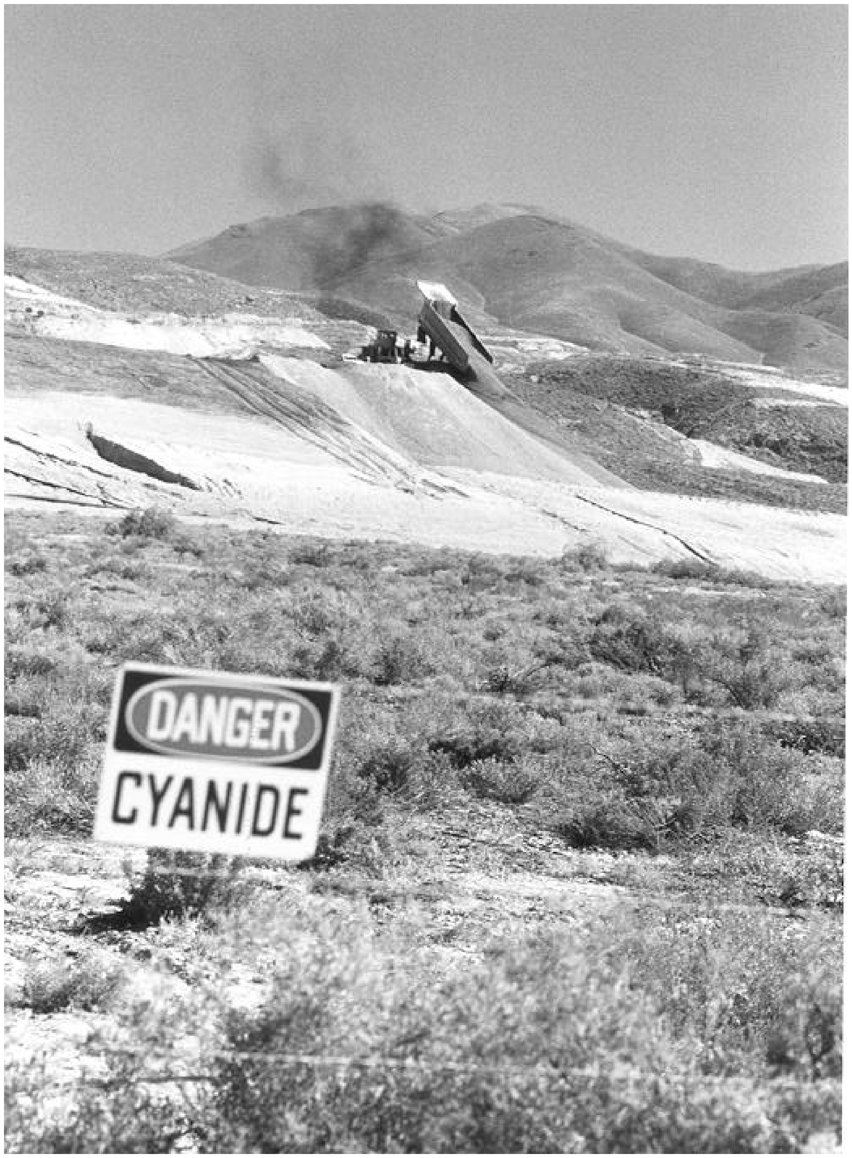
CYANIDE LEACH MINING PACKET



Mineral Policy Center

Compiled August 2000

MINERAL POLICY CENTER

Protecting Communities and the Environment

CYANIDE LEACH MINING PACKET: INTRODUCTION

Cyanide leach mining is now the dominant method used by the hardrock mining industry to extract gold and other metals from ore. The idea of using cyanide for the recovery of gold was first developed in Scotland in the late 19th century. By 1969, the US Bureau of Mines proposed cyanide heap-leaching as a method to recover gold from extremely low-grade ore.[1]

Put into widespread practice in the 1970's, cyanide processing is extremely efficient. It makes the mining of extremely low-grade ores profitable, while creating huge quantities of waste. At some mines, *several hundred* tons of ore must be mined to produce small quantities of gold. For example, Nevada's Carlin Trend Mine mined 129.8 million tons of ore in 1989 to recover 3.7 million ounces of gold.[2]

There are 2 types of cyanide leach mining: vat and heap-leaching. In 1998, approximately 70% of gold recovered from cyanide use was from vat-leaching operations, about 30% from heap-leaching operations.[3] All in all, cyanide leaching is now used to process over 90% of gold ores (by weight) mined in the United States.[4]

The use of cyanide in mining is becoming more and more controversial. Mining such low-grade ores creates vast open pits, unearthing and releasing a host of potentially dangerous toxins. In 1998, the mining industry released over 3.5 billion pounds of toxic chemicals, such as cyanide, arsenic, lead, mercury, chromium and sulfuric acid.[5] In addition, cyanide is extremely toxic. A teaspoon of a 2% cyanide solution can kill a person.

In recent years, a string of cyanide-related mine accidents has added to environmental and community concerns. The disaster in Romania at Aural Gold Plant is one example. On January 30, 2000, 3.5 million cubic feet of cyanide-contaminated waste entered the Tisza River, eventually poisoning the Danube and infecting over 250 miles of rivers in Hungary and Yugoslavia.

[1] The cyanide process for extracting gold was an improvement over the inefficient mercury amalgamation process that was used at that time, which usually recovered no more than 60% of an ore body's gold. In contrast, leaching finely ground ore with cyanide could recover more than 97% of the ore's gold value. Adopted quickly by industry, the new leaching process first saw widespread use in the Witwatersrand gold fields of South Africa in the late 1800's. Cyanide heap leaching is an outgrowth of these early methods of processing cyanide and gold ore. The U.S. Bureau of Mines first proposed heap leaching with cyanide in 1969 as a means of extracting gold from ores that had been considered too low in value to process economically. By the 1970's, the U.S. gold industry adopted the technique, soon making heap-leaching the dominant method for treating gold ores. From <u>Golden Dreams, Poisoned Streams</u>. MPC. 1997.

[2] From <u>Golden Dreams, Poisoned Streams</u>. MPC. 1997.

[3] From "Gold" by Earle B. Amey. United States Geologic Survey. 1998.

[4] From <u>Golden Dreams, Poisoned Streams</u>. MPC. 1997.

[5] Mining can be compared to the processing of beef and the subsequent spread of ecoli bacteria. When ecoli is in the cow, people are not exposed to it, and therefore, are not susceptible to it. However, it is when the cow is slaughtered and the beef ground up that ecoli becomes a life-threatening problem. Similarly, when mining companies grind up rock and ore, they expose to the air, water and environment harmful toxins contained within the rock that can make people sick. From **MPC's Citizen's Guide: TRI Toolkit**. MPC 2000.

1612 K Street, NW
Suite 808
Washington, D.C. 20006

Telephone: 202.887.1872
Fax: 202.887.1875
Email: mpc@mineralpolicy.org
Website: www.mineralpolicy.org

In reaction to cyanide accidents, communities are beginning to speak out against cyanide leach mining. Most notably, voters in Montana passed an initiative in November 1998 banning cyanide heap-leach mining. The initiative, now state law, prohibits the development of new open-pit cyanide leach mines. This initiative was a response to the dismal track record of open-pit cyanide leach mining in Montana and the failure of the state to adequately regulate such mines.[6]

Cyanide leach mining can have a profound impact on the environment, human health and wildlife. This packet is designed to give readers a closer look at cyanide and the heap-leaching process. The following materials are included:

- **Cyanide Leach Mining Packet: Introduction**
- **Mineral Policy Center Fact Sheet: Cyanide**. Mineral Policy Center. 2000.
- Introduction from **Cyanide Uncertainties: Observations on the Chemistry, Toxicity, and Analysis of Cyanide in Mining-Related Waters.** By Dr. Robert Moran. Mineral Policy Center Issue Paper No.1. 1998.
- **The Heap-Leach Method**. *The Sacramento Bee*. (A diagram of the heap-leach process.)
- **A Gold Mine's Toxic Bullet.** *The Washington Post*. February 15, 2000.
- **Agency for Toxic Substances and Disease Registry ToxFAQs – Cyanide.** From www.atsdr.cdc.gov.
- Environmental Protection Agency's Toxic Release Inventory (TRI). 1998 releases of cyanide compounds and hydrogen cyanide. From www.epa.gov/triexplorer. Top 15 facility releases for cyanide compounds and hydrogen cyanide.
- Excerpts from **Poi$oned Profit$: Cyanide Heap Leach Mining and its Impacts on the Environment**. National Wildlife Federation.
- Suggested Reading List.

[6] From Montana Environmental Information Center. (www.meic.org/success.html)

MINERAL
POLICY
CENTER

Protecting Communities and the Environment

MPC FACT SHEET: CYANIDE

What is Cyanide?
Cyanide refers to a group of compounds made of carbon and nitrogen. Cyanide solutions readily bond with gold, silver and other metals, which is why the mining industry uses it.

Cyanide is usually stored and transported as a solid. It is stable when dry. Most cyanide solids will dissolve in water to produce toxic cyanide gas. Cyanide gas is colorless, but smells of bitter almonds.

Cyanide is produced naturally in minute, harmless quantities in several plants, such as in apple seeds, apricot pits, soil bacteria and species of invertebrate organisms.

How does Cyanide affect living organisms?
Cyanide is *highly* toxic. Cyanide is the killing agent used in gas chambers.

Cyanide poisoning can occur through inhalation, ingestion and skin or eye contact. One teaspoon of a 2% solution can kill a person. In general, fish and other aquatic life are killed by cyanide concentrations in the *microgram per liter* range (part per billion), whereas bird and mammal deaths result from cyanide concentrations in the *milligram per liter* range (part per million).

A cyanide spill in Romania on January 30th, 2000, killed thousands of tons of fish and made a significant portion of the Tisza River watershed undrinkable and hostile to aquatic life. See the United Nations Environment Programs report at http://www.unep.ch/roe/baiamare.htm.

Evidence shows that cyanide compounds linger in affected plant and fish tissues and can persist in the environment for long periods of time.

How is Cyanide used in mining?
There are two types of cyanide-leaching processes used by the modern mining industry. Vat-leaching, where extracted ore is combined with cyanide in vats, and heap-leaching (described below). Cyanide-leaching allows mining companies to reopen and expand mines containing what were previously unprofitable mineral reserves.

The heap-leaching process, more commonly used than vat-leaching, involves -
- digging enormous pits, so large they could swallow cities, and piling the extracted ore into heaps that would cover many football fields several hundred feet high;
- spraying a cyanide solution over the heaps so that the cyanide trickles down through the ore, bonding with microscopic flecks of gold or silver, whereupon a heap pad (a rubber blanket) underlying the heap channels the solution into a holding pond; and
- stripping the solution of the precious minerals, recovering the used cyanide, then respraying the cyanide solution over the heap.

In the extraction of copper, nickel, cobalt and molybdenum, cyanide is used during the milling and concentration processes.

1612 K Street, NW
Suite 808
Washington, D.C. 20006

Telephone: 202.887.1872
Fax: 202.887.1875
Email: mpc@mineralpolicy.org
Website: www.mineralpolicy.org

What are the dangers of using Cyanide?

Cyanide-leaching, as practiced by the modern mining industry, is inherently dangerous to the environment and the communities surrounding a mine that uses the process. As cyanide use continues, so do serious accidents and spills. 4 recent examples are:

- Zortman-Landusky Mine, Montana, 1982: 52,000 gallons of cyanide solution poison the drainage that supplies fresh drinking water for the town of Zortman. A mine employee discovered the accident when he noticed the smell of cyanide in his tap water at home.
- Summitville Mine, Colorado, 1992: Summitville gold mine was responsible for contaminating 17 miles of the Alamosa river with cyanide and other contaminants.
- Kumtor Gold Mine, Kyrgyzstan, central Asia, 1998: A truck carrying 2 tons of sodium cyanide crashed into the Barskoon river. 2,600 poison cases and 4 deaths were reported in the aftermath.
- Aural Gold Plant, Romania, eastern Europe, 2000: A cyanide-laden tailings spill sent a toxic slug of cyanide and metals rolling down the Tisza river and into the Danube, killing aquatic wildlife and poisoning water supplies as far as 250 miles downriver.

Cyanide reacts with many other elements and is known to breakdown into several hundred different cyanide-related compounds. Despite the risks posed by these breakdown compounds, mines are **not** required to monitor or report these chemicals. For more information contact Mineral Policy Center (202-887-1872) and the Agency for Toxic Substances and Disease Registry (http://www.atsdr.cdc.gov/).

Does society require we use Cyanide to supply gold?

Probably not. Potential cyanide-mining substitutes aside, we may not need to use cyanide in gold mining simply because there are already enormous supplies of gold, already mined and refined, above ground in reserve banks (like the Federal Reserve in the U.S.). Reserve banks and international financial institutions store more than 34,000 tons of gold as currency reserves, an amount equivalent to nearly one-quarter of all gold ever mined. A dollar used to be redeemable for a dollar's worth of gold. That is no longer the case now; gold reserves are an anachronism of a past era. Meanwhile, 34,000 tons of gold could satisfy current global demand for 8 years. (And, by the way, 85% of the gold demand is for jewelry, only 12% for industry.)

Moreover, by holding these gold reserves, central banks are costing taxpayers money. The U.S., the world’s largest holder of gold reserves, has lost $215 billion since 1980 due to plummeting gold prices, and we stand to lose more if other governments sell their gold reserves first, which is already happening. Reserve banks in the Netherlands, Switzerland, UK, and Australia have already sold or decided to sell significant portions of their gold reserves. For more information, see our report ***Gold: At What Price?*** on our website at: http://www.mineralpolicy.org/publications/books-reports.php3?nav=4.

What is the bottom line about Cyanide?

Despite mining industry assertions to the contrary, the record clearly demonstrates that cyanide-leach mining is not being practiced safely. It is potentially very dangerous to the environment, wildlife and humans. The hardrock mining industry has a history of cyanide spills, with billions of gallons of cyanide contamination released into the environment, ever since cyanide-leaching began in the 1970s. Furthermore, cyanide-mining may not be necessary. Enormous stockpiles of unused gold already exist above-ground in reserve banks around the world.

For more Reading:

"Cyanide in Mining: Some Observations on the Chemistry, Toxicity and Analysis of Mining Related Waters." Robert Moran, Ph.D. Invited Paper, Presented at the Central Asia Ecology – 99 Meeting, Lake Issyk Kul, Kyrgyzstan. Sponsored by Soros Foundation. June 1999. Available on the web at http://www.mpi.org.au/features/esm_background.html or contact Robert Moran at remoran@aol.com.

"Cyanide Spill at Baia Mare Romania." United Nations Environment Program (UNEP) and Office for the Coordination of Humanitarian Affairs (OCHA) Assessment Mission. March 2000. Available on the web at http://www.unep.ch/roe/baiamare.htm.

"Cyanide Uncertainties: Observations on the Chemistry, Toxicity, and Analysis of Cyanide I Mining-Related Waters." Robert Moran, Ph.D. 1998. Mineral Policy Center Issue Paper No. 1 Cyanide. Available on the web at http://www.mineralpolicy.org/publications/issuepapers.php3?nav=4.

Gold: At What Price? The Need for a Public Debate on the Fate of National Gold Reserves. John E. Young. February 2000. Prepared for Mineral Policy Center, Project Underground and Western Organization of Resource Councils. Available on the web at www.mineralpolicy.org/publications/books-reports.php3?nav=4.

CYANIDE UNCERTAINTIES: INTRODUCTION

The use of cyanide compounds by the mining industry, coupled with limitations in current analysis and monitoring of these compounds, raises serious concerns regarding public safety and environmental protection at mine sites using cyanide processing.

Mining and regulatory documents often state that cyanide in water rapidly breaks down—in the presence of sunlight—into largely harmless substances, such as carbon dioxide and nitrate or ammonia. However, cyanide also tends to react readily with many other chemical elements, and is known to form, at a minimum, hundreds of different compounds. (Flynn and Haslem, 1995) Many of these breakdown compounds, while generally less toxic than the original cyanide, are known to be toxic to aquatic organisms. In addition, they may persist in the environment for long periods of time, and there is evidence that some forms of these compounds can be accumulated in plant (Eisler, 1991) and fish tissues. (Heming, 1989)

Despite the risks posed by these cyanide-related breakdown compounds, regulatory agencies do not require mine operators to monitor this group of chemicals in mining-related waters. Therefore, while much of the cyanide used at mining sites does break down fairly readily, either as a result of natural degradation or the various treatment processes sometimes employed, significant amounts of the original cyanide form potentially toxic compounds that remain unaccounted for in the monitoring of mining operations.

Mining with Cyanide

Cyanide compounds are widely used by the mining industry to assist in the extraction of both precious and non-precious metals from rock. In gold mining, a dilute cyanide solution is sprayed on crushed ore that is placed in piles, commonly called heaps, or mixed with ore in enclosed vats. The cyanide attaches to minute particles of gold to form a water-soluble, gold-cyanide compound from which the gold can later be recovered. Cyanide is used in a similar manner to extract silver from ores. In the extraction of non-precious metals, such as copper, nickel, cobalt, and molybdenum, cyanide is used in the milling and concentration processes to separate the desirable metals from the wastes. Consequently, cyanide and related compounds often are contained in discarded mine wastes.

While most of the cyanide used by the industry is handled without obvious negative impact, the unique chemical behavior and toxic nature of these compounds, combined with the risk of serious mine waste spills, suggest that this topic merits a closer look.

Complex Chemical Behavior

The general term “cyanide” refers to various compounds having the chemical group CN, that is, one single atom of carbon (C) and one single atom of nitrogen (N). Several plants, some soil bacteria, and several species of invertebrate organisms produce natural cyanide and related compounds. Nevertheless, cyanide compounds are seldom present in uncontaminated waters in measurable concentrations.

Cyanide readily combines with most major and trace metals—a property that makes it useful in extracting metals from ores. Cyanide also tends to react readily with many other chemical elements, producing a wide variety of toxic, cyanide-related compounds. And because cyanide is carbon based—an organic compound—it reacts readily with other carbon-based matter, including living organisms.

Despite this complexity, regulators generally require that mine operators monitor for only three categories of cyanide: free cyanide, weak-acid-dissociable (WAD) cyanide, and total cyanide. Furthermore, the analytical procedures used to determine these categories of cyanide fail to indicate the presence of many of the other toxic breakdown products of cyanide. (See page 12 for discussion on analytical procedures.)

For example, routine analyses of cyanide fail to identify cyanates and thiocyanates, two significant cyanide breakdown products found at mine sites. Water samples from mining sites where cyanide is used as a process chemical may have WAD and/or total cyanide concentrations that are quite low or undetected, yet when the same samples are analyzed specifically for cyanates and thiocyanates, they may show tens of milligrams per liter (mg/L) or more of these compounds.

Numerous research and regulatory documents describe these categories of cyanide-related compounds as somewhat toxic, but generally do not state at what concentrations, and regard their potential presence as unimportant. Since routine analyses do not report these other compounds, it is often impossible to know if they are present at a mine site, and at what concentration.

Mine Waste Spills

In recent years, a number of cyanide-related leaks, discharges, and accidents at U.S. and international mine sites have been reported in the news media. (See box on page 5.) These accidents raise questions about the current operating practices, monitoring, and enforcement at cyanide-related mine sites worldwide.

EXAMPLES OF RECENT CYANIDE-RELATED MINE ACCIDENTS

Colorado, U.S.A.: In Colorado, spills of cyanide and other contaminants from the Summitville gold mine, owned by Galactic Resources Ltd, contributed to severe environmental problems on a 17-mile stretch of the Alamosa River. The mine was opened in 1986, and abandoned in 1992. It is now a federal Superfund site.

Montana, U.S.A.: Pegasus Corporation recently closed the Zortman-Landusky gold mine in Montana. Opened in 1979, it was the first large-scale cyanide heap leach mine in the United States. The mine experienced repeated leaks and discharges of cyanide solution throughout its operating life, resulting in wildlife deaths and severe contamination of streams and groundwater.

Nevada, U.S.A.: Following the failure of a leach pad structure in 1997, the Gold Quarry mine in Nevada released about 245,000 gallons of cyanide-laden waste into two local creeks. In 1989 and 1990, a series of eight cyanide leaks occurred at Echo Bay Company's McCoy/Cove gold mine in Nevada, releasing a total of almost 900 pounds of cyanide into the environment.

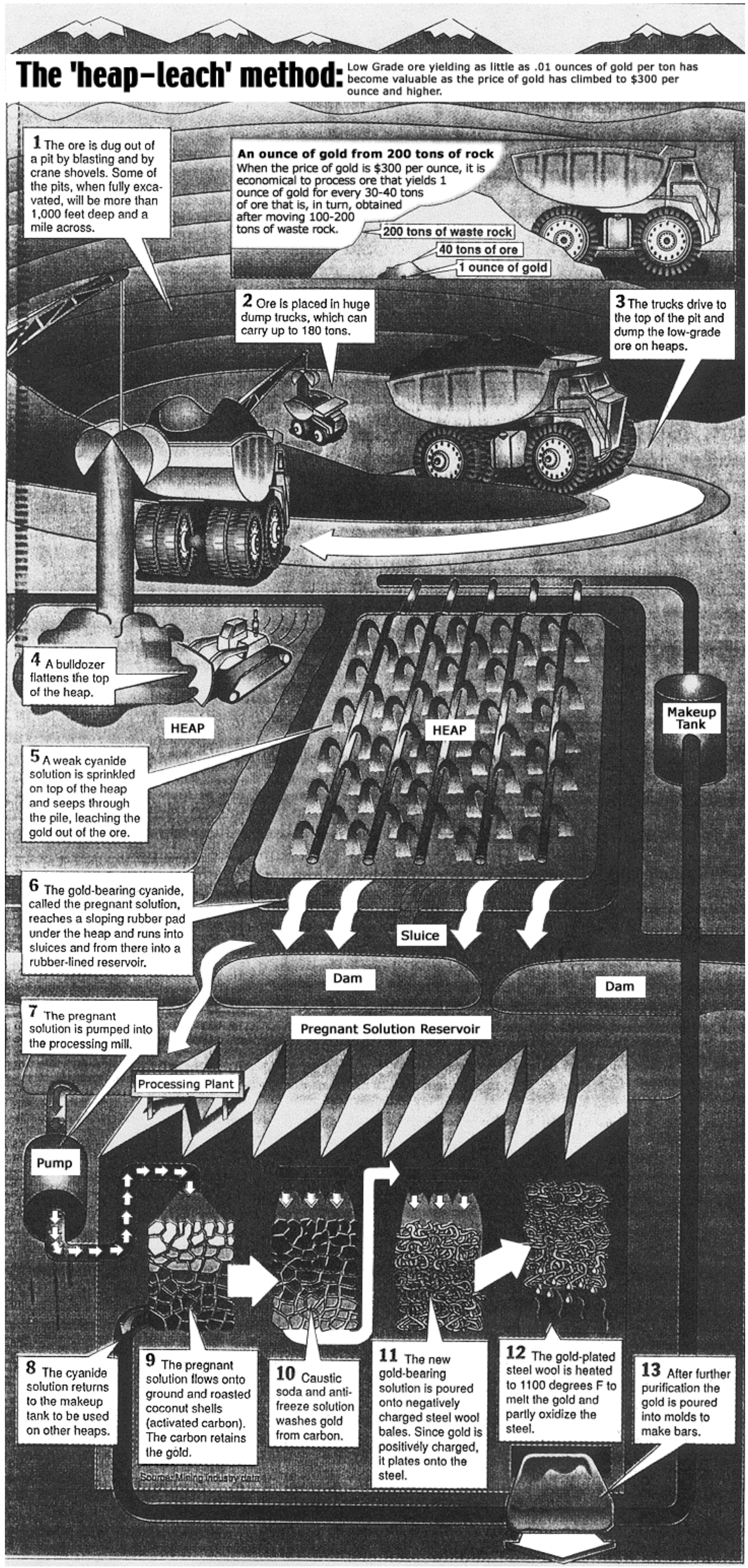
South Dakota, U.S.A.: On May 29, 1998, six to seven tons of cyanide-laced tailings spilled from the Homestake Mine into Whitewood Creek in the Black Hills of South Dakota, resulting in a substantial fish kill. It is likely to be years before the stream fully recovers.

Kyrgyzstan: On May 20,1998, a truck transporting cyanide to the Kumtor mine in Kyrgyzstan plunged off a bridge, spilling almost two tons of sodium cyanide (1,762 kilograms) into local surface waters.

Guyana: In 1995, more than 860 million gallons of cyanide-laden tailings were released into a major river in Guyana when a dam collapsed at Cambior mining company's Omai gold mine.

Spain: A dam at the Los Frailes zinc mine in southern Spain ruptured in April 1998, releasing an estimated 1.3 billion gallons of acid, metal-laden tailings into a major river and over adjacent farm lands. While news reports of the associated massive fish kill did not mention cyanide or related compounds in the wastes, their presence seems likely given the nature of the metals extracted at this site.

A Typical Modern Mining Process



(Credit: *The Sacramento Bee*)

The Washington Post
Tuesday, February 15, 2000

A Gold Mine's 'Toxic Bullet'

Romanian Cyanide Spill Reaches the Danube

BY WILLIAM MCNULTY—THE WASHINGTON POST

By **GUY GUGLIOTTA**
Washington Post Staff Writer

An enormous "toxic bullet" of deadly cyanide that accidentally overflowed a dam at a Romanian gold mine has contaminated 250 miles of rivers in Hungary and Yugoslavia, killing millions of fish, shutting down water supplies and leaving a trail of aquatic devastation that will require years to repair.

Yesterday the cyanide and heavy metal pollutants were drifting down the Tisza and Danube rivers in Yugoslavia, with another 400 miles to go before reaching the Black Sea. The concentration of contaminants in the water has fallen sharply in recent days, so damage downstream is expected to be less severe.

But Hungarian officials described the spill as Europe's worst environmental catastrophe since the 1986 nuclear accident at Chernobyl. Tons of dead and bloated fish were pulled from the Tisza, along with birds and small mammals.

Branislav Blazic, environment minister of Yugoslavia's dominant province, Serbia, told the official

See CYANIDE, A18, Col. 2

CYANIDE, *From A1*

news agency Tanjug “the Tisza is dead,” and predicted it would take the river up to five years to recover. The spill further fouled waters already corrupted by oil spills, sunken obstacles and other detritus from NATO airstrikes during last year’s Kosovo war.

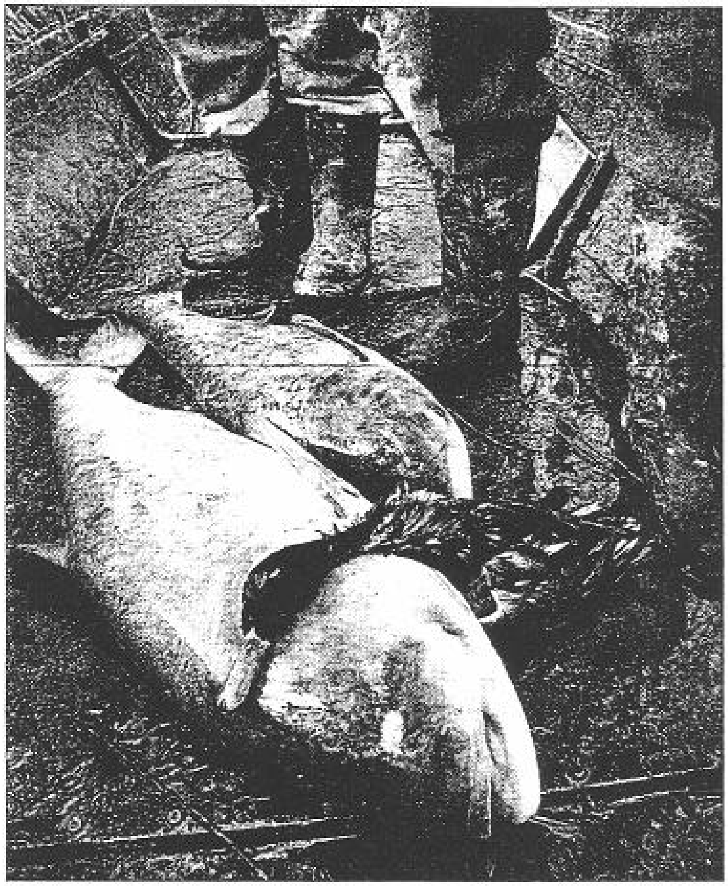
“What’s happening is fairly massive fish kills, essentially the death of all aquatic life,” said Steve D’Esposito, president of the Washington-based Mineral Policy Center, which tracks environmental issues related to mining.

“What you’ll hear is that cyanide will dissipate quickly when it’s exposed to sun and air, but the river is frozen over and the water is cold, and that process is not taking place,” D’Esposito continued. "What you have is this toxic bullet making its way down the river. We could be talking about years of cleanup.”

The Serbian minister of agriculture, forestry and water resources said that cyanide concentrations in the Danube were dissipating hourly, but warned riverside residents east of Belgrade not to use the water for anything, Tanjug reported. The ministry banned fishing and the sales of fish throughout Serbia, the largest remnant of the former Yugoslavia.

The spill, which occurred Jan.
30, has spawned a vituperative exchange between Hungary and Yugoslavia, on one side, and Romania and Esmeralda Exploration Ltd., the Australian co-owner of the Baia Mare mine, on the other.

The Hungarian government has said it will seek compensation from Romania and from Esmeralda Exploration. Serbia’s Blazic said yesterday that his



government will demand compensation from Romania before an international tribunal.

A Romanian government minister has blamed Esmeralda for lax safeguards at Baia Mare, Reuters reported last week. An Esmeralda spokesman in Perth suggested Hungarian estimates of the damage were “grossly exaggerated.”

The cyanide spilled when heavy snow and winter rain caused holding basin to overflow at the mine in northwestern Romania on the border with Hungary. News reports said as much as 3.5 million cubic feet of cyanide-contaminated water entered the Szamos River, which flows into the Tisza.

The mine is a Romanian-Australian joint venture, with Perth-based Esmeralda Exploration owning-half interest. The company began mining last year, using a cyanide leaching technique to extract gold from old tailings or residues that had not been economically viable in the past. While cyanide is used in mining all over the world, it must be carefully controlled because it is extremely toxic to animals, including humans. There is an additional hazard due to heavy metals, another mining byproduct. Unlike cyanide, heavy metals do not dissolve or disintegrate quickly.

In the United States, the Environmental Protection Agency prohibits cyanide concentrations of greater than 0.07 milligrams per liter in mine waste water. Levels any higher begin killing wildlife quickly and in large numbers. Cyanide suffocates animals by deactivating the enzymes that allow them to use the oxygen in their blood.

In the Tisza, scientists last week were routinely recording cyanide levels of 1.1 milligrams per liter, with spikes reaching as high as 2.0 milligrams per liter. The Tisza is a commercial waterway and popular vacation area famous for the beautiful scenery lining its banks.

In Hungary, fishermen on scenic Lake Tisza were pitchforking dead fish, including three- and four-foot-long catfish, from the contaminated water. Hungarian authorities reported removing as much as 45 tons of fish from the Tisza in a single two-day period and 100 tons by yesterday.

The cyanide crossed the Yugoslavia border in the Tisza Friday, and entered the much larger Danube north of Belgrade late Sunday. By yesterday, Yugoslav authorities reported cyanide levels below 0.2 milligrams per liter, a concentration that is not lethal for humans.

But even so, news dispatches reported significant numbers of fish still floating on the fouled waters. From Belgrade, the Danube winds south and east through Yugoslavia, Romania, Bulgaria, Moldova and Ukraine before emptying into the Black Sea.

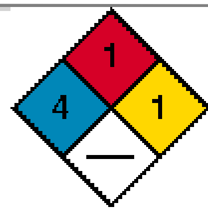
Both Romania and Esmeralda have expressed what Esmeralda Chairman Brett Montgomery called “considerable skepticism” that the cyanide could retain its virulence over such a long distance.

But independent experts said the cold weather may delay the chemical’s dispersal: “There’s no formula for cleaning it up,” noted the Mineral Policy Center’s D’Esposito. And besides, he added, the lingering problem is likely the heavy metals, not the cyanide. “That could last along time."

*Photo by SASA STANKOVIC
Agence France-Presse

Cyanide

CAS# 57-12-5, 74-90-8, 143-33-9, 151-50-8, 592-01-8, 544-92-3, 506-61-6, 460-19-5, 506-77-4
September 1997



Agency for Toxic Substances and Disease Registry

This fact sheet answers the most frequently asked health questions (FAQs) about cyanide. For more information, call the ATSDR Information Center at 1-800-447-1544. This fact sheet is one in a series of summaries about hazardous substances and their health effects. It's important you understand this information because this substance may harm you. The effects of exposure to any hazardous substance depend on the dose, the duration, how you are exposed, personal traits and habits, and whether other chemicals are present.

HIGHLIGHTS: Cyanide is a very poisonous chemical. Exposure to high levels of cyanide harms the brain and heart, and may cause coma and death. Exposure to lower levels may result in breathing difficulties, heart pains, vomiting, blood changes, headaches, and enlargement of the thyroid gland. Cyanide has been found in at least 415 of the 1,430 National Priorities List sites identified by the Environmental Protection Agency (EPA).

What is cyanide?

Cyanide is usually found joined with other chemicals to form compounds. Examples of simple cyanide compounds are hydrogen cyanide, sodium cyanide and potassium cyanide. Cyanide can be produced by certain bacteria, fungi, and algae, and it is found in a number of foods and plants. In the body, cyanide combines with a chemical to form Vitamin B_{12}. Cyanide occurs naturally in cassava roots, which are potato-like tubers of cassava plants grown in tropical countries.

Hydrogen cyanide is a colorless gas with a faint, bitter, almond-like odor. Sodium cyanide and potassium cyanide are both white solids with a bitter, almond-like odor in damp air. Cyanide and hydrogen cyanide are used in electroplating, metallurgy, production of chemicals, photographic development, making plastics, fumigating ships, and some mining processes.

What happens to cyanide when it enters the environment?

- Cyanide enters the environment from both natural processes and human industrial activities.
- In air, cyanide is mainly found as gaseous hydrogen cyanide; a small amount is present as fine dust particles.
- It takes about 1–3 years for half of the hydrogen cyanide to disappear from the air.
- Most cyanide in surface water will form hydrogen cyanide and evaporate.
- Cyanide does not build up in the bodies of fish.

- At high concentrations, cyanide becomes toxic to soil microorganisms and can pass through soil into underground water.

How might I be exposed to cyanide?

- Breathing air, drinking water, touching soil, or eating foods containing cyanide
- Smoking cigarettes and breathing smoke-filled air during fires are major sources of cyanide exposure
- Breathing air near a hazardous waste site containing cyanide
- Eating foods containing cyanide compounds, such as cassava roots, lima beans, and almonds
- Working in an industry where cyanide is used or produced, such as electroplating, metallurgy, metal cleaning, and photography

How can cyanide affect my health?

Animal testing is sometimes necessary to find out how toxic substances might harm people or to treat those who have been exposed. Laws today protect the welfare of research animals and scientists must follow strict guidelines.
In large amounts, cyanide is very harmful to people. Exposure to high levels of cyanide in the air for a short time harms the brain and heart, and may cause coma and death.

Exposure to lower levels of cyanide for a long time may result in breathing difficulties, heart pains, vomiting, blood changes, headaches, and enlargement of the thyroid gland. People who eat large amounts of cyanide may have symptoms including deep breathing and shortness of breath, convulsions, and loss of consciousness, and may die.
Use of cassava roots as a primary food source in tropical Africa has led to high blood cyanide levels.

People with high blood cyanide levels have also shown harmful effects such as weakness of the fingers and toes, difficulty walking, dimness of vision, deafness, and decreased thyroid gland function, but chemicals other than cyanide may have contributed to these effects. Skin contact with cyanide can produce irritation and sores.

It is not known whether cyanide can directly cause birth defects in people. Birth defects were seen in rats that ate diets of cassava roots. Effects on the reproductive system were seen in rats and mice that drank water containing sodium cyanide.

How likely is cyanide to cause cancer?

The **EPA** has determined that cyanide is not classifiable as to its human carcinogenicity. There are no reports that cyanide can cause cancer in people or animals.

There are medical tests to measure blood and urine levels of cyanide; however, small amounts of cyanide are always detectable in blood and urine. Tissue levels of cyanide can be measured if cyanide poisoning is suspected, but cyanide is rapidly cleared from the body, so the tests must be done soon after the exposure. An almond-like odor in the breath may alert a doctor that a person was exposed to cyanide.

Has the federal government made recommendations to protect human health?

The **EPA** has set a maximum contaminant level of cyanide in drinking water of 0.2 milligrams cyanide per liter of water (0.2 mg/L). The **EPA** requires that spills or accidental releases into the environment of 1 pound or more of hydrogen cyanide, potassium cyanide, sodium cyanide, calcium cyanide or copper cyanide be reported to the **EPA**.
The **Occupational Safety and Health Administration (OSHA)** and the **American Conference of Governmental Industrial Hygienists (ACGIH)** have set a permissible exposure limit of 5 milligrams of cyanide per cubic meter of air (5 mg/m^3) in the workplace during an 8-hour workday, 40-hour workweek.

Reference

Agency for Toxic Substances and Disease Registry. 1995. Toxicological profile for cyanide (update). Atlanta, GA; U.S. Department of Health and Human Services, Public Health Service.

Where can I get more information?

ATSDR can tell you where to find occupational and environmental health clinics. Their specialists can recognize, evaluate, and treat illnesses resulting from exposure to hazardous substances. You can also contact your community or state health or environmental quality department if you have any more questions or concerns.

For more information, contact:

Agency for Toxic Substances and Disease Registry
Division of Toxicology
1600 Clifton Road NE, Mailstop E-29
Atlanta, GA 30333
Phone: 1-800-447-1544
Fax: 404-639-6359

TRI DATA OVERVIEW[7]

(See accompanying cyanide data)

What is the Toxics Release Inventory (TRI)?

TRI was established in 1986 by the Emergency Planning and Community Right-to-Know Act (EPCRA)[8] and administered by the EPA. TRI requires industrial facilities to disclose to the public the levels of pollutants they have discharged annually into the air, water and land, or transferred to other sites for incineration, recycling or disposal.

Expansion of TRI to Mining

When the TRI program initially began, the mining industry was not included among the specific manufacturing industries that were required to report. In 1990, the Mineral Policy Center along with the Environmental Defense Fund and the National Audubon Society petitioned the EPA to include the mining industry in the TRI program.[9] Finally, on May 1, 1997, the EPA published its Final Rule, adding 7 new industry groups, including metal mining, to the list of facilities required to report.

Chemicals Likely to be Reported

A significant portion of the manufacturing, processing and otherwise used activities at metal mining facilities involve the release of heavy metals present in mineral ores. Common chemicals reported by mining facilities are: Aluminum, Antimony, Arsenic, Barium, Beryllium, Cadmium, Chromium, Cobalt, Copper, Cyanide, Lead, Manganese, Mercury, Nickel, Selenium, Silver, Thallium, Vanadium, Zinc, and each of these chemicals in compound form (such as aluminum compounds). Other chemicals mining facilities may use are: Ammonia, Benzene, Hydrochloric Acid, Nitric Acid, Sulfuric Acid, Phosphoric Acid, Thiourea and Xylene. For a complete list of reportable chemicals, go to http://www.epa.gov/tri/chemical.htm.

Cyanide Data in this Packet

In this leach mining packet are the TRI 1998 reported releases of 'hydrogen cyanide' and 'cyanide compounds.' 'Cyanide' is not reported under TRI, probably because cyanide rarely exists as a singular chemical. More often cyanide bonds with other elements such as hydrogen, sodium and potassium - given its chemical nature. These cyanide compounds are extremely toxic. Hydrogen cyanide is one of the most toxic forms of cyanide. Other cyanide compounds, such as metal and organic cyanide complexes, while having the potential for being extremely toxic, are also poorly understood.[10] Little is known about chronic effects of many cyanide compounds to humans and aquatic life.

For hydrogen cyanide releases, the metal mining industry was responsible for 26% of all reported U.S. releases, or 724,600 pounds out the total 2,773,460 pounds. For cyanide compounds, the mining industry was responsible for 44% of all reported U.S. releases, or 3.8 million pounds out of the total 8.7 million pounds. The data following this page are the top 15 releasers of hydrogen cyanide and cyanide compounds for the metal mining industry in 1998.

---

[7] Taken and condensed from **Mineral Policy Center Citizen's Guide: TRI *Toolkit***. MPC 2000.

[8] The purpose of EPCRA is to promote emergency planning, to minimize the effects of an accident, such as the 1984 Bhopal accident in Indiana, and to provide the public with information on releases of toxic chemicals in their communities.

[9] Mineral Policy Center, Environmental Defense Fund and National Audubon Society letter to William K. Reilly, Administrator, EPA, October 10, 1990.

[10] From "Cyanide Uncertainties: Observations on the Chemistry, Toxicity, and Analysis of Cyanide in Mining-Related Waters." By Robert Moran, Ph.D. MPC. 1998.

TRI *Explorer*

EPA Office of Environmental Information

Facility Report

See Note Return to selection

TRI On-site and Off-site Releases (in pounds), All Facilities (of 63) for Releasing CYANIDE COMPOUNDS, U.S., 1998, New Industry: Metal mining (SIC code 10)

Facility	TRIF ID	Form Rs	Form As	Total Air Emissions	Surface Water Discharges	Under-ground Injection	Releases to Land	Total On-site Releases	Total Off-site Releases	Total On- & Off-site Releases
NEWMONT GOLD COMPANY,TWIN CREEKS MINE, 35 MILES N.E. OF GOLCONDA, HUMBOLDT, NV	89414NWMNT35MIL	1	0	0	0	0	1,100,000	1,100,000	0	1,100,000
KENNECOTT RIDGEWAY MINING CO., 227 SUMMER RD., FAIRFIELD, SC	29130KNNCT227SU	1	0	24,000	0	0	1,000,000	1,024,000	0	1,024,000
BARRICK GOLDSTRIKE MINE, 27 MILES N. OF CARLIN, ELKO, NV	89803BRRCK27MIL	1	0	0	0	0	530,000	530,000	0	530,000
GOLDEN SUNLIGHT MINES INC., 453 MONTANA HWY. 2 E., JEFFERSON, MT	59759GLDNS453MO	1	0	0	0	0	350,000	350,000	0	350,000
NEWMONT GOLD CO. - CARLIN NORTH AREA, 25 MILES N. OF CARLIN, EUREKA, NV	89822NWMNT25MIL	1	0	0	0	0	210,000	210,000	0	210,000
GETCHELL GOLD CORP., 28 MI N.E. GOLCONDA, HUMBOLDT, NV	89414GTCHL28MIN	1	0	0	0	0	122,241	122,241	0	122,241
MCLAUGHLIN MINE, 26775 MORGAN VALLEY RD., LAKE, CA	95457MCLGH26775	1	0	0	0	0	100,925	100,925	0	100,925
NEWMONT GOLD CO. -LONE TREE MINE, STONEHOUSE EXIT 212, HUMBOLDT, NV	89438NWMNTSTONE	1	0	0	0	0	89,000	89,000	0	89,000
GLAMIS DEE GOLD MINE, 33 MILES N.W. OF CARLIN NV, ELKO, NV	89438GLMSD33MIL	1	0	0	0	0	68,062	68,062	0	68,062
KENNECOTT UTAH COPPER MINE CONCENTRATORS & POWER PLANT, 12300 S. UTAH HWY. 111, SALT LAKE, UT	84006KNNCT12300	1	0	2,500	1,100	0	50,000	53,600	0	53,600
CLIMAX MOLYBDENUM CO. - HENDERSON MILL, 19302 COUNTY RD. 3, GRAND, CO	80468CLMXM19302	1	0	10	0	0	33,005	33,015	0	33,015
NEWMONT GOLD CO. -RAIN AREA MINE, 15 MILES E. OF CARLIN, ELKO, NV	89822NWMNT15MIL	1	0	1,700	2	0	25,000	26,702	0	26,702
KINROSS DELAMAR MINE, #1 DELAMAR RD., MALHEUR, OR	97910KNRSS1DELA	1	0	0	0	0	26,086	26,086	0	26,086
KENNECOTT BARNEYS CANYON MINING CO., 8200 S. 9600 W., SALT LAKE, UT	84006KNNCT8200S	1	0	17,000	0	0	0	17,000	0	17,000
KENNECOTT RAWHIDE MINING CO., 55 MILES S.E. OF FALLON, CHURCHILL, NV	89406KNNCT55MIL	1	0	16,000	0	0	0	16,000	0	16,000
KETTLE RIVER OPS. MILL, 363 FISH HATCHERY RD., FERRY, WA	99166KTTLR363FI	1	0	0	0	0	16,000	16,000	0	16,000

TRI *Explorer*

EPA Office of Environmental Information

Facility Report

See Note Return to selection

TRI On-site and Off-site Releases (in pounds), All Facilities (of 27) for Releasing HYDROGEN CYANIDE, U.S., 1998, New Industry: Metal mining (SIC code 10)

Facility	TRIF ID	Form Rs	Form As	Total Air Emissions	Surface Water Discharges	Under-ground Injection	Releases to Land	Total On-site Releases	Total Off-site Releases	Total On- & Off-site Releases
GLAMIS RAND MINE, 27850 E. BUTTE AVE., KERN, CA	93554GLMSR27850	1	0	157,731	0	0	0	157,731	0	157,731
GOLDEN SUNLIGHT MINES INC., 453 MONTANA HWY. 2 E., JEFFERSON, MT	59759GLDNS453MO	1	0	24,000	0	0	110,000	134,000	0	134,000
GLAMIS MARIGOLD MINING CO., 3 MILES S. OF VALMY, HUMBOLDT, NV	89438GLMSM3MILE	1	0	89,499	0	0	0	89,499	0	89,499
NEWMONT GOLD COMPANY,TWIN CREEKS MINE, 35 MILES N.E. OF GOLCONDA, HUMBOLDT, NV	89414NWMNT35MIL	1	0	55,000	0	0	0	55,000	0	55,000
HOMESTAKE MINE, 630 E. SUMMIT, LAWRENCE, SD	57754HMSTK630ES	1	0	38,079	0	0	0	38,079	0	38,079
HYCROFT RESOURCES & DEVELOPMENT NC, 52 MILES W. ON JUNGO RD., HUMBOLDT, NV	89446HYCRF52MIL	1	0	31,900	0	0	0	31,900	0	31,900
NEWMONT GOLD CO. CARLIN SOUTH AREA, 6 MILES N. OF CARLIN, EUREKA, NV	89822NWMNT6MAIL	1	0	27,180	0	0	0	27,180	0	27,180
NEWMONT GOLD CO. -LONE TREE MINE, STONEHOUSE EXIT 212, HUMBOLDT, NV	89438NWMNTSTONE	1	0	19,000	0	0	0	19,000	0	19,000
FLORIDA CANYON MINING INC., EXIT 138, I-80, PERSHING, NV	89418FLRDCEXIT1	1	0	15,780	0	0	0	15,780	0	15,780
CORTEZ GOLD MINES, CORTEZ MILL # 1, STAR RTE. HC66-50, LANDER, NV	89821CRTZGSTARR	1	0	15,180	0	0	0	15,180	0	15,180
JERRITT CANYON JOINT VENTURE, 50 MILES N. OF ELKO NV ON SR 225, ELKO, NV	89801JRRTT50MIL	1	0	12,000	0	0	2,500	14,500	0	14,500
CORTEZ GOLD MINES, PIPELINE MINE, MILL #2, STAR RTE. HC66-50, LANDER, NV	89821CRTZGSTARA	1	0	14,300	0	0	0	14,300	0	14,300
GETCHELL GOLD CORP., 28 MI N.E. GOLCONDA, HUMBOLDT, NV	89414GTCHL28MIN	1	0	14,189	0	0	0	14,189	0	14,189
BARRICK GOLDSTRIKE MINE, 27 MILES N. OF CARLIN, ELKO, NV	89803BRRCK27MIL	1	0	14,000	0	0	0	14,000	0	14,000
COEUR ROCHESTER INC., I-80 EXIT 119, PERSHING, NV	89419CRRCH180EX	1	0	12,000	0	0	0	12,000	0	12,000
NEWMONT GOLD CO. - CARLIN NORTH										

EXCERPTS FROM *POI$ONED PROFIT$: CYANIDE HEAP LEACH MINING AND ITS IMPACTS ON THE ENVIRONMENT*

HEAP LEACH MINING REGULATION:

1. Heap Leach Mining Regulation on Federal Lands.

Approximately 270 million acres of federal lands are open to hard rock mining, and 1.2 million mining claims cover as much as 24 million acres of federal land.

The federal Bureau of Land Management (BLM) is responsible for regulating hard rock mining activity on the public lands, while the Forest Service has responsibility for managing the surface impacts of mining on National Forests. The BLM requires mining operators to "take such reasonable measures as will prevent unnecessary or undue degradation of the Federal lands, including reshaping land disturbed by operations to an appropriate contour and, where necessary, revegetating disturbed land so as to provide a diverse vegetative cover." (43 CFR 3809.0-3 j**)** Unfortunately, this standard has been loosely interpreted to permit all activities that the mining industry considers to be part of the normal course of mining operations. Rarely, if ever, are operators required to fill in or recontour open pits or take other measures to reclaim lands and contaminated water resources to a productive post mining land use. Because of this loose interpretation, the federal regulations are virtually meaningless in ensuring complete reclamation of mined lands, and protection of groundwater resources.

Despite the absence of effective federal regulations, the BLM has recognized the potential impacts of heap leach mining and recently published a new "policy" for managing these operations on federal lands. The "Policy for Surface Management of Mining Operations Utilizing Cyanide or other Leaching Techniques" dated August, 1990. attempts to make cyanide management on federal lands consistent from state to state. The cyanide policy requires the BLM to prepare cyanide management plans that reflect local conditions and state regulations that ensure environmental protection, prevent wildlife deaths and guarantee safety measures.

The BLM cyanide policy also directs that all operations using cyanide, "conduct such operations using the best practicable technology in order to ensure environmental protection through containment or neutralization of solutions lethal to humans or wildlife29." Wildlife mortalities must be avoided at cyanide operations, and wildlife mortalities shall be reported to the appropriate state regulatory agency and the BLM.

Unfortunately, this new policy does not contain any enforcement mechanism to ensure that it will be implemented. BLM has not provided the personnel necessary to develop cyanide management plans or ensure that mine plans for mining activities using cyanide follow the policy. Inspection and enforcement personnel also are lacking.

2. State Heap Leach Mining Regulations.

Ultimately, the responsibility for ensuring that heap leach operations meet applicable environmental laws and regulations lies with the state regulatory authority with enforcement authority for the mine. Table 1 summarizes some of the standards set out in state law and regulation for hard rock mining on federal lands, including cyanide heap leach operations.

The only state to develop a specific regulatory program for mining operations using cyanide is Oregon. The Oregon heap leach mining statute creates a regulatory program for heap leach mining and can serve as a model for other western states.

With the exception of Oregon's state heap leach mining law, state and federal regulatory programs are ineffective in regulating the myriad of environmental and potential public health impacts associated with hard rock mining. For example, the two states with the greatest number of producing gold mines -- California and Nevada -- fail to require that the open pits created by mining operations be backfilled or reshaped to the land's original contour. Thus, those areas of our public lands will not be returned to any productive use.

Ongoing environmental violations occur at heap leach facilities, according to state reports in Montana, Utah and California, yet the regulatory program is unable to bring the mines into compliance with applicable law. Clearly, national attention should be addressed to the impacts of heap leach operations and their effective regulation.

CONCLUSION:

Open-pit heap leach mining for gold is an exceptionally profitable way for mining companies to refine large quantities of low-grade gold ore cheaply, and is widely used in the West. A major reason this method of mining is inexpensive is that the full costs to the environment have not been taken into account - or borne - by mine operators. The significant adverse environmental and public health risks associated with the use of this methodology are well documented but poorly regulated by the federal or state governments responsible for overseeing mining operations on our public lands.

The adverse impacts of open-pit heap leach mining must be addressed in a federal regulatory program designed to ensure that damage to the environment and threats to public health and safety are minimized during and after the mining operation. Any damage to the land and water resources from mining should be minimized, and the operator must be liable for returning the lands and waters to a productive post-mining use. Reclamation bonds need to be available that are adequate to reclaim any land or water impacts from mining, in the event an operator fails to meet his or her reclamation obligations. Under certain circumstances, open pit cyanide heap leach operations should not be permitted at all. Finally, water quality standards must be clearly addressed and met at all phases of the mining and reclamation of a gold heap leach site, and groundwater quality and quantity should be fully protected.

SUGGESTED READING LIST

Cascadia Times. "Greetings from Cyanide Lake Idaho." May-June 2000. Volume 5, Number 1.

"Cyanide and the Environment." Two Volumes edited by Dirk Van Zyl. (Collected proceedings of a conference held in Tucson, AZ, December 11-14 1984.) Fort Collins, Colorado, Colorado State University, 1985.

"Cyanide in Mining: Some Observations on the Chemistry, Toxicity, and Analysis of Mining Related Waters." Robert Moran, Ph.D. Invited Paper, Presented at the Central Asia Ecology- 99 Meeting, Lake Issyk Kul, Kyrgyzstan. Sponsored by Soros Foundation. June 1999. Available on the web at http://www.mpi.org.au/features/esm_background.html (note the underscore) or contact Robert Moran at remoran@aol.com.

"Cyanide Spill at Baia Mare Romania." United Nations Environment Program (UNEP) and Office for the Coordination of Humanitarian Affairs (OCHA) Assessment Mission. March 2000. Available on the web at http://www.unep.ch/roe/baiamare.htm.

"Cyanide Uncertainties: Observations on the Chemistry, Toxicity, and Analysis of Cyanide in Mining Related Waters." Robert Moran, Ph.D. Mineral Policy Center Issue Paper No. 1. Available on the web at http://www.mineralpolicy.org/publications/issuepapers.php3?nav=4.

"Montana's Open-Pit Cyanide-Leach Gold Mines: Water, Property and Taxpayers at Risk." Montana Environmental Information Center. September 1998. A publication for Montanans for common sense mining laws – I137. Contact MEIC at (406) 443-2520 for information.

"Poi$oned Profit$: Cyanide Heap Leach Mining and its Impacts on the Environment." National Wildlife Federation.