

Mining 101

AP Environmental Science



The Principles of Mining

- **Mining** is the extraction of valuable minerals or other geological materials from the earth from an orebody, lode, vein, seam, or reef, which forms the mineralized package of economic interest to the miner.



Mining

- Mining is required to obtain any material that cannot be grown through agricultural processes, or created artificially in a laboratory or factory.
- Mining in a wider sense includes extraction of any non-renewable resource such as petroleum, natural gas, or even water.



Land Claim

- **A MINING Land Claim** is a parcel of land for which the claimant has asserted a right of possession and the right to develop and extract a discovered, valuable, mineral deposit.
- There are three basic types of minerals on federally-administered lands: locatable, leasable, and salable. Mining claims are staked on locatable minerals on public domain lands.

Locatable, Salable and Leasable

- Locatable minerals include gold, silver, copper and other hard rock minerals. (purchased or acquired land - General Mining Law of 1872)
- Salable minerals, such as sand, gravel, stone and clay require a contract or permit to mine
- Leasable minerals include oil and gas, oil shale, geothermal resources, potash, sodium, native asphalt, solid and semisolid bitumen, bituminous rock, phosphate, and coal.

Economic mineralogy

- Study of minerals heavily used in manufacturing.
- Important part of domestic & international commerce
- Mostly metal ores
- Some non-metallics are: graphite, quartz, diamonds.

Important Industrial Minerals	
Mineral	Use
Gold, silver, diamond	Jewelry, electronics, grinding
Gypsum, calcite	Construction
Copper, hematite	Electronics, manufacturing
Clay minerals	Paper industry

Metal Resources

Metal	Uses	Millions Metric Tons Annually
Iron	Heavy machinery, steel production	740
Aluminum	Packaging foods & beverages, transportation, electronics	40
Manganese	High-strength, high-resistant steel alloys	22.4
Copper	Building construction, electric/electronic industry	8
Chromium	High strength steel alloy	8
Nickel	Chemical industry, steel alloys	0.4
Lead	Leaded gasoline, car batteries, paint, ammunition	
Silver	Photography, electronics, jewelry	
Gold	Medical, aerospace, electronic use, money, jewelry	
Platinum	Automobile catalytic converters, electronics, medical uses, jewelry-	

Metal Resources

Biggest Users of Metals

- United States
- Japan
- Europe

Biggest Producers

- South America
- South Africa
- Russia

Blood Diamonds

- **Blood diamonds** (also called a **conflict diamonds**, **converted diamonds**, **hot diamonds**, or **war diamonds**) is a term used for a diamond mined in a war zone and sold to finance an insurgency, an invading army's war efforts, or a warlord's activity.
- Diamonds mined during the recent civil wars in Angola, Ivory Coast, Sierra Leone, and other nations have been given the label.



Non-Metal Resources

- Sand & gravel (highest volume & dollar value than any other non-metal & greater volume than metals)
 - Uses: brick & concrete construction, paving, road filler, sandblasting, glass (high silica content sand)
- Limestone
 - Uses: concrete, road rock, building stone, pulverized to neutralize acidic soil or water.
- Evaporites- halite, gypsum, potash
 - Uses: halite- rock salt for roads, refined into table salt
 - Gypsum- makes plaster wallboard
 - Potash- for fertilizer (potassium chloride, potassium sulfates)
- Sulfur deposits
 - Uses: sulfuric acid in batteries & some medicinal products

Strategic Metals & Minerals

- We depend on about 80 metals & minerals
- 18 of these are considered rare & in short supply
 - EX: Tin, platinum, gold, silver, & lead
- Some are strategic resources- we use but cannot produce ourselves.



Strategic Metals & Minerals

- If foreign politics, government are unstable, could cut off supplies, causing a crippling of economy or military strength
- We stockpile when resource is cheap & available “just in case.”
- EX: bauxite (ore containing aluminum), manganese, chromium, tin, cobalt, tantalum, palladium, platinum
- Many LDC sell their strategic resources to make money for country.
 - Zambia- 50% of national income comes from cobalt exports.

	Nonfuel Mineral	Adequacy of U.S. Reserves for Cumulative U.S. Demand 1982-2000						Major Foreign Source
		0	20	40	60	80	100%	
Essentially No Reserves	Manganese							S. Africa, Gabon, Brazil
	Cobalt							Zaire, Zambia
	Tantalum							Malaysia, Thailand, Brazil
	Niobium							Brazil, Canada
	Platinum							South Africa, C.I.S.
	Chromium							C.I.S., S. Africa
	Nickel							Canada, New Caledonia
	Aluminum							Jamaica, Australia
	Tin							Malaysia, Bolivia
	Antimony							South Africa, Bolivia
	Fluorine							Mexico, South Africa
	Asbestos							Canada, South Africa
	Vanadium							South Africa, Chile
	Reserve Deficiency	Mercury						
Silver								Canada, Mexico
Tungsten								Canada, Bolivia
Sulfur								Canada, Mexico
Zinc								Canada, Mexico
Gold								Canada, C.I.S.
Potash								Canada, Israel

Steps in Obtaining Mineral Commodities

- **Prospecting-** finding places where ores occur
- **Mine exploration & development-** learn whether ore can be extracted economically
- **Mining-** extract ore from ground
- **Beneficiation-** separate ore minerals from other mined rock
- **Smelting & refining-** extract pure mineral from ore mineral (get the good stuff out of waste rock)
- **Transportation-** carry mineral to market
- **Marketing & sales-** find buyers & sell the mineral

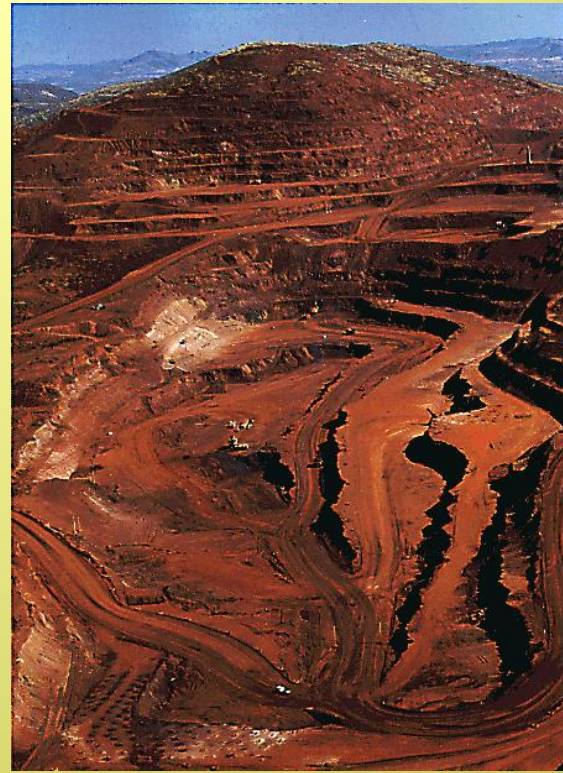
Types of Mining

- Surface- scoop ore off surface of the earth or dig big holes and scoop
 - Cheap
 - Safe for miners
 - Large amount of environmental destruction
- Subsurface- use shafts to reach deeply buried ores
 - Expensive
 - Hazardous for miners
 - Less environmental damage



Types of Surface Mining

1. Open Pit Mining
 - a. Overlaying material is removed using large equipment
 - b. Creates pits that are hundreds of meters wide and hundreds of meters deep.



Types of Surface Mining

2. Strip mining

- Like open pit but not as deep of a pit
- Same environmental damage

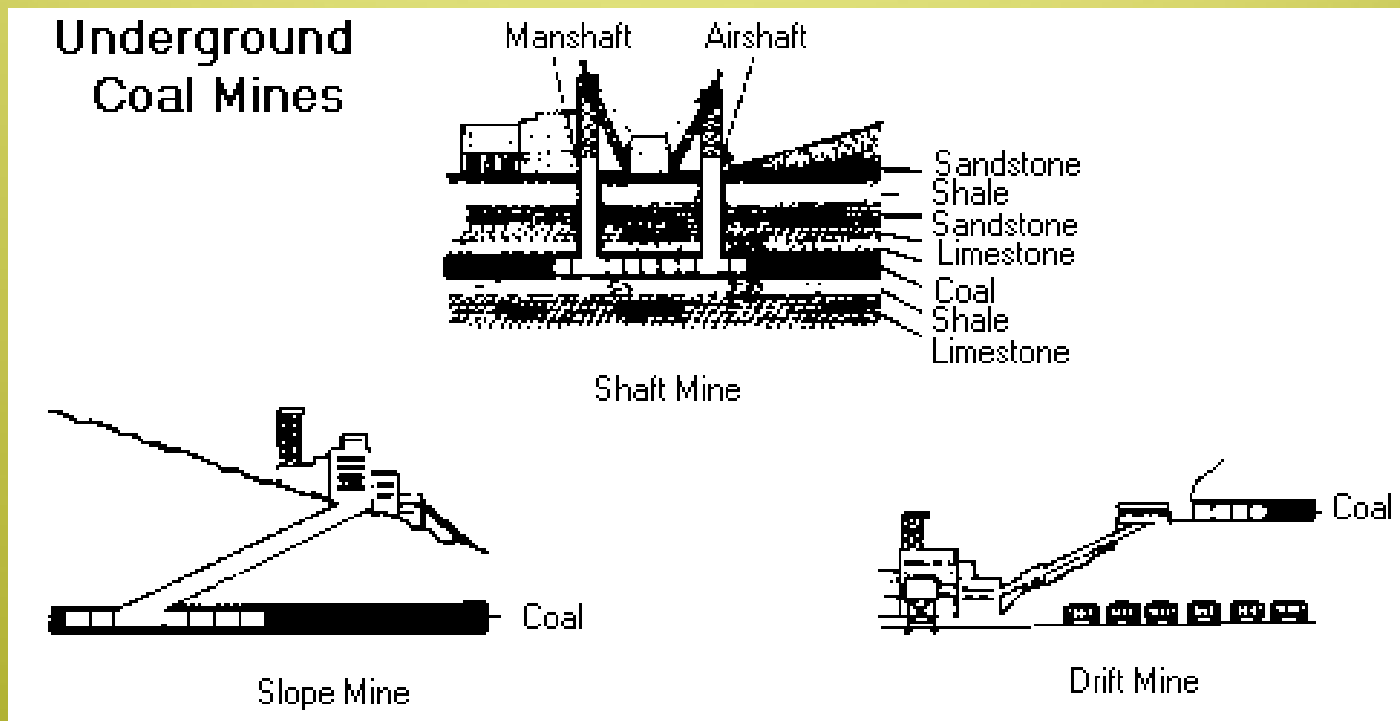




Large bucket wheel extractor being moved through Germany. Moves 10 meters per minute. Takes 5 people to operate. Used in strip mining

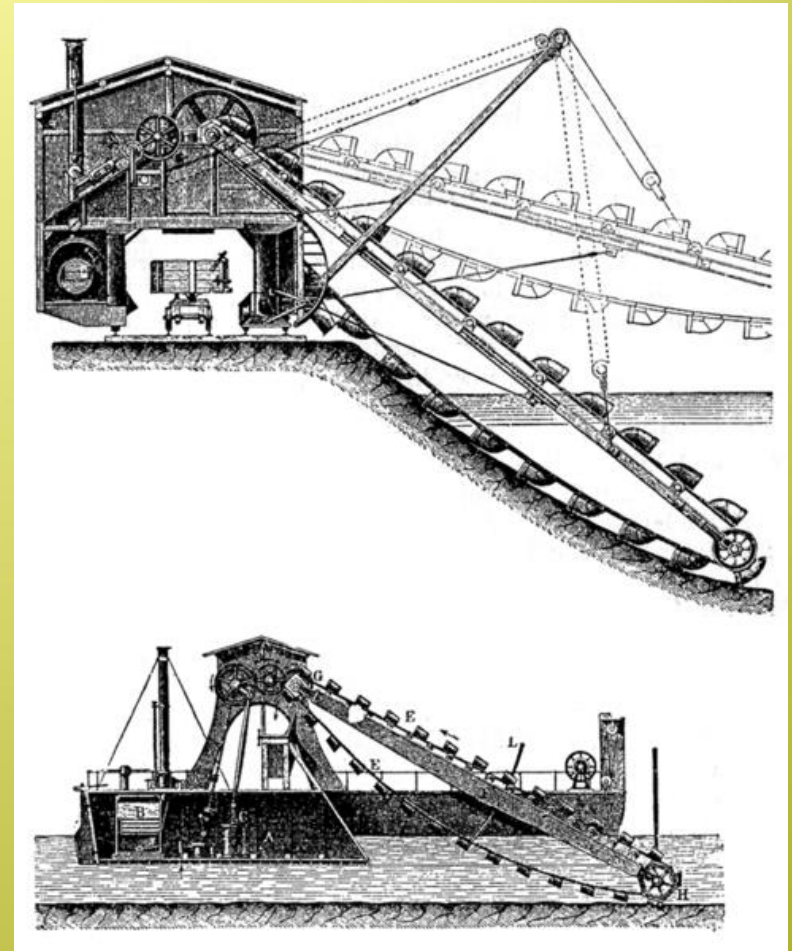
Types of Subsurface mining

- Coal Shaft, Slope and Drift mining
- In situ mining – for radioactive Uranium
- Hydraulic Fracturing- fracking



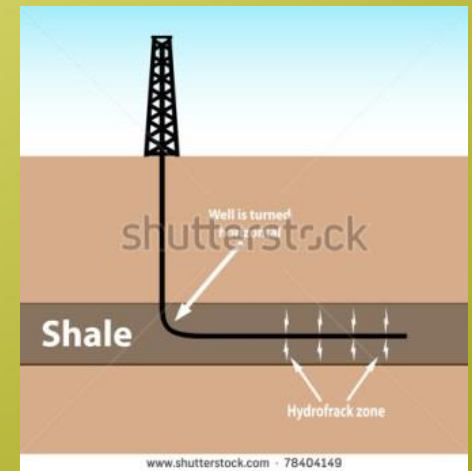
Types of Subsurface Mining

- Dredging
 - Sand is removed from bottom of ocean
 - Can be done to restore beaches (after hurricane)
 - Destroys fragile benthic ecosystems



Subsurface Fracturing

- **Fracking** refers to the procedure of creating fractures in rocks and rock formations by injecting fluid into cracks to force them further open. The larger fissures allow more oil and gas to flow out of the formation and into the wellbore, from where it can be extracted.
- Hydraulic Fracturing/Fracking



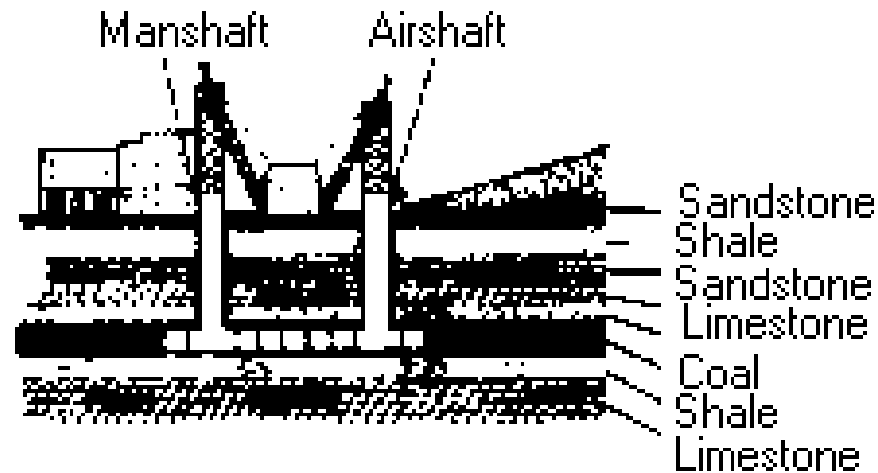
Subsurface Mine Structures

- Mine adit- is an entrance to an underground mine which is horizontal or nearly horizontal. A mine adit serves as an entrance, a portal to drain water and for tunnel ventilation.¹

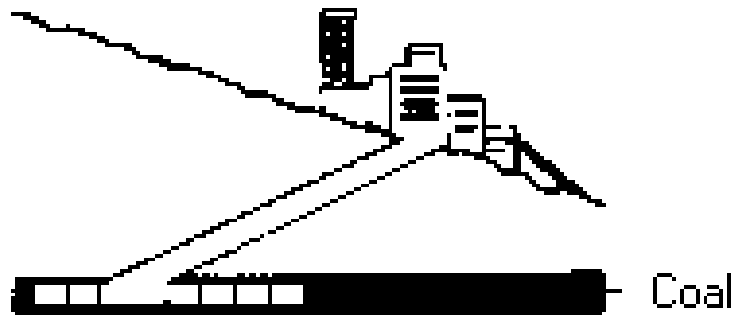


Subsurface Mining: Shaft, Slope and Drift Mining

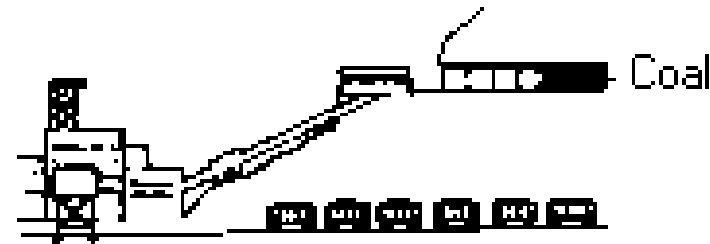
Underground Coal Mines



Shaft Mine



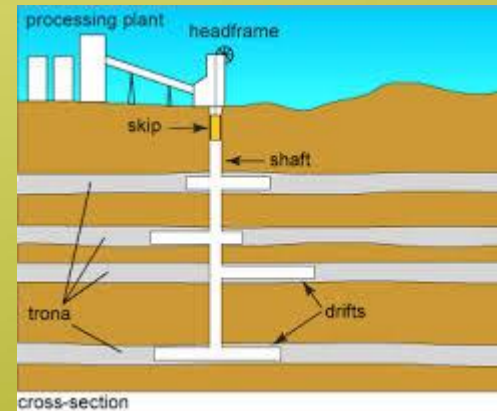
Slope Mine



Drift Mine

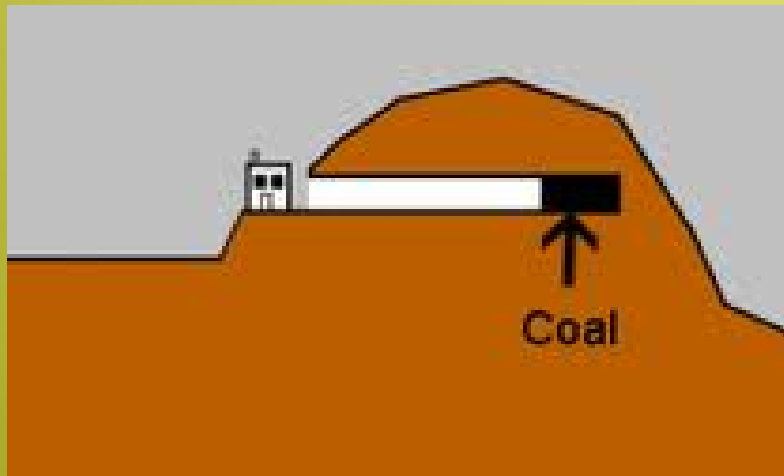
Mine Shafts and Winzes

- **Shaft mining** refers to the method of excavating a vertical or near-vertical tunnel from the top down with no bottom access.. When the top of the excavation is the ground surface, it is referred to as a shaft; when the top of the excavation is underground, it is called a **winze** or a sub-shaft.

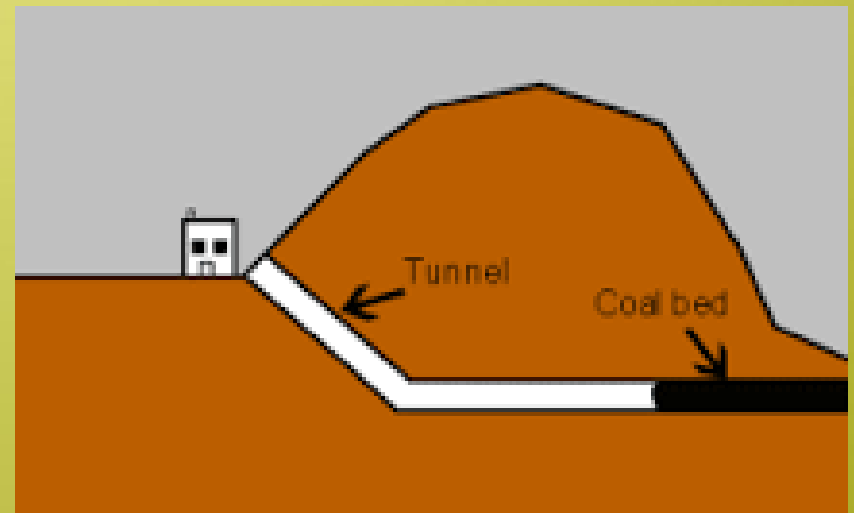


Drift Mining and Slope Mining

- [Drift mining](#) utilizes horizontal access tunnels, [slope mining](#) uses diagonally sloping access shafts.
- Drift Mining



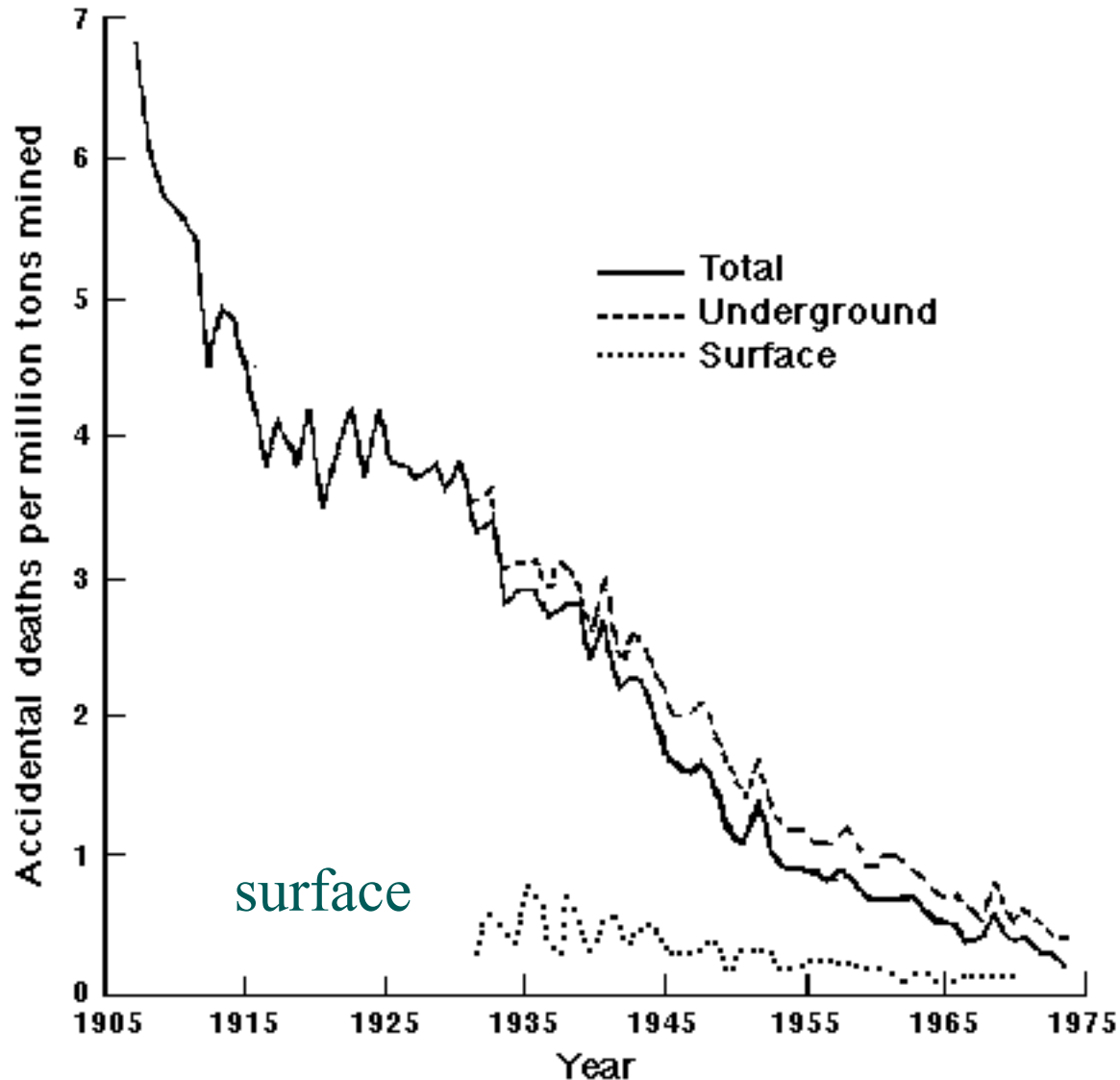
Slope Mining



Mining Issues

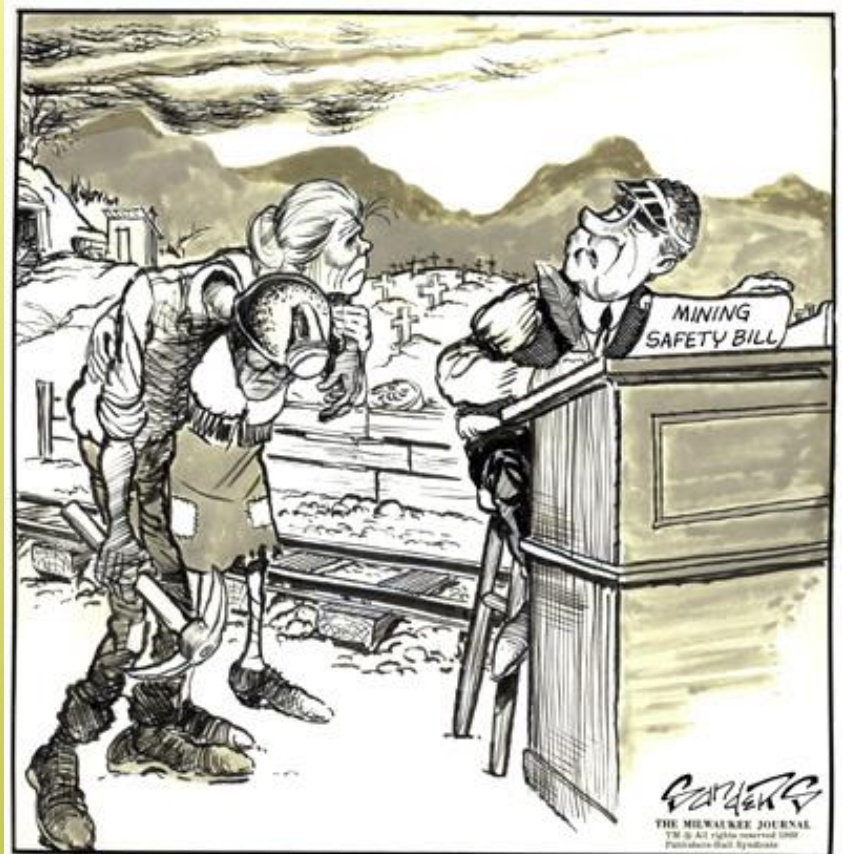
Mine Safety:

In U.S., stringent mining regulations have led to a reduction in fatalities, both in terms of total deaths per year, deaths per person-hour worked, and deaths per ton mined.



Health Problems

- mine collapse
- fire (methane, coal dust, etc.).
- asphyxiation (methane, carbon monoxide)
- pneumoconiosis (from inhaling coal dust)
- asbestosis (from inhaling asbestos fibers)
- silicosis (from inhaling silicate dust)
- heavy metal poisoning (e.g. mercury)
- radiation exposure (in uranium mining)



'Please, madam. I'm trying to determine which is less expensive . . . funerals or safety standards.'

Black Lung/ CWP

- Black lung disease is a common name for any lung disease that develops from inhaling coal dust. This name comes from the fact that those with the disease have lungs that look black instead of pink. Medically, it is a type of pneumoconiosis called coal workers' pneumoconiosis (CWP).



MSHA

- **Mine Safety and Health Administration (MSHA)** is an agency of the United States Department of Labor which administers the provisions of the Federal Mine Safety and Health Act of 1977 (Mine Act) to enforce compliance with mandatory safety and health standards, eliminate fatal accidents, reduce the frequency and severity of nonfatal accidents, minimize health hazards, and to promote improved safety and health conditions in the nation's mines.¹

Environmental Damage

- Gaping holes in ground (old open pit mines)
- Tailings and Spoil Banks- cause Acid Mine Drainage
- Accidental draining of rivers and lakes
- Disruption of ground water flow patterns
- Loss of topsoil in strip-mined regions (350 to 2,700 km² in US alone)
- Contamination from sulfuric acid (H₂SO₄) produced through weathering of iron sulfide (FeS₂, pyrite) in tailings.
 - $4\text{FeS}_2 + 14\text{H}_2\text{O} = 4\text{Fe}(\text{OH})_3 + 8\text{H}_2\text{SO}_4$
- Water leaking into mine shafts, washes dissolved metals & toxic material into water sources.
 - (550,000 abandoned mines in U.S.- 12,000 mi of rivers & streams contaminated with mine drainage- cost to clean up \$32-\$72 billion)

Lake Peigneur, Louisiana

- Lake Peigneur **WAS** a freshwater lake then on November 20, 1980, a Texaco oil rig accidentally drilled into the Diamond Crystal Salt Company salt mine under the lake. It created a giant hole that resulted in a whirlpool which sucked in the drilling platform, eleven barges, many trees and 65 acres (260,000 m²) of the surrounding terrain and the entire Lake Peigneur. Oops.



Mine Tailings (Waste)

- **Tailings**, also called **mine dumps**, **culm dumps**, **slimes**, **tails**, **refuse**, **leach residue** or **slickens**,
- Tailing are the materials left over after the process of separating the valuable fraction from the uneconomic fraction (gangue) of an ore.
- Tailing waste contaminates the soil and water with leaching of heavy metals (e.g. arsenic, mercury)

Coeur D' Alene Mine in Colorado



“Gangue”- mine tailings



Acid Mine Drainage

The impact of
mine drainage
on a lake after
receiving
effluent from an
abandoned
tailings
impoundment
for over 50
years



Relatively fresh tailings in an impoundment.

http://www.earth.uwaterloo.ca/services/whaton/s06_and.html

The same tailings impoundment after 7 years of sulfide oxidation. The white spots in Figures A and B are gulls.



Shoreline of a pond receiving AMD showing massive accumulation of iron hydroxides on the pond bottom



Spoil Banks

- Spoil banks are where holes were filled in with waste- cheap & easy- susceptible to erosion, chemical weathering, causes high sediment runoff in watersheds. Steep slopes are slow to re-vegetate (succession happens slowly- no topsoil)





Mine effluent
discharging from
the bottom of a
waste rock pile
(gangue)

Surface Mining Control & Reclamation Act (SMCRA)

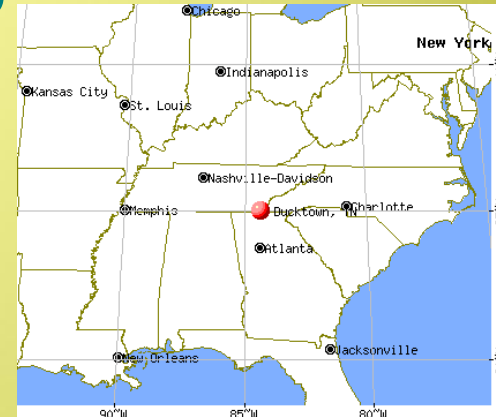
- 1977
- Requires better restoration of strip-mined lands
- Restoration is difficult & expensive
- Takes long time for soil to regain fertility
 - Topsoil gets buried
 - Compacted, poor drainage
 - Root growth restricted
- Minimum cost- \$1000 per acre



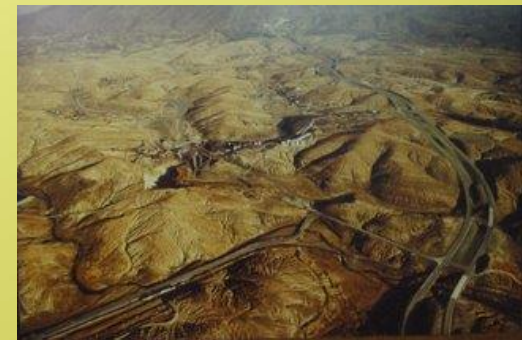


Georgia vs. Ducktown, TN (1915)

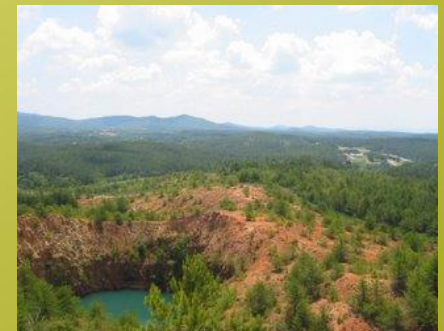
- In 1800's began mining copper in Ducktown, TN
- Built huge open air wood fires by cutting down trees in area. Burned ore to release copper
- Damage caused:
 - Clouds of sulfur dioxide released from burning sulfide ore poisoned plants & acidified soil.
 - Massive interstate air pollution
 - Rain caused massive erosion
 - Siltation of reservoirs on Ocoee River impaired electricity generation by the Tennessee Valley Authority (TVA)
- In 1930's clean up began- spend \$250,000 per year for clean up
- Trees still spindly, but only 4% of area is still "denuded"



1940's



Now



US Sulfur Dioxide Emissions

