

**Summary of my experience in hydrogeology:** I earned a PhD in Earth Sciences from Johns Hopkins University. I joined the Maine DEP as its first hazardous waste hydrogeologist in 1981, at which time I was part of the team drafting the first set of regulations. I also visited and reviewed data from all listed hazardous waste sites in Maine. I later turned to consulting, including exploration and management of drinking water supplies developed from groundwater. I was recently honored with the Erickson Groundwater Award from the New England Water Works Association “for commitment to the technical advancement of the groundwater industry in New England”. It is in this area of public water supply development that I begin my testimony regarding the proposed rules, starting with the basic geochemistry of sulfides and water. I choose sulfides because I understand that most of Maine’s metallic metal deposits fall into a group called “massive sulfide deposits”.

**Geochemistry of sulfides in water.** Sulfide minerals occur in many rocks. The most common sulfide is pyrite (known colloquially as fool’s gold). It is iron sulfide, abbreviated FeS<sub>2</sub>. It occurs in shales, some limestones, some granites and in the massive sulfide deposits of interest to mining companies as ores for gold, silver, copper and zinc especially. Below I choose pyrite to illustrate a point not only because pyrite is abundant in massive sulfide deposits but because similar processes occur with other metallic sulfides such as copper or zinc sulfides.

Pyrite is stable in air, but exposed to oxygen and water it dissolves, following the equation below (expressed in common chemical notation):



**s** = solid, **g** = gas, **l** = liquid, **a** = aqueous (dissolved in water)

Explanation: pyrite in the presence of oxygen and water dissolves to produce ferrous iron + sulfate + hydrogen ions, all in solution. Hydrogen ions represent acidity. Sulfate and hydrogen ions are functionally the same as sulfuric acid. Sulfuric acid is also known as “acid mine drainage”.

The significance of this equation came alive for me during my development of the public groundwater supply in Tenants Harbor. The aquifer there is a fractured granite with a minor mineral component (<0.5%) of pyrite. Water withdrawn from the Water District’s Production Wells initially contained iron close to the drinking water standard of 0.3 parts per million. (Water with a higher concentration is objectionable because it results in rusting bathroom fixtures.) Following successful testing and permitting, the system engineers did not consider that the drawdown caused by pumping the wells was

a novel situation in the bedrock aquifer because it had never occurred prior to the installation and use of the public supply wells. That drawdown exposed pyrite in the granite to oxygenated groundwater.

Within a year the quality of groundwater pumped from the Tenants Harbor wells showed increasing concentrations of iron, sulfate and acidity. The water then needed to be treated to reduce excessive concentrations of iron and to increase pH. The Water District will need to treat their water in perpetuity for these issues. The above story illustrates what can happen to water quality given even a slight change in exposure of the rock to a new regime of groundwater flow. This story illustrates what can happen even with very low percentages of sulfide minerals in the rock and essentially no removal of material from the ground.

The same geochemical process will be multiplied many fold by mining of massive sulfide deposits if any projects are permitted according to Maine's proposed mining rules. This is due to three facts:

1. All sulfide minerals follow a similar transition to that illustrated in the equation above if exposed to oxygenated water.
2. I understand that the massive sulfide deposits in Maine may consist of up to 50% of the volume of the rock being mined.
3. The rock will be removed from the ground and exposed to air and rainwater or groundwater.

Additional geochemical reactions come into play under such circumstances, resulting in additional dissolution and increases in acidity (= much lower pH).

If these proposed rules go into effect it will be imperative that DEP staff be certain that Subchapter 5 Mining Standards, Sections G, H, I and J (Reactive Mine and Designated Chemical Materials Management Systems, Containment Structures, Storage Piles and Water Management Systems) can contain the inevitable production of huge quantities of dissolved metals and neutralize the acid drainage resulting from exposure of broken rock to oxygen and precipitation over the area of the mining operation.

Though I am not a mining engineer, I have not found convincing reference to any such systems for mine waste water management in my on-line researches in preparation of this testimony. Furthermore, the litany of mining sites across the country that have failed this basic chemistry test and left a legacy of acid mine drainage for others (taxpayers) to clean up does not give me comfort in supporting the mining of massive sulfides while guaranteeing maintenance of high quality surface waters in Maine.

This is especially so in Maine which has one of the wettest climates in the country, and with the rest of the US Northeast has experienced a general increase in precipitation of between 5 and 20% for the period 1991-2012 compared to 1901-1991.

On the subject of surface waters, it is a truism that all groundwater eventually drains to surface water. So I don't understand the premise of the regulations that some groundwater will inevitably be contaminated by mining, yet surface water draining from the site will not be contaminated. Furthermore, there is a very large difference between water quality standards for groundwater

(22.B.(12)(b)), which are mostly Primary Drinking Water Standards, and ambient water quality criteria for the protection of aquatic life in surface waters (see table below).

Component	Drinking Water Standards for Human Consumption		Ambient Water Quality Criteria for Freshwater Aquatic Life Protection	
	Max Exposure Guideline (Maine)	Max Contaminant Level (Federal)	acute	chronic
<b>Arsenic</b>	10	10	340	150
<b>Cadmium</b>	1	5	0.42	0.08
<b>Copper</b>	500	1300	3.07	2.36
<b>Cyanide</b>	4	200	22	5.2
<b>Mercury</b>	2	2	1.7	0.9
<b>Nickel</b>	20		120	13.4
<b>Zinc</b>	2000		30.6	30.6

all concentrations given in parts per billion (= micrograms per liter)

You will note that that for almost all components (potential contaminants) in this list the Water Quality Criteria for the protection of aquatic life are orders of magnitude lower than the Drinking Water Standards (arsenic is the large exception). The table above suggests that even if groundwater quality standards can be met beyond the defined area of the mine (which I doubt without pumping to constrain groundwater flow from the mine area to a treatment system on site, a system that is maintained for up to 30 years following mine closure), it is difficult to imagine how surface water quality criteria can be met given the inevitable generation of acid mine drainage.

Those involved in the exploration for metallic ore deposits use changes in surface water chemistry in streams emanating from the ore to locate likely prospects. These changes are caused by natural dissolution of the kind I illustrated for the Tenants Harbor Water District wells at the beginning of this testimony. Mining, however, greatly increases the rate of dissolution by increasing by orders of magnitude the exposure of ore deposits to air and water. The product is acid mine drainage on steroids. Given the abundance of precipitation and groundwater recharge in Maine (exceeded only in the Pacific Northwest coastal ranges and the Mississippi Delta region), it is difficult to imagine how contamination of groundwater and surface waters downgradient of any mine by acid mine drainage can be avoided.

### Siting

I am astonished, given the environmentally dangerous nature of the mining of massive sulfide deposits in a generally wet climate, that the Siting Standards (Section 20B, page 51) allow mining operation in floodplains or flood hazard areas. I recently had trouble from staff of both DEP and the Corps of Engineers siting a non-motorized recreational trail in such a setting!

Then again I am surprised at the relatively limited buffers required (Section B(2)), including the siting of excavations within a few hundred feet of private wells and property boundaries and mine waste units 1000 feet from public water supplies. This, again from my personal experience, a private well can be contaminated to exceptional concentrations from a town sand/salt pile located 1000 feet away. From what I understand of the very limited mining that was done in Brooksville in the five years from 1968-1972, that environmental damage was widespread. Others will comment on how widespread and the tax dollars required to repair the damage.

#### **DEP oversight and likely causes of failure**

In my career I have witnessed the aftermath of catastrophic failures of a landfill (in Norridgewock) and a site construction project (in Benton). Failures took place after heavy rain events (though neither was a 24 hour 500-year storm event), despite the fact that DEP staff had approved and oversaw both projects. Given that mining projects operating under the proposed Chapter 200 rules incorporate “wet mine waste units” (leachate ponds) for containment of acid mine drainage, not merely soil piles as in the two projects cited, I have little confidence that DEP staff can effectively oversee projects under conditions of exceptional rainfall that could cause catastrophic failure of containment. This is especially so given the increased intensity of some rainfall events in the Northeast, due to climate change. It is my belief that stormwater standards 38 MRS Section 420-D as referred to in 20.C(2) are insufficient for the reactive mine wastes that would flow out of wet mine waste units derived from Groups A and B Mine Wastes (20.F.(1&2))

#### **Recommend against acceptance of the Rules**

For these reasons I recommend against BEP acceptance of DEP Rules, Chapter 200 as recently amended. The changes as written are insufficient to overcome the environmental damage that is likely from mining of massive sulfide deposits in Maine. This is especially so when considering the real life examples I provided of DEP limitations in oversight of projects with considerably smaller scope. This is not to cast aspersions on the qualifications or integrity of DEP staff. However, a massive sulfide mining operation is orders of magnitude more complicated than the management of an established landfill or a new construction site. Failures do occur and my point is that of failure of any one of several portions of a massive sulfide mining project would be catastrophic by comparison.