FACTS ABOUT COAL AND MINERALS

NMA

CONTENTS

Facts About Coal and Minerals

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Haul trucks used in surface mining can hold more than 400 tons of ore.

Think of your everyday life.... Do you drive or bike to work or school? The iron ore, bauxite, copper, platinum and other minerals used in the manufacture of cars and bicycles are products of mining. Do you use a computer? Did you know it takes as many as 66 minerals to make the screen, case, chips, circuitry and the battery? And it is likely that more than half the electricity you used today was generated either by coal or uranium, both products of mining.

Did you know?

THE AVERAGE PERSON IN THE U.S. USES NEARLY 40,000 POUNDS OF NEWLY MINED MINERALS – INCLUDING THREE TONS OF COAL – EACH YEAR.

We are surrounded by these raw materials — minerals and coal — that make nearly everything possible in our daily lives. But we often take them for granted because they are everywhere in our lives, even when we don't see them. They keep our lights on, provide essential building blocks for manufacturing and provide materials vital to advanced technologies we all depend on.

For the U.S., mining has a direct economic impact of about $600 billion annually, or about three percent of the U.S. gross domestic product (GDP), which is a measure of the market value of goods, services and structures produced in a country during a given time period. Mining activity takes place in all 50 states, in fact the U.S. has significant deposits of 78 minerals and major commodities - the most of any nation.

Today's mining industry that produces these building blocks of American prosperity utilizes sophisticated equipment and a highly skilled and trained workforce to not only mine, but also to restore land after resource extraction has occurred.

All aspects of our economy including electricity, communications, transportation systems, computer networks, national security, space and medical technology — require minerals and coal. Fortunately, the U.S. is home to extensive domestic reserves of many important mineral resources and the world's largest supply of recoverable coal.

Although the U.S. has an abundance of high quality, diverse mineral resources, due to the lengthy federal permitting process, it can take seven to 10 years for a mine to receive approval to operate.

MINING and the ECONOMY

The products of mining take center stage in helping fulfill our advanced society's most basic needs. An abundant food supply, clothing, shelter, electricity, transportation and communication would not be possible without mining. The typical house contains concrete and masonry block in the foundation, gypsum wallboard and copper pipes and wiring — to name just a few mined products. Coal provides a third of the electricity we rely on — and it takes at least 29 different minerals neede to get that electricity to our homes and businesses. Nuclear energy, which is generated from uranium, provides 20 percent of our electricity.

A wind turbine may contain 335 tons of steel, 4.7 tons of copper, 13 tons of fiberglass, 3 tons of aluminum and 1,200 tons of reinforced concrete.

According to the U.S. Geological Survey (USGS), $110 billion of coal and minerals were mined in 2015, with $78 billion of non-fuel minerals processed into $630 billion worth of products.

USGS and the U.S. Department of Commerce estimate that industries, such as construction and durable goods manufacturing, that use processed mineral material, added $2.4 trillion to the U.S. economy in 2015 — or about 14 percent of GDP.

According to the National Park Service, the Statue of Liberty contains 31 tons of copper 3/32 inches thick.

Aside from their dollar impact, these minerals have other tangible benefits. The National Research Council of the National Academy of Sciences concluded that one of the primary advantages the U.S. has over its strongest industrial competitors is its domestic resource base. For example, with affordable and abundant domestic coal, U.S. electricity costs are highly competitive, an asset in the global marketplace.

Mining companies also pay taxes to the communities in which they operate. Companies pay more than $40 billion in federal, state and local taxes on company profits and employee wages, property taxes on equipment and structures, and excise taxes on output.

	Direct & Indirect Employment	Labor Income	Contribution to GDP
	Number	(Millions)	(Millions)
Alabama	37,046	$2,130	$4,753
Alaska	9,959	547	1,884
Arizona	65,666	3,518	16,589
Arkansas	13,916	674	1,001
California	99,129	7,353	13,538
Colorado	50,126	3,051	7,671
Connecticut	8,402	598	1,074
Delaware	2,348	137	264
D.C.	2,503	262	439
Florida	60,388	3,388	5,375
Georgia	39,298	2,265	4,123
Hawaii	3,662	238	418
Idaho	15,283	629	1,822
Illinois	64,742	4,467	8,220
Indiana	41,980	2,501	5,112
Iowa	13,373	640	1,350
Kansas	10,826	502	1,761
Kentucky	63,366	3,655	6,377
Louisiana	22,907	1,402	2,845
Maine	4,984	198	318
Maryland	25,615	1,747	2,124
Massachusetts	12,435	1,049	2,088
Michigan	50,239	3,675	6,367
Minnesota	63,488	2,480	7,618
Mississippi	9,233	475	905
Missouri	31,873	1,607	2,668
Montana	21,038	1,302	2,612
Nebraska	7,020	399	738
Nevada	55,248	4,159	12,739
New Hampshire	5,212	318	497
New Jersey	19,531	2,263	2,439
New Mexico	23,351	1,307	3,037
New York	48,903	3,374	7,032
North Carolina	30,909	1,694	3,181
North Dakota	9,781	683	1,414
Ohio	59,671	3,536	6,879
Oklahoma	16,854	873	2,097
Oregon	17,249	1,037	2,046
Pennsylvania	122,822	6,859	11,370
Rhode Island	2,580	160	278
South Carolina	18,113	924	1,702
South Dakota	5,214	256	535
Tennessee	27,950	1,411	2,408
Texas	122,147	7,605	16,041
Utah	43,022	2,432	5,320
Vermont	3,891	171	332
Virginia	53,101	3,568	6,629
Washington	18,845	1,400	4,072
West Virginia	63,435	4,214	8,253
Wisconsin	24,029	1,236	3,691
Wyoming	45,656	3,261	8,370
Total Operations	**1,688,364**	**103,724**	**$220,423**

Sources: NMA analysis based on Mine Safety & Health Administration (2015) data and IMPLAN modeling system

Coal, copper, gold, gravel and iron ore are all mined, but are they all minerals?

Not all of them. Scientifically, a mineral is a naturally formed inorganic solid (element or chemical compound) with a limited range of chemical composition and an orderly internal atomic structure. Coal and aggregates such as sand and gravel contain varying amounts of mineral matter, but are technically rocks.

Coal is a carbonaceous sedimentary rock. It is formed from organic matter and contains carbon and other elements, such as hydrogen, oxygen and nitrogen. Most coal was formed 280 to 345 million years ago as trees, ferns and other plants decomposed and were buried under prehistoric seas and swamps. Pressure and temperature compressed and altered the plant remains, concentrating carbon content, and over millions of years, transformed the material into coal.

Coal is divided into four major types based on the amount of transformation undergone from the earlier plant and peat stages, heating value and other characteristics:

Lignite is a coal with generally high moisture and ash content and low carbon content. Significant reserves are located in Texas, North Dakota and Montana.

Subbituminous coal has a higher heating value than lignite. Wyoming produces the bulk of subbituminous coal in the Powder River Basin area.

Bituminous coal is a soft, intermediate grade that is most common in the United States. It is mined chiefly in Appalachia and the Midwest.

Anthracite is the hardest type of coal, consisting of nearly pure carbon. Mined in Pennsylvania, it has the highest heating value and lowest moisture and ash content.

Is coal being formed today?

It's likely that the process that formed coal and other fossil fuels is still occurring in swampy areas where plant material accumulates.

Minerals, also called nonfuel or hardrock minerals, are classified as metallic and nonmetallic:

Metalllic minerals are further classified as ferrous and nonferrous. The category of **ferrous minerals** includes iron and iron alloys such as steel. **Nonferrous minerals** include, among many others, copper, silver, platinum, gold, uranium and zinc.

Gold Ore

Nonmetallic minerals include "structural materials" — stone, sand, gravel and synthetic materials like cement. They usually are composed of some of the 25 most abundant minerals and are used for the nation's infrastructure.

Nonmetallic minerals also include "industrial minerals," which are used as paper coatings, paints, varnishes, enamels, fertilizers, abrasives, and so forth. These minerals include sulfur, salts, limestone, clays, barite and industrial diamonds.

A **mineral deposit** is a naturally occurring mineral accumulation that may have potential value. An **ore deposit** is a mineral deposit that has been tested and is known to be of sufficient quality to be mined economically. Sometimes several metals occur in the same deposit, such as lead, zinc and copper, or silver and gold.

ORE is rock that contains important minerals, including metals.

Resources are concentrations of minerals, coal or other commodities in such form that they can be extracted with current technology or the extraction potential is considered feasible in the future. Resources may be known to exist, or they may be surmised to exist based on geologic evidence. U.S. coal resources are estimated to be nearly 4 trillion tons, enough to provide fuel for many generations of Americans.

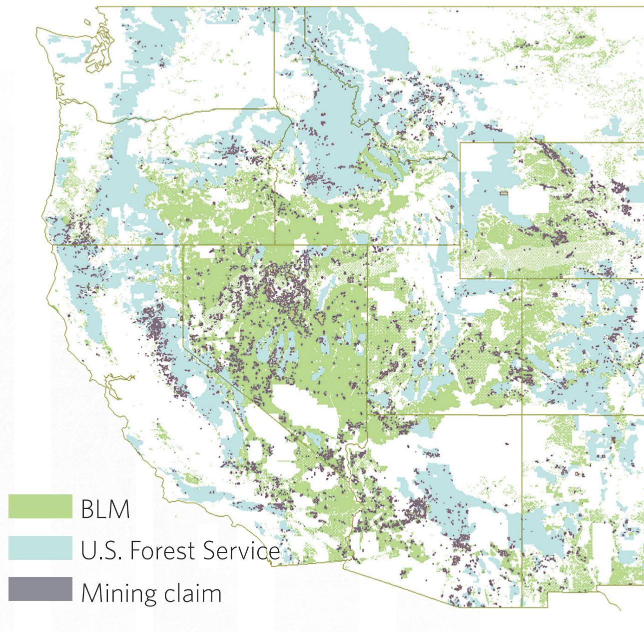
Reserves are known, identified resources from which a usable mineral commodity can be technologically, economically and legally extracted at the time of determination. A fall in price, for instance, can change the character of a deposit from "reserve" to "resource." Additionally, exploration drilling that further delineates a deposit can add to reserves. According to the U.S. Energy Information Administration (EIA), the U.S. has more than 250 billion tons of recoverable coal reserves — enough to more than 250 years at current rates of use.

Where are resources found?

Most U.S. mineral resources are located in the Western states including Alaska; and the areas with the most promise for ore discoveries are primarily within federally-managed public lands. The Bureau of Land Management (BLM) manages 700 million acres of subsurface public land, representing as much as 60 percent of the nation's hardrock mineral estate; however, less than half of that area currently is open for mineral exploration and production.

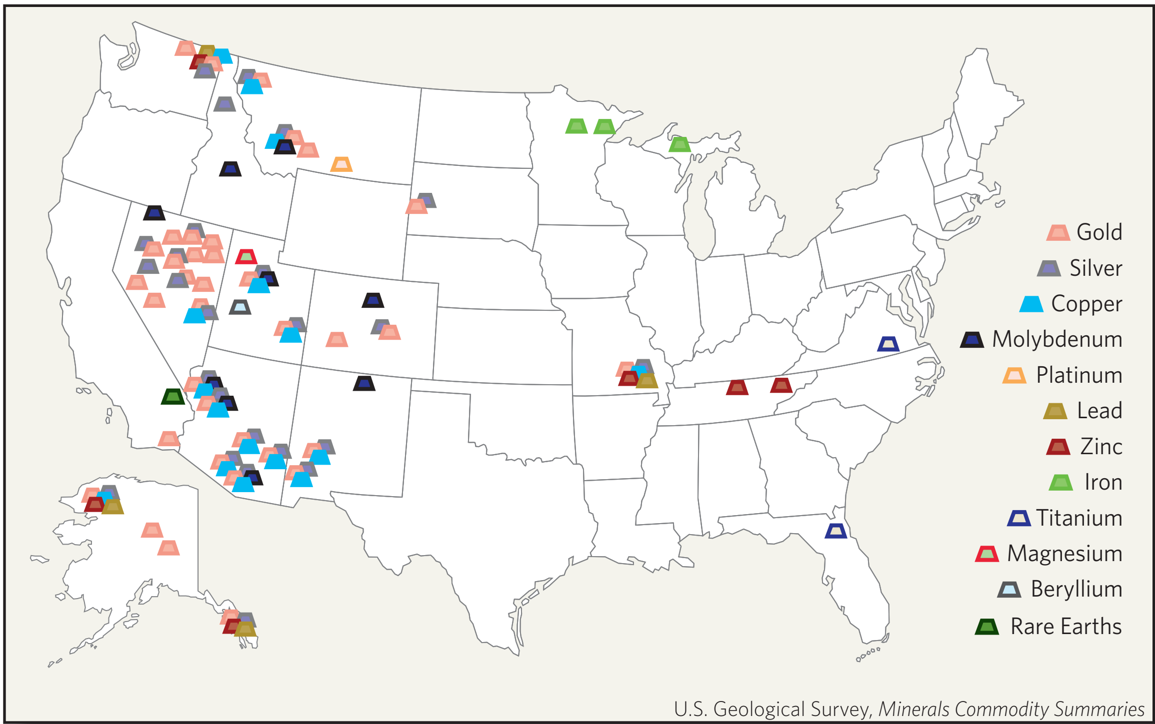
Coal is present in 38 states and underlies nearly half a million square miles — or 13 percent of the nation's land area. Coal reserves are split between the Eastern and Western states — the most important coal deposits in the East are in Appalachia, which includes portions of nine states. The West contains the Wyodak coalbed, which is the nation's leading source of coal and part of the Powder River Basin of Wyoming and Montana. In the interior states, coal occurs in several basins located from Michigan to Texas.

Mining Claims on Federal Land in the West

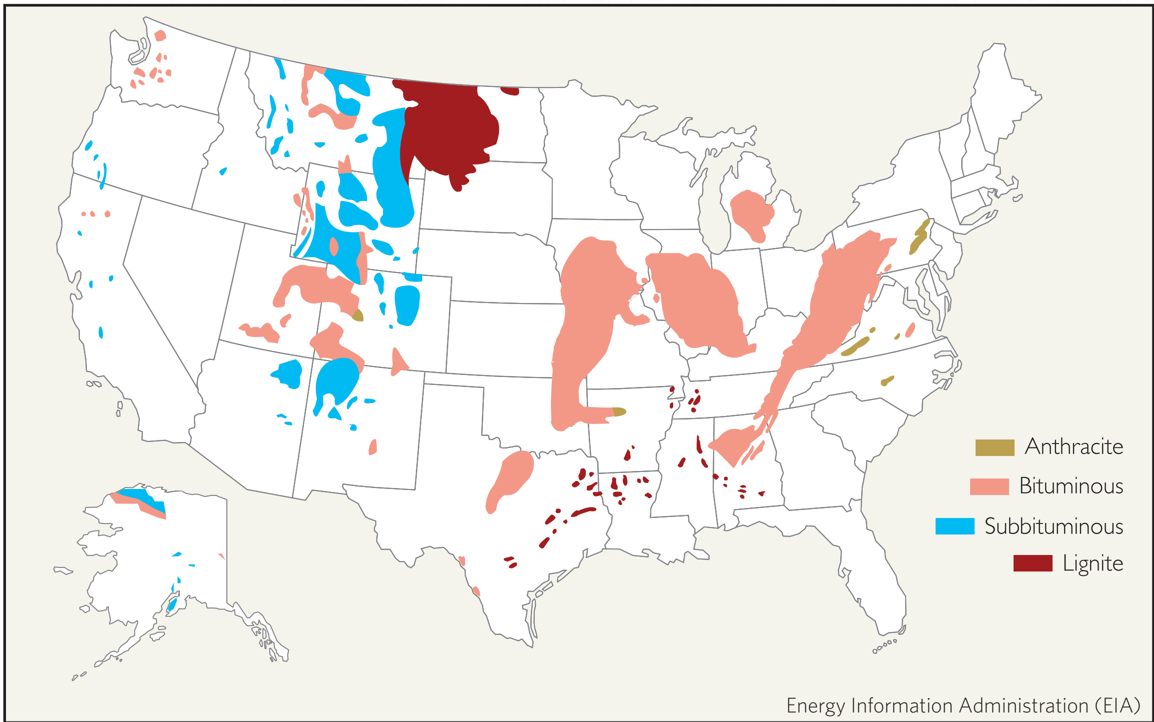


www.geocommunicator.gov

Major Metals Mineral Producing Areas



Major Coal Reserves



Aluminum was considered a rare metal and a chemical curiosity until 1886. Researchers in the U.S. and France independently discovered the continuous electrolytic reduction process used to make aluminum metal from bauxite.

U.S. coal recoverable reserve base 2015, top 10 states

(billion short tons)

	State	Total Reserves
1	Montana	74.5
2	Wyoming	36.2
3	Illinois	37.7
4	West Virginia	16.7
5	Kentucky	14.0
6	Ohio	11.3
7	Pennsylvania	11.2
8	Colorado	9.5
9	Texas	9.1
10	New Mexico	6.8
	Rest of U.S.	27.9
	Total U.S.	254.9

Energy Information Administration

U.S. mineral reserves by commodity, 2015

	Reserve	% World Reserve
In thousand metric tons of metal content:		
Barite	15,000	3.9
Copper	33,000	4.6
Iron Ore	3,500,000	4.1
Lead	5,000	5.6
Molybdenum	2.7	24.5
Zinc	11,000	5.5
In thousand metric tons of ore/rock:		
Phosphate Rock	1,100,000	1.6
In metric tons of metal content:		
Gold	3,000	5.4
Platinum Group Metals	900	1.4
Rare Earths	1,800,000	1.4
Silver	25,000	4.4

U.S. Geological Survey

quick question

What are 'precious' metals?

Precious metals are minerals that are relatively scarce and valuable, such as gold, silver and platinum group metals.

U.S. Mint American Eagle Bullion Coin

GPS satellite

In order to maintain a national reserve base, geologists are continuously looking for new mineral deposits. The exploration process undertaken to find these elusive deposits can be compared to searching for a needle in a haystack.

Exploration often starts with literature and field investigation of a region covering up to 100,000 square miles. Bit by bit, the exploration team narrows this region down to smaller target areas that are considered highly favorable for mineral resource deposits. Tools such as remote sensing satellites help identify favorable areas in relatively inaccessible places. Global positioning systems (GPS) aid in pinpointing resource locations. Other tools of the modern explorationist include:

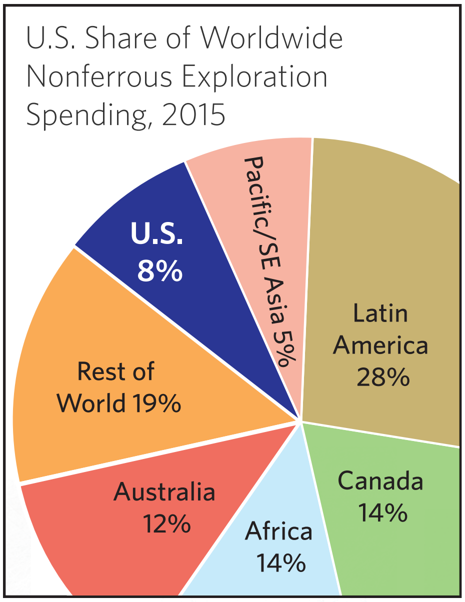
- Airborne magnetometers to detect minerals that affect the earth's magnetic field;
- Geochemical prospecting using analyses of water, soil and vegetation to pinpoint hidden concentrations of minor elements; and
- Electrical, electromagnetic, seismic and radiometric techniques.

Once a promising site is identified, core samples are taken and submitted to chemical analysis, X-ray microanalysis and other testing. If all of these tests indicate an economically viable deposit, a company can begin to decide if a mine should be constructed. Millions of dollars and upwards of five years are spent on a single exploration campaign that may or may not end in mineral production.

Unlike most minerals, the location and quantity of U.S. coal reserves are fairly well known. As a result, coal exploration efforts are usually focused not on where coal deposits are, but rather on the geology and composition of the reserves. The tools and techniques used to gather and utilize these data range from the traditional to the cutting edge. As with minerals exploration, they include drilling for core samples to reveal cross sections of the underlying rock and coal strata, laboratory analyses, surveying and mapping — all of which help engineers plan the mine's design and production plan.

How are minerals named?

For some common minerals, such as quartz and gypsum, the names are ancient and the precise origins are unknown. Newer minerals are named by the mineralogist who first describes them in print, and are often named for a person or place.



SNL - Metals Economics Group

While every mine has unique characteristics and some require special extraction techniques, the essential process of mining — whether coal or hardrock — includes five basic phases:

The state with the most coal production is Wyoming, which mined approximately 376 million tons in 2015.

1 **Exploration** — Today's mining companies use an array of techniques to pinpoint ore bodies and determine a site for a possible mine. Geologists map and take samples. They are supported by geophysicists, drillers, environmental engineers, geochemical technicians, computer-aided design, information technology experts and office support. Environmental, engineering and cultural studies are also conducted.

2 **Permitting and Bonding** — Before a mining company can break ground, it must go through permitting and bonding processes. Permits ensure that federal, state and local laws and regulations are followed (see p. 23 for a list). Financial bonds are secured to ensure that surface-mined land will be returned to an agreed-upon use at the completion of the mining process.

3 **Mining** — Whether coal or hardrock, mining operations themselves are usually one of two types — surface (also called "open pit") or underground (also called "deep"). Operations begin only after hundreds of drill holes, metallurgical tests and environmental studies have confirmed that a new deposit can be mined safely and profitably and with minimal long-term environmental impact. Mining engineers design mine plans and processing plants. Drillers and blasters shatter the ore-bearing rock so it can be removed with giant shovels and trucks. Mine geologists and survey teams using GPS continuously monitor mining progress. Environmental scientists and technicians make sure the environment is protected. The logistics of running a mining operation are supported by dozens of administrative personnel.

4 **Processing** — In both coal and minerals mining, the extracted resource is often sent from the mine to a processing facility. Rocks

U.S. coal production by state, 2015 (million short tons)

	State	Total	% of Total U.S.
1	Wyoming	375.8	41.9%
2	West Virginia	95.6	10.7%
3	Kentucky	61.4	6.8%
4	Illinois	56.1	6.2%
5	Pennsylvania	50.0	5.6%
6	Montana	41.9	4.7%
7	Texas	35.9	3.9%
8	Indiana	34.3	3.8%
9	North Dakota	28.8	3.2%
10	New Mexico	19.7	2.2%
	Other States (28)	97.4	11.0%
	Total U.S.	896.9	100%

Energy Information Administration, *2015* preliminary data bearing mineral ores are crushed and subjected to a variety of chemical reactions to remove the valuable metal from surrounding rock. Coal is taken to preparation plants, where it is cleaned and separated by quality. Impurities in the coal are removed by various mechanical techniques, including pulsating water currents, rapidly spinning water and liquids of different densities. In all cases, metallurgists, mechanical engineers, electricians, welders and other skilled technicians are critical to keeping the operation of these processing facilities running smoothly. (See page 16 for more information on processing).

5 **Restoration** — Once mining is complete at a site, engineers, metallurgists and environmental specialists begin the restoration process — returning the landscape to its natural form or to another acceptable use, such as recreation, wildlife habitat or economic development areas. At large coal surface mines and some minerals mines, reclamation often begins in the sections where the coal or minerals have already been removed, even while mining is continuing elsewhere at the site. Waste rock is treated and the topography is carefully contoured. Mined areas can be successfully converted to wetlands and other approved uses. The earth is seeded with indigenous species, and biologists and hydro-geologists monitor sites for years after mining is completed to ensure environmental goals are met.

Estimated Nonfuel Minerals Values
(billion dollars)

Year	U.S. Production	Materials Processed
2009	$57.1	$454
2010	$64.0	$578
2011	$74.0	$633
2012	$76.5	$704
2013	$74.2	$665
2014	$77.6	$697
2015	$78.3	$630

USGS *Minerals Commodity Summaries*

Since 1977, U.S. mining companies have restored more than 2.8 million acres of mined land and have planted more than 500 million trees.

Mineral production is a cyclical business, with production levels for any given period showing peaks and valleys for almost every mineral. Production rates are determined by worldwide demand as much as by exploration success. Of 2,500 known minerals, about 50 are major economic commodities that are commonly explored, mined and traded internationally.

The United States produces 78 major mineral commodities, more than any other nation involved in mining. These include: antimony, bauxite, beryllium, borax, boron, clays, coal, copper, diamonds, diatomite, feldspar, gold, gypsum, iron ore, lead, limestone, molybdenum, perlite, phosphate rock, platinum and palladium, pumice, rare earth metals, salt, sand and gravel, silver, sodium sulfate, stone, trona and uranium. By comparison, Russia produces the next largest number of mineral commodities (60), followed by China (53), Canada (49), India (46), South Africa (44), Germany (44) and Australia (42).

Mined Products from Your State, 2015

Alabama Coal, cement, stone, lime, sand and gravel, common clays, kyanite	**Alaska** Coal, zinc, gold, lead, silver, sand and gravel	**Arizona** Coal, copper, molybdenum, sand and gravel, cement, stone, silver	**Arkansas** Coal, bromine, stone, cement, sand and gravel, lime, gypsum	**California** Sand and gravel, cement, boron, stone, gold
Colorado Coal, molybdenum, sand and gravel, cement, gold, stone, uranium	**Connecticut** Stone, sand and gravel, common clays, gemstones	**Delaware** Stone, sand and gravel, magnesium, gemstones	**Florida** Phosphate rock, stone, cement, sand and gravel, zirconium	**Georgia** Clays (kaolin, fuller's earth), stone, cement, sand and gravel
Hawaii Stone, sand and gravel, gemstones	**Idaho** Phosphate rock, sand and gravel, silver, lead, stone	**Illinois** Coal, sand and gravel, stone, cement, tripoli	**Indiana** Coal, stone, cement, lime, sand and gravel	**Iowa** Stone, cement, sand and gravel, lime, gypsum
Kansas Coal, helium, cement, salt, stone, sand and gravel, gypsum	**Kentucky** Coal, stone, lime, cement, sand and gravel, common clays	**Louisiana** Coal, salt, sand and gravel, stone, lime	**Maine** Sand and gravel, cement, stone	**Maryland** Coal, cement, stone, sand and gravel
Massachusetts Stone, sand and gravel, lime, common clays	**Michigan** Iron ore, cement, nickel concentrates, stone, sand and gravel, salt, cobalt	**Minnesota** Iron ore, sand and gravel, stone, lime	**Mississippi** Coal, sand and gravel, stone, clays (fuller's earth, ball, bentonite)	**Missouri** Coal, cement, stone, lead, lime, sand and gravel

USGS; *state mineral offices; mining company websites*

Mined Products from Your State, 2015

State	Mined products
Montana	Coal, palladium, molybdenum, copper, platinum, gold
Nebraska	Cement, sand and gravel, stone, lime
Nevada	Gold, copper, silver, lime, diatomite, sand and gravel, stone, gypsum
New Hampshire	Sand and gravel, stone, gemstones
New Jersey	Stone, sand and gravel, greensand marl, peat
New Mexico	Coal, copper, potash, sand and gravel, cement, salt, molybdenum
New York	Salt, stone, sand and gravel, cement, wallastonite
North Carolina	Stone, phosphate rock, sand and gravel, feldspar
North Dakota	Coal, sand and gravel, stone, lime, common clays
Ohio	Coal, stone, salt, sand and gravel, lime, cement
Oklahoma	Coal, stone, cement, sand and gravel, helium, gypsum
Oregon	Stone, sand and gravel, cement, diatomite, perlite
Pennsylvania	Coal, stone, cement, lime, sand and gravel
Rhode Island	Sand and gravel, stone, gemstones
South Carolina	Cement, stone, sand and gravel
South Dakota	Gold, cement, sand and gravel, stone, lime
Tennessee	Coal, stone, zinc, cement, sand and gravel, clays
Texas	Coal, stone, sand and gravel, cement, salt, lime, gypsum
Utah	Coal, molybdenum, copper, magnesium metal, potash, salt, beryllium
Vermont	Stone, sand and gravel, talc, gemstones
Virginia	Coal, stone, cement, sand and gravel, lime, zirconium concentrates, kyanite
Washington	Sand and gravel, stone, gold, cement, zinc, diatomite
West Virginia	Coal, stone, cement, lime, sand and gravel
Wisconsin	Sand and gravel, stone, lime
Wyoming	Coal, soda ash, bentonite clays, uranium, helium, sand and gravel, cement, uranium

USGS; *state mineral offices; mining company websites*

Dragline controls at a Wyoming coal mine.

No matter what resource is being extracted, the process of modern mining is highly automated and technologically advanced. Today, sophisticated machinery is critical to mining.

For both coal and minerals, mining is usually accomplished by surface or underground mining techniques. The type of technique used depends on several factors, including resource type, location and the surrounding geology.

Other types of minerals mining include **quarrying**, a type of surface mining in which large blocks of rock are mined intact or the rock itself is the intended final product. Granite, limestone, marble and sandstone are often mined this way. **Placer mining** is used to recover precious materials, such as gold or platinum, from sand or gravel in streambeds. Sand and gravel are mixed with water and swirled or shaken so that the valuable heavy metals sink and the relatively lightweight sand stays on top to be washed away. Gold panning is a simple form of placer mining that is enjoyed by recreational miners.

Another method is the **Frasch process**, currently in use in sulfur mines in the Gulf of Mexico. In this process, hot water is injected into a native sulfur deposit that is melted underground and brought to the surface by compressed air.

U.S. Coal Production, 2005-2015

(million short tons)

Year	Total Coal Production
2005	1,131.5
2006	1,162.8
2007	1,146.6
2008	1,171.8
2009	1,074.9
2010	1,084.4
2011	1,095.6
2012	1,016.5
2013	984.8
2014	1,000.0
2015p	896.9

EIA, p = preliminary

Coal seams deeper than 200 feet below the surface are typically mined by underground methods. Deposits at a shallower depth are extracted by surface mining, which accounts for 65 percent of U.S. coal production.

Underground coal mining is usually one of four types:

Longwall – accounts for 55 percent of underground mine production. The longwall miner is a machine with a rotating drum that moves mechanically back and forth across a wide coal seam.

Continuous – also known as room and pillar mining, this method accounts for most of the remaining underground production. Utilizing a special cutting machine, coal is removed from a seam and automatically transported by conveyor to the mine mouth.

Conventional – one of the oldest, but increasingly less common, methods of mining coal uses explosives to break up a coal bed.

Shortwall – accounts for less than 1 percent of underground production. This method uses a continuous mining machine in a longwall-like method to mine smaller faces than are mined in longwall mining.

The preparation process is crucial in readying coal and minerals for the marketplace. This step assures that the resource sent to the end user is of the highest possible quality. In the case of coal, there is also an environmental benefit — physical coal cleaning can remove as much as 90 percent of the inorganic, or "pyritic," sulfur that could otherwise contribute to emissions during the combustion process.

Preparation plants crush and screen coal and employ a circuit of cleaning techniques to remove non-coal materials and separate the coal into different quality grades.

And for some minerals, including structural materials like sand and gravel, washing and separating for size is typically all that is involved.

For metallic ores, however, it is a different story. The number and complexity of steps in processing these ores is often directly related to the complexity of the ore itself and the degree of purity needed for the end product.

In order to separate the mineral from surrounding ore, the first step is typically to transport the ore to a **mill**, where the mineral is concentrated. The process begins by **crushing or grinding** the ore to the degree of fineness needed to extract the mineral material contained within. Then the mineral is physically separated by leaching (using a percolating liquid to remove soluble parts), flotation or solvent extraction.

Flotation is a chemical and physical process in which the ground ore is mixed with water and a foaming agent. The slurry is then agitated, much as if in a washing machine, and bubbles are created. The mineral material attaches to the bubbles and floats to the top to be skimmed off. This process makes it possible to access lower-grade mineral deposits that otherwise would not be utilized.

Solvent extraction-electrowinning (SX-EW) is a process that is used in copper production. The process uses electricity to extract the metal from a solvent solution and attach it to an cathode. SX-EW has increased in use since the mid-1980s partly because it can recover copper from lower grade ores that otherwise could not be processed.

For both coal and minerals, the processing step is referred to as **beneficiation** – the processing of coal and ores to regulate size, remove impurities and improve quality. Some minerals undergo further refinement, sometimes by a smelting process, to obtain the desired degree of purity. Once this level of purity has been achieved, the mineral is ready for commercial use, whether gold for electronics and jewelry, copper for plumbing or electrical wire, or one of many other potential end uses.

U.S. Per Capita Consumption of Minerals and Coal, 2015

Mineral	Pounds
Cement	638
Clays	152
Coal	4,988
Copper	12
Iron Ore	270
Lead	11
Phosphate Rock	194
Salt	477
Sand and Gravel	7,064
Stone	9,551
Zinc	7
Manganese	4
Uranium (2014)	0.25

NMA calculations based on preliminary USGS, EIA and U.S. Census Bureau data.

COAL and MINERAL USE

From A-to-Z, U.S. Coal and Mineral Resources and Their Uses *(abridged)*

Antimony
Batteries, cable sheaths, solder, fireworks, semiconductor technology, medicine.

Beryllium
Computers and telecommunications, aircraft alloys, fluorescent lamps, X-rays, nuclear industry.

Coal
The source of about 1/3rd of U.S. electricity generation.

Cobalt
Superalloys for jet engines, chemicals, permanent magnets.

Copper
Electric cables and wires, switches, plumbing, heating.

Feldspar
Glass and ceramics, enamelware, soaps, bonding agent.

Gold
Dentistry, medicine, jewelry, coins, scientific, electronic instruments.

Gypsum
Prefabricated wallboard, plaster, cement manufacture, agriculture.

Halite (salt)
Food seasoning and preservation, soda ash, soaps, highway de-icing.

Iron Ore
Steel manufacture, metallurgy by-products, auto parts, medicine.

Lead
Batteries, solders, electrical and electronic applications.

Lithium
Batteries, ceramics and glass, medicine, lubricants and greases.

Mica
Electronic insulators, paints, joint cement, dusting agent.

Molybdenum
Alloy and tool steels, cast irons, superalloys, chemicals and lubricants.

Phosphate Rock
Fertilizers, livestock feed additives, elemental phosphorus.

Perlite
Roof insulation boards, filters, filter aids, horticulture.

Platinum Group Metals
Catalytic converters, jewelry, electrical contacts, dental alloys.

Silica
Computer chips, glass and refractory materials, ceramics, abrasives.

Silver
Chemistry, jewelry, photography, currency, electronics, dental.

Sulfur
Sulfuric acid, fertilizers, chemicals, explosives, fungicides, dyestuff.

Titanium
Jet engines, airframes, space and missile applications.

Uranium
Electricity generation, medicine, atomic dating.

Vanadium
Metal alloys, aerospace, dyes, target material for X-rays.

Zinc
Protective coating for steel, die casting, component of brass.

COAL and MINERAL USE

Mining makes possible a wide range of necessary products that sustain our way of life. The products of mining are essential, not only to meet basic needs, but also for higher aspirations — a continuously improving standard of living, cleaner environment, and societal prosperity, security and stability. Here are just a few of the many ways coal and minerals benefit people every day.

Agriculture

Minerals are needed for our most basic requirement for life — food. Although most people recognize that magnesium, iron and zinc are important for healthy diets, they don't often connect minerals with productive farming. Fertilizers made from potash, phosphate rock and sulfur are essential to grow crops. Harvesting and transporting crops to market is achieved by machinery and transportation vehicles made from minerals. Processing food takes still more machinery and equipment, as does packaging.

Construction and Housing

Minerals are society's building blocks. Rocks and minerals are present in nearly every building and structure — skyscrapers, hospitals, bridges, factories, fast food restaurants and the house in which you live. Minerals are commonly used in gypsum wallboard; aluminum or galvanized steel gutters; copper or stainless steel pipes; copper wiring; concrete foundations; asphalt roof shingles; and windows made from glass (trona, silica, sand and feldspar).

Communications

The revolution in consumer technologies for communications and data have led to exciting new applications for minerals. Copper wiring, ceramic insulators, steel printing presses, gold connectors and silicon chips – all forms of communication, from newspapers to smart phones to satellites - require mineral components. A computer typically requires as many as 66 minerals, including silicon, boron, lead, indium, strontium, barium and phosphorous for the screen; calcium carbonate, talc, clays, sulfur and mica for the case; silicon for the chips; gold, copper, aluminium, steel, lithium, tungsten, chromium, titanium, silver, cobalt, nickel, germanium, tin, lead, tantalum and zinc for the circuitry; and cadmium and lithium for the battery.

Energy

Coal accounts for about a third of the nation's electricity generation. Over the past four decades, as the U.S. economy has become increasingly dependent on electricity to meet energy demand, coal use by electric utilities has nearly doubled. At the same time, air quality has improved with declines in coal power plant emissions of sulfur dioxide, nitrogen oxide and particulate matter, according to U.S. Environmental Protection Agency (EPA) data.

According to Energy Information Administration (EIA) data, coal-based power plants are expected to remain a key source of electricity. Meanwhile, another product of mining, uranium, provides an additional 20 percent of U.S. electricity generation through nuclear power plants. Combined, coal and nuclear plants are responsible for more than 50 percent of the nation's electricity.

Liquid fuels also can be produced from coal. The production of coal-to-liquid (CTL) transportation fuels begins with coal as a raw material or feedstock. The indirect liquefaction process is proven and already being used in other parts of the world. CTL can be a domestically sourced alternative to imported oil.

Medicine

Modern medicine relies on many drugs and tools made from minerals. Protection from X-rays is offered by a lead apron. Gold is used in lasers, pacemakers and medical diagnostic tools. Sulfur and salts are basic ingredients in many drugs and preparations; and copper, zinc, iron, magnesium and many other minerals are used in vitamins, mineral supplements and medicines.

Arts and Entertainment

Much in the field of art and entertainment would be impossible without the products of mining. Consider a concert hall — the instruments and building itself are made of many minerals; the electricity for powering the event is likely to have come from coal or uranium; and even the tickets for admittance to the event are likely to contain trona, limestone, gypsum, kaolin, sulfur, magnesium, sodium, calcium and more.

Manufacturing and Consumer Goods

The products of mining have a huge impact in this area, from cell phones, appliances and cookware to cosmetics, toothpaste and fireworks. Virtually

all consumer products contain natural resources from the earth, whether it's soapstone for powders, trona for glass or gold for electronic connectors. It would also be difficult, if not impossible, to find an industry that does not use some form of rock or mineral in manufacturing a product or providing a service. Even organic-based products frequently use rock or mineral-based materials. Kaolin clay, for instance, is used in coating paper, as well as in ceramics, paints, plastics, fiberglass, adhesives and rubber products.

What are strategic minerals?

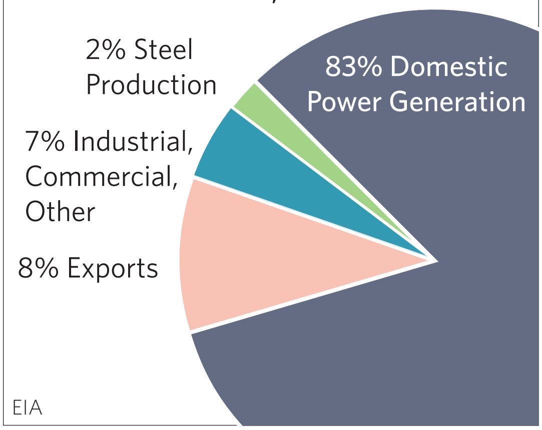
Strategic minerals are those considered essential for a country's economic and defense needs, such as metals for weapon systems, satellite communications, aircraft, automobile parts and medical instruments.

F-22 Raptor, U.S. Air Force photo

What is coking coal?

A bituminous coal, sometimes called metallurgical coal, with special characteristics that allows it to be converted into coke and used in the steel manufacturing process.

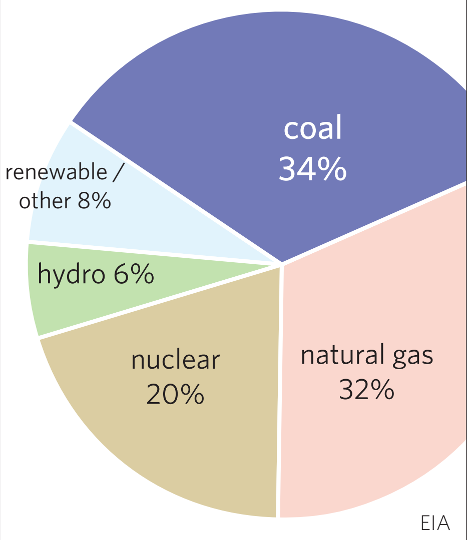
U.S. Coal End Uses, 2015



Coal is used in nearly every state, primarily to generate electricity. Today, many people don't actually see coal the way they did 100 years ago, when it was widely used to heat homes. But coal is working just as hard for America as it did in the past — only in a different way.

Of the coal mined in the United States, more than 90 percent is used to generate electricity at home and abroad. Coal consumption for electricity has more than doubled from less than 400 million tons annually in the early 1970s to about 800 million tons today. Coal is also used directly by industries and manufacturing plants, especially those making chemicals, cement, paper, ceramics and various metal products, to generate power and process steam. It is still an important source of coke for the steel industry, and coal byproducts serve as the basis for many day-to-day items, including linoleum, synthetic rubber and insulation and various compounds used in medications, detergents, perfumes and food preservatives.

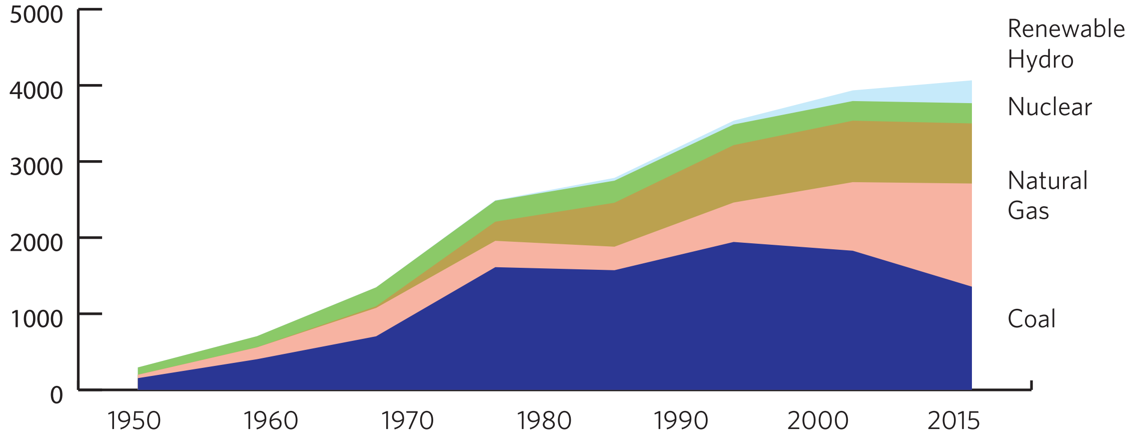
Power Sector Generation by Fuel, 2015 (billion kWh)



At conventional power plants, pulverized coal is burned to produce high-pressure steam that drives an electric generator. Some power plants are "mine mouth" facilities, constructed near one or more mines that provide a convenient source of coal. In general, each ton of coal used by a power plant generates about 2,000 kilowatt hours of electricity. A pound of coal supplies enough electricity to light more than 100 9-watt (40-watt equivalent) compact fluorescent light bulbs for about an hour. Every American uses an average of 14 pounds of coal daily.

Aside from its abundance, coal's low price in relation to competing energy sources is one of its major advantages as a fuel for electricity generation. EIA reports that coal averaged $2.22 per million Btu in 2015 — natural gas, on the other hand, averaged $3.22 per million Btu.

U.S. Electric Power Sector Net Generation, 1950-2015 (billion kWh)



Annual Mining Wages vs. All Industries, 2015			
	State	Mining*	All Industries**
1	Alaska	$108,199	$54,033
2	Hawaii	$96,585	$44,402
3	Nevada	$92,678	$44,528
4	N. Dakota	$87,069	$51,579
5	Wyoming	$86,906	$45,785
6	Montana	$84,794	$39,013
7	Colorado	$82,469	$54,512
8	Illinois	$81,956	$56,327
9	West Va.	$81,900	$40,927
10	Alabama	$81,020	$43,370
	All U.S.	$74,695	$52,874

*Excludes oil and gas extraction. **Average.
U.S. Bureau of Labor Statistics.

The mining workforce includes a broad range of professions — from geologists and engineers to accountants and equipment operators. In addition, thousands of men and women who may never see a mine make their living building the equipment used to extract coal and minerals from the ground.

Computerization, mechanization and technological innovations have had a tremendous effect on American industry and mining in recent years. Although mining is still a demanding and often challenging profession, today's mining personnel are highly skilled and well-trained in the use of modern, state-of-the-art instruments and equipment. This includes a level of sophistication that demands unprecedented skill, training and education. It is no surprise that as mining becomes increasingly high-tech, computer programmers and technicians are playing a greater role in mining's future.

These advances have significantly altered the overall size of the mining's workforce. In recent years, the trend has been toward fewer, more highly skilled mining personnel to operate sophisticated equipment that performs tasks once done by many laborers.

Mining Employment in the United States, 1985-2015

Sector	1985	1990	1995	2000	2005	2015
Metal	43,961	54,005	48,734	37,650	30,395	41,459
Non-metal	37,002	33,818	29,441	25,918	23,039	21,235
Coal	183,373	146,505	103,076	76,025	81,891	68,413
Sand/Gravel/Stone	121,877	121,214	115,924	127,614	126,245	99,767
Contractors	28,948	48,773	64,472	81,340	83,266	112,035
Total	415,161	404,315	361,647	348,547	344,836	342,909

MSHA. Includes workers in mines, processing plants, independent shops and yards, office workers.

MINING'S WORKFORCE

According to the Mine Safety and Health Administration (MSHA), in 2015, coal, metal, non-metal, stone, sand and gravel segments of the mining industry provided approximately 340,000 jobs.

Mining's average annual pay of more than $74,000 is among the highest wage in the U.S. private sector. Although mining accounts for less than one percent of private sector employment, it has held one of the top average annual pay positions every year since 1980, when the Bureau of Labor Statistics began publishing pay levels for industries.

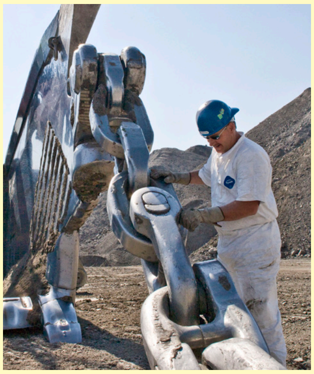
Mining operations are the leading employer in some parts of the country, particularly rural areas. As such, mining contributes substantially to the economic health of those communities.

Working conditions in mines are demanding, but there is no room for unsafe practices or conditions in today's mines. While one accident or fatality is one too many, the rates of all types of accidental injuries in the nation's mines steadily declined in recent decades.

Technological advances, improved engineering methods, advanced training and conscientious safety awareness by mine operators and equipment manufacturers have been principal factors in decreasing fatalities and injuries while simultaneously improving productivity. The mining industry's **CORE**Safety framework is a safety systems approach to mine safety and health designed to prevent accidents before they happen. The framework integrates leadership and culture into the industry management system. Mining has a rate of occupational injuries lower than many other sectors of the American economy.

fast fact

The mining industry will add more than 11,000 jobs per year over the next 20 years, according to the Society for Mining, Metallurgy and Exploration (SME)

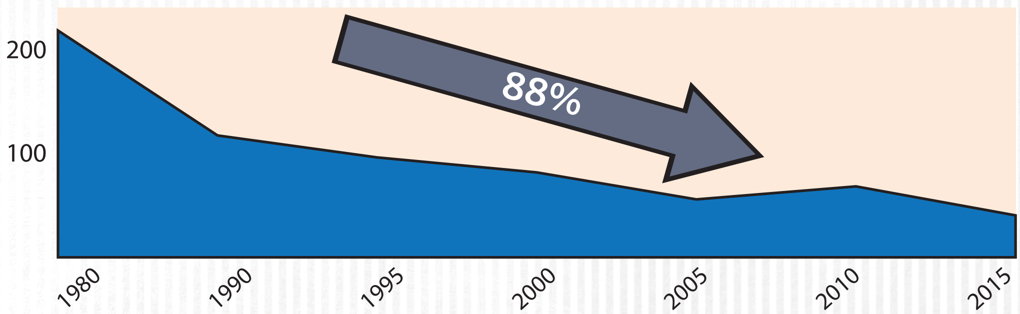


Coal Mine Productivity, 1980-2015 (Average Tons per Miner per Hour)

Year	Underground	Surface	All Mines
1980	1.21	3.27	1.93
1990	2.54	5.94	3.83
2000	4.15	11.01	6.99
2010	2.89	9.47	5.55
2015	3.45	10.95	6.28

Energy Information Administration

U.S. Mining Fatalities 1980 - 2015



Mine Safety and Health Administration

Restored coal mine land in Wyoming

U.S. mining companies are not only in the business of producing minerals and coal, but also protecting the environment. Millions of dollars are spent by mining companies each year to restore mined lands, protect air and water resources, provide habitat for wildlife and create wetlands for migratory waterfowl. Minerals also play an important role in providing products that help protect the environment.

Mining activity is subject to a broad range of state and federal laws and regulations, covering every aspect of exploration, mine development, operations, protection of wildlife and native vegetation, water quality and eventual land restoration. And in many individual cases, companies go significantly beyond what is required because they are committed to the highest level of environmental stewardship. In short, they set their own high standards.

Although activities vary by company, location and type of operation, a typical mining approach to environmental protection generally includes the following:

1. Strict compliance with local, state and federal requirements.

Major laws applicable to coal and mineral mining operations

Federal

- Surface Mining Control and Reclamation Act;
- National Environmental Policy Act;
- Clean Water Act;
- Safe Drinking Water Act;
- Clean Air Act;
- Resource Conservation and Recovery Act;
- Superfund and Toxics Release Inventory;
- Endangered Species Act;
- National Historic Preservation Act; and
- Federal Land Policy Management Act.

State

- State environmental policy acts;
- State surface water discharge permits;
- State ground water protection laws or regulations;
- Storm water permits;
- Construction permits for dams or impoundments;
- Air quality permits;
- Solid waste disposal;
- Water appropriation permits;
- Mine operating permits;
- Reclamation plan approvals or permits;
- Reclamation bonding; and
- Environmental performance bonding.

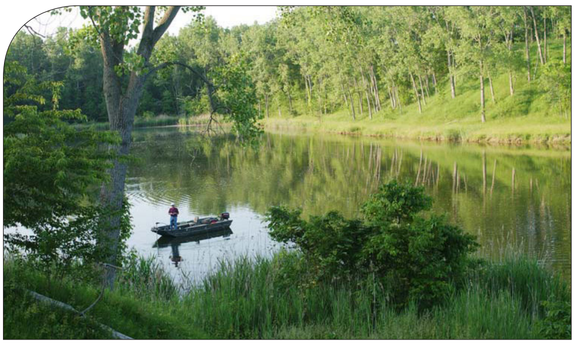
2. Minimizing the impact of actual mining operations on the surrounding environment.
3. Conducting restoration activities to restore air, land and water resources, and wildlife habitat to pre-mining or better conditions, with an eye toward long-term sustainability.
4. Fostering constructive dialogue and interaction with individuals and groups who have a positive interest in the company's environmental stewardship.
5. Ensuring protection of significant archaeological and historic resources.

Some major areas where environmental efforts are focused generally include:

Reclamation of Actively Mined Land — This means restoring land and environmental values at an operating or recently operated mining site, whether surface or underground, after the coal or minerals have been extracted. Restoration is as much a part of the modern mining process as the actual removal of the resource that will be processed into raw materials, products or energy. Detailed restoration plans must be approved by government officials and permitting agencies before mining begins, and activities are closely monitored by federal, state and local officials once underway. Mining companies must provide financial insurance, called "bonding," to guarantee that restoration will take place at surface mines. Without it, mines will not receive the necessary permits to begin operations. In general, restoration steps include the contouring of affected soil; the placement of topsoil or an approved substitute on the graded area; reseeding with native vegetation, crops and/or trees; and years of careful monitoring to assure success. Ultimately, restored sites are returned to many productive uses, including wildlife habitat, parks, wetlands, recreation areas and commercial development.

Abandoned Mine Lands (AML) — Although modern mining practices and federal and state regulatory programs preclude abandoning mines in an unsafe or unrestored condition, some lands that were mined in bygone eras were abandoned without adequate restoration. Since 1997, the mining industry has operated a major program to address some of the problems of the past. The Abandoned Mine Land Initiative, launched by the Western Governors' Association and the National Mining Association, is a voluntary effort focusing on reporting high-priority AML sites and identifying, measuring and reporting on the progress of current cleanup programs on an annual basis. Coal mining companies pay taxes into the Abandoned Mine Land fund, established by the 1977 Surface Mining Control and Reclamation Act. That money is used to reclaim old surface mines, restore stream beds, treat mine subsidence damage, cover refuse piles and prevent or control erosion from abandoned mine areas. Overall, U.S. mining is committed to addressing issues raised by abandoned mines by developing strategies to reclaim abandoned sites that have no identifiable owner and will not be cleaned up under a state or federal regulatory program.

Water Quality — Operations must, under law, meet standards for protecting surface and ground waters from contamination, including acid mine drainage. Typically, this involves mitigating any contaminated drainage, assuring that any discharges to surface waters meet legal standards and protecting wetlands. The five principal technologies used to control water flow at mine sites are diversion systems, containment ponds, groundwater pumping systems, subsurface drainage systems and subsurface barriers. The end result of these activities can be a radical improvement in downstream water quality, including rehabilitation or enhancement of public sport fisheries and increased viability of local



species habitats. Care is also taken to minimize erosion and excessive runoff where ground cover has been temporarily removed. Special flood control and sediment control, such as the construction of settling ponds, are utilized to prevent unnecessary damage. Where permitted, companies often take the extra step of creating new or enhancing existing wetlands, adding valuable habitat for waterfowl and other wildlife.

Air Quality — Mining causes little impact on air quality. Steps are taken by mining operations to suppress dust from haul roads, rock crushing, ore concentrating, and the removal, transport and storage of coal and minerals. Major expenditures have been made by mineral smelting and refining operations to control emissions, particularly of sulfur dioxide (SO_2). SO_2 also figures prominently as a concern in the use of coal, where it is a byproduct of combustion by power plants. However, while coal use by U.S. utilities increased from 320 million tons in 1970 to about 800 million tons at present, SO_2 emissions dropped from 15.8 million tons annually to 2.2 million tons in 2014, the most current year available. In addition, particulates from coal-fired plants declined some 80 percent over the same period, according to the U.S. Environmental Protection Agency (EPA).

Wildlife and Habitat Protection — While wildlife protection or mitigation plan is required by law for today's mines, many operations go well beyond the regulations to implement resource protection and habitat improvement programs. Reclamation and water quality procedures are often designed to provide food, shelter and an attractive environment for various native animal species. Many operations institute specific, targeted projects, including saving threatened amphibians; providing Bald Eagle nesting sites; reintroducing once threatened species, such as the peregrine falcon; and improving in-stream fish habitat and populations. For many companies, wildlife habitat restoration, creation or enhancement is seen as the primary beneficial post-mining land use.

Subsidence — Planned surface subsidence is usually gradual, but can sometimes be the abrupt settlement of rock and soil layers above an underground mine. Any surface subsidence must be anticipated and accounted for in the plans for a mining operation. In coal mining, modern procedures, such as longwall mining technology, provide mines with a more effective way of predicting and dealing with subsidence. With longwall mining, it is easier to anticipate when and where subsidence will occur (usually immediately after the mining operation is completed in a given location). This allows mine operators to carefully monitor changes in the surface and make repairs as needed, working cooperatively with owners of surface structures. Company subsidence programs also include attention to water resources, offering both temporary and permanent solutions to affected supplies.

Cultural Resources — The National Historic Preservation Act and various state laws require assessment and protection of archaeological and historic resources located on federal and state lands. Mining companies assess, protect and mitigate, where necessary, disturbances to these resources and often work with state, federal, archaeological, historic, Native American tribal and other organizations to catalogue, inventory or display artifacts and other items discovered during the extraction or reclamation process. Some companies erect interpretive signs and centers to make relics available for viewing by the general public.

A closer look at clean coal technologies

Because coal is one of America's most plentiful and readily available energy resource, research has been directed at finding ways to use coal in a more efficient, cost-effective and environmentally friendly manner. The mining industry joined with the U.S. Department of Energy in the Clean Coal Technology Program (CCTP), an industry-government partnership, which has successfully developed and deployed more efficient and cleaner technologies in the marketplace to satisfy America's need for electricity and a cleaner environment for years to come.

Advanced clean coal technologies can use coal more efficiently, with reduced emissions of sulfur and nitrogen oxides and carbon dioxide (CO_2), while also providing distinct advantages over conventional coal systems. Existing coal plants can often be retrofitted with these new technologies, and they can be used for new coal plants to reduce emissions to limits that may be required by new regulations.

Clean coal technologies typically fall into one of four categories: **pre-combustion** — the washing and sizing stage before coal is burned; **combustion** — where coal is combined with other substances in the boiler to improve efficiency and remove impurities; **post-combustion** — where "scrubbing," chemical cleaning, or use of precipitators remove sulfur, other impurities and particulate matter from emissions going up the flue; and **conversion** — where heat and pressure convert coal to a gas or liquid that can be further refined and utilized cleanly.

The CCTP has developed advanced pollution controls — such as **low nitrogen oxide (NO_x) burners** now deployed at more than 75 percent of U.S. coal power plants — that help utilities comply with more stringent Clean Air Act requirements. Other NO_x control technologies, such as Selective Catalytic Reduction, demonstrate even more impressive air quality improvement capability. As a result of advances pioneered in the program, an additional 70 percent NO_x emission reduction from 2000 levels was achieved in 2015 even though coal consumption increased, according to the EPA.

Similarly, the program redefined **flue gas desulfurization** (FGD) capabilities, bringing to the market more efficient and cost-effective scrubber technology.

Fluidized-bed combustion and **integrated gasification combined cycle** have entered the marketplace and offer even greater operating efficiency and air quality improvements. According to the Department of Energy, each percentage improvement in operating efficiency translates into a nearly equal percentage reduction in CO_2 emissions, a factor important in addressing climate change. In addition, great advances have been made in technologies that enhance the potential to capture, separate and store carbon. Coupled with higher efficiency power plants, **carbon capture and storage** technologies offer a way to achieve reductions in CO_2, while allowing full utilization of plentiful domestic coal resources.

Additionally, new coal combustion systems — using **supercritical and ultra-supercritical technologies** — operate at higher temperatures and pressures to achieve better efficiencies than conventional systems in addition to significant CO_2 reductions. **Supercritical steam cycle technology** is currently commercially available and in use in several countries. **Ultra-supercritical** units operating at even higher efficiencies are currently being studied and new steel alloys developed to withstand the increased pressure and to resist corrosion.

TRANSPORTATION

Coal and minerals usually get from mine to market in one of three ways — by rail, truck or water transportation. Coal can also be shipped by way of conveyor to "mine mouth" power plants located nearby. In all cases, a modern, reliable and economic transportation infrastructure is an important factor in the overall cost and competitiveness of domestically mined products.

Mined products represent nearly three out of every five tons of revenue freight carried by railroads and approximately one-half of all commodity tonnage handled by barge lines operating on the nation's inland waterways. Coal shipments alone account for 17 percent of total freight revenue and nearly 40 percent of total freight tonnage transported by Class I railroads. When it comes to barges, 17 percent of coal is moved via our inland waterways.

While some mining commodities are shipped intramodally (using a single form of transport between mine and destination), others are moved intermodally (by different types of carriers). For example, a coal shipment might be hauled a shorter distance via truck to a loading terminal, then placed aboard barges or rail hopper cars for the longer trip to a power plant. For many mining products, trucks (and, in the case of coal, also conveyor systems) commonly provide relatively short-haul transportation to railroad tipples and barge terminals. However, rail carriers also originate many shipments and link with barge lines, Great Lakes carriers and dry-bulk oceangoing vessels to complete shipments to domestic and export customers.

Railroads

Mining products carried by rail typically include coal, crushed stone, sand and gravel, metallic ores, metals and non-metallic minerals. In 2015, these mining commodities accounted for about a third of total rail commodity carloadings in the United States, according to Association of American Railroad (AAR) data.

As a single commodity, coal has been a significant annual user of rail transportation. According to AAR, more than 630 million tons of coal were shipped domestically by rail in 2015. Unit trains, large groupings of rail cars assigned to a specific, non-stop route between a mine and power plant, account for more than half of railroad coal shipments. Because the entire train is dedicated exclusively to moving coal in railcars carrying 100 to 125 tons each, economical, high volume shipments are possible.

Among other major mining commodities hauled by rail, 2015 totals included: 160 million tons of non-metallic minerals, 46 million tons of metals and products, 43 million tons of stone, clay and glass products, and 59 million tons of metallic ores.

Because mining products represent such an important segment of railroad business, there has been much focus over the past three decades on improving rail efficiency and capacity. In addition to increasing car capacity, many railroads are now using more fuel-efficient alternating current locomotives instead of older direct current models. As with mining, railroads have embraced information technologies, such as electronic data interchange (EDI) to improve efficiency. EDI permits shippers to communicate commodity-specific information to customers, track shipments while in transit and dispatch time-sensitive information, such as bills of lading, invoices and payment for rail car services.

TRANSPORTATION

Waterborne Transport

Waterborne transportation modes, such as inland waterways, the Great Lakes, coastal shipments and ocean freight, are also vital components in moving coal and minerals to market.

Among major U.S. waterborne commodities, coal and coke shipments totaled 292 million tons in 2014, ranking it as the largest, according to U.S. Army Corps of Engineers' data. Other major mining products, including sand, gravel, iron ore, other ores and metal products, also registered significant tonnage totals.

Coal, limestone and iron ore are the major commodities shipped on the Great Lakes. Mining commodities like cement, salt and sand are among other dry bulk cargoes with significant tonnage totals. The largest ships on the Great Lakes can carry more than 70,000 tons of cargo.

2015 Great Lakes Coal and Mineral Shipments (net tons)	
Iron Ore	40,864,953
Coal	17,654,314
Limestone	23,142,584

Lake Carriers' Association

As with rail lines, inland barge lines have increased their efficiency in recent years. Modern 1,500-ton capacity barges are in service on waterways with shipping channels that allow the use of larger units, including the Ohio and Mississippi rivers and some of their tributaries, replacing older 1,000-ton capacity barges. The 1,500-ton capacity barges carry the equivalent of 15 train cars or as many as 60 semi trucks. The average towboat on the Upper Mississippi River pushes 15 of these barges — five barges deep and three abreast. That's the equivalent of a train three miles long or a line of trucks stretching more than 35 miles.

In addition, barge lines make broad use of modern communications and command and control technology for assuring fleets are scheduled in a manner that minimizes the movement of empty barges and optimizes the number of loaded barges handled by individual towboats.

Truck Transportation

Trucks are essential to U.S. mining, whether hauling ore-laden rock from a mine to processing facility or taking a shipment of coal short distances to local power plants or trans-shipment terminals. In coal mining, trucks carry more than 80 million tons annually directly to electric generating facilities and another 15 million tons or more to other consuming sectors.

Trucks generally hold 20 to 35 tons of coal per shipment in single unit and combined tractor trailer types of on-road vehicles. The maximum load a truck can carry on highways is regulated by state laws. Special haul trucks that remain on mine property can be of enormous size, sometimes holding more than 400 tons of material.

TRANSPORTATION

In recent years, advances have also been made in highway trucking operations for movement of mining products. Aluminum truck bodies are being used, allowing higher payloads through reduced empty weights of the trucks, and more powerful truck engines expedite truck shipments.

Newer technologies in transporting ore from the mine to the processing location by truck include trolly-assist systems for steep grade transport, GPS monitoring systems for movement control and remote-control truck operation.

Other Shipping Methods

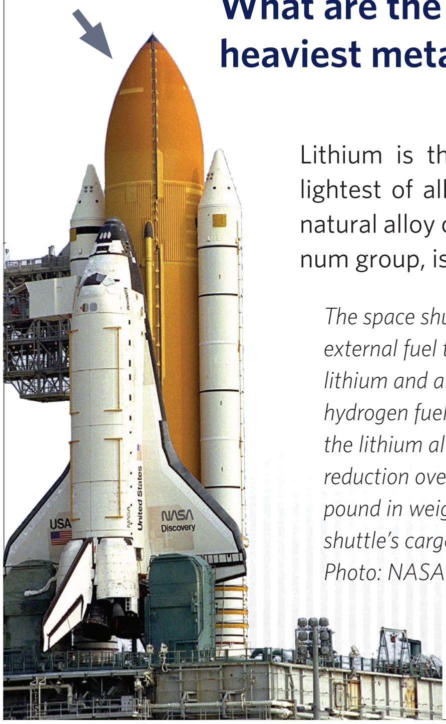
Conveyors and pipelines are two additional transportation methods employed in mining. Versatile conveyor systems and aerial tramways are normally used to move coal or mineral ore from production sites to storage and transportation facilities, processing plants or nearby power plants. Tramways usually cover relatively short distances, while conveyors can be several miles long.

The average car contains:

- 2,000 lbs. iron & steel
- 300 lbs. aluminum
- 50 lbs. carbon
- 40 lbs. copper, (75 lbs. for a hybrid)
- 40 lbs. silicon
- 24 lbs. lead
- 22 lbs. zinc
- 17 lbs. manganese
- 15 lbs. chromium
- 9 lbs. nickel
- 4.5 lbs. magnesium
- 2 lbs. sulfur
- 1 lb. molybdenum
- and smaller amounts of vanadium, platinum, antimony, barium, beryllium, cobalt, gallium, gold, neodymium, indium, palladium, rhodium, silver, strontium, tin, titanium, tungsten and zirconium

USGS, NMA, SME

What are the lightest and the heaviest metal minerals?



Lithium is the lightest metal and third lightest of all elements. Platiniridium, a natural alloy of two members of the platinum group, is the heaviest.

The space shuttle's super lightweight external fuel tank was made from an alloy of lithium and aluminum. It provided the liquid hydrogen fuel required for liftoff. The use of the lithium alloy provided a 7,000 lb. weight reduction over previous tanks, and each pound in weight increased the shuttle's cargo capacity by nearly a pound. Photo: NASA

fast fact

The Institute for Defense Analysis estimates that roughly 750,000 tons of minerals are required annually to maintain our national defense.

EXPORTS and TRADE

Exporting U.S. mining products has a significant positive impact on the nation's balance of trade. In 2015, U.S. exports of raw and processed mineral materials totaled an estimated $108 billion, according to the USGS. American coal exports for 2015 were 74 million tons, valued at about $6 billion. In addition, the United States is a significant exporter of mining machinery and equipment and has pioneered the development and commercialization of clean coal technologies, for which a growing overseas market is possible in the near future.

Among major minerals, the U.S. is a leading world producer of beryllium, diatomite, gold, helium and soda ash (trona) and coal. The most significant exported U.S. mineral commodities include iron ore, soda ash, copper, gold, zinc, titanium and cement.

Despite the United States' abundant mineral supply, in recent years, the U.S. has increasingly relied on imports to meet its needs for some minerals, particularly strategic and critical minerals. The U.S. share of worldwide investment in minerals mining has declined over the last 20 years due to a time consuming and highly inefficient permitting system. According to USGS data, strategic mineral commodities, for which the U.S. imported more than half of its supply in 2015, included titanium, silver, zinc, barite, platinum and others (see table, page 32). Many of these strategic and critical minerals are crucial for manufacturing jet aircraft, satellites, communications equipment and other items vital for national security. In recent years, America's import reliance on processed mineral materials has risen to more than $131 billion annually, according to USGS.

U.S. coal is exported to more than 40 nations. Major markets for American coal include the United Kingdom, the Netherlands, Brazil, South Korea, China and Canada. The U.S. exports both steam coal for generating electricity and metallurgical coal used in the steel-making process. Metallurgical coal comprised about 62 percent of U.S. coal exports in 2015, with steam coal making up the remainder.

fast fact

The U.S. is rich in many of the minerals it requires and is a major exporter of some commodities, including iron ore, soda ash, copper and cement.

Exports of Selected Mineral Commodities and Coal, 2011-2015 (Metric Tons)

Commodity	2011	2012	2013	2014	2015e
Coal*	107,259,000	125,746,000	117,659,000	97,257,000	73,958,000
Iron Ore	11,100,000	11,200,000	11,000,000	12,100,000	8,100,000
Soda Ash (Trona)	5,470,000	6,110,000	6,470,000	6,670,000	6,700,000
Copper	252,000	301,000	348,000	410,000	380,000
Zinc	653,000	591,000	669,000	644,000	740,000
Cement	1,414,000	1,749,000	1,670,000	1,397,000	1,300,000
Lead	223,000	214,000	210,000	356,000	350,000
Lime	231,000	212,000	270,000	319,000	300,000

Figures are rounded. * short tons
e = estimated. Source: U.S. Geological Survey, Mineral Commodity Summaries 2016; Energy Information Administration.

The United States tends to be a "swing" supplier in overseas steam coal markets, increasing shipments when other lower-cost competing exporting nations (primarily Colombia, South Africa, Australia, Indonesia and China) cannot meet demand.

Mining Equipment Exports

As the globalization of mining has increased, the opening or expanding of mines in overseas locations has created more opportunities for marketing U.S. mining equipment in foreign countries. According to 2014 analysis by Freedonia Group, growth in industrializing countries like China and India is creating a global mining machinery market valued at more than $100 billion.

According to U.S. government data, more than $5 billion worth of U.S. mining and minerals processing equipment was shipped to overseas destinations in 2014. In addition, another $33.2 billion of construction machinery, including surface mining equipment, was shipped to foreign destinations in 2014. The table below shows the types of products mining machinery equipment suppliers shipped in 2014 (data latest available).

Shipments of Mining and Construction Machinery

Product	Value (million $)
Mining and Mineral Processing Equipment — 2014	**$5,058.0**
Underground mining machinery (except parts)	$2,212.0
Mineral Processing and benefication machinery (except parts sold seperately)	$152.3
Crushing, pulverizing and screening (except parts sold seperately)	$735.9
Drills and other mining machinery (except parts)	$289.8
Parts and attachments for mining machinery and equipment (sold seperately)	$1,487.2
Mining machinery and equipment, not specified by kind, total	$180.8
Construction Machinery — 2014	**$33,241.8**
Power cranes, excavation loaders, dozers, tractors, trucks, trailers, mixers, etc.	$25,575.3
Other construction machinery and equipment (excluding parts)	$4,219.0
Parts for construction machinery and equipment, sold seperately	$2,827.4
Construction machinery, not specified by kind, total	$620.1

Department of Commerce, Bureau of the Census. Data latest available.

EXPORTS and TRADE

Selected U.S. Mineral Materials Ranked by Net Import Reliance, 2015

Commodity	Percent	Major Sources
Arsenic	100	Morocco, China, Belgium
Asbestos	100	Brazil, Canada
Bauxite	100	Jamaica, Guinea, Brazil, Guyana
Cesium	100	Canada
Fluorspar	100	Mexico, China, South Africa, Mongolia
Gallium	100	Germany, China, United Kingdom, Ukraine
Graphite (Natural)	100	China, Mexico, Canada, Brazil
Indium	100	Canada, China, Belgium, Republic of Korea
Manganese	100	South Africa, Gabon, Australia, Georgia
Mica, Sheet (Natural)	100	India, Brazil, China, Belgium
Niobium (Columbium)	100	Brazil, Canada
Quartz Crystal (Industrial)	100	China, Japan, Romania, United Kingdom
Rubidium	100	Canada
Scandium	100	China
Strontium	100	Mexico, Germany, China
Tantalum	100	China, Germany, Indonesia, Kazakhstan
Thallium	100	Germany, Russia
Thorium	100	India, France
Vanadium	100	Czech Republic, Canada, Rep. of Korea, Austria
Gemstones	99	China, Belgium, Peru, United Kingdom
Bismuth	95	Germany, United Kingdom, China, Canada
Titanium Mineral Concentrates	91	South Africa, Australia, Canada, Mozambique
Platinum	90	South Africa, Germany, United Kingdom, Canada
Garnet (Industrial)	88	Australia, India, China
Germanium	85	China, Belgium, Russia, Canada
Antimony	84	China, Bolivia, Belgium, Thailand
Diamond (Dust, Grit, Powder)	84	China, Ireland, Romania, Republic of Korea
Potash	84	Canada, Russia, Israel, Chile
Stone (Dimension)	83	China, Brazil, Italy, Turkey
Zinc	82	Canada, Mexico, Peru, Australia
Rhenium	79	Chile, Poland, Germany
Silicon Carbide (Crude)	77	China, South Africa, Netherlands, Romania
Rare Earths	76	China, Estonia, France, Japan
Cobalt	75	China, Norway, Finland, Russia
Tin	75	Peru, Indonesia, Bolivia, Malaysia
Silver	72	Mexico, Canada, Poland, Peru
Barite	70	China, India, Morocco, Mexico
Peat	69	Canada
Titanium (Sponge)	68	Japan, Kazakhstan, China
Chromium	66	South Africa, Kazakhstan, Russia
Palladium	58	Russia, South Africa, United Kingdom, Switzerland
Tungsten	49	China, Bolivia, Canada, Germany
Magnesium Compounds	43	China, Brazil, Canada, Austria
Aluminum	40	Canada, Russia, United Arab Emirates
Gold 1/	40	Mexico, Canada, Colombia, Peru
Mica, Scrap and Flake (Natural)	39	Canada, China, Finland, India
Silicon	38	Russia, Brazil, China, Canada
Nickel	37	Canada, Australia, Russia, Norway
Copper	36	Chile, Canada, Mexico

1/ - 2011 data

GLOSSARY

aggregate: Uncrushed or crushed gravel, crushed stone or rock, sand or artificially produced inorganic materials that form the major part of concrete.

alloy: A substance with metallic qualities that is composed of two or more chemical elements, of which at least one is an elemental metal.

anthracite: See "ranks of coal."

assayer: One who analyzes ores and alloys, especially bullion, to determine the value and properties of precious metals.

auger mining: A form of underground coal mining that uses an auger, which looks like a large carpenter's wood drill. The auger bores into a coal seam and discharges coal out of the spiral onto a waiting conveyor belt. When mining is finished, the openings are backfilled. This method is usually employed to recover any additional coal left in deep overburden areas that cannot be reached economically by contour or area mining.

backfill: Refilling an area where overburden has been removed. May also refer to the material used to refill an excavation.

base metals: Any of the non-precious metals — copper, lead and zinc — are usually considered the primary base metals, but tin, aluminum and magnesium are also among those important to modern society.

bedrock: Any solid rock exposed at the surface of the earth or overlain by unconsolidated material.

bioleaching: Addition of naturally occurring bacteria to extract or remove a soluble substance from ore.

bituminous coal: See "ranks of coal."

blasting: The operation of breaking coal, ore or rock by boring a hole in it, inserting an explosive charge, and detonating or firing it. Also called shot firing.

bond: As a prerequisite for obtaining a mining permit, companies must post a reclamation bond to ensure that the regulatory authority will have sufficient funds to reclaim the site in the event the company fails to complete the reclamation plan approved in the permit.

Btu: British thermal unit. This is a measure of the energy required to raise the temperature of one pound of water one degree Fahrenheit. On average, coal contains about 22 million Btu per ton.

bullion: Mixture of gold and silver in cast bars. Also called dore.

cage: An elevator used to carry people and materials up and down a mine shaft. Cages may be single or multidecked. Often there are two cages in simultaneous operation in separate areas of the shaft, traveling in opposite directions.

captive mine: A mine whose coal is used largely or totally by its owners or a subsidiary operation.

clean coal technologies: A number of innovative technologies designed to use coal in a more efficient and cost-effective manner while enhancing environmental protection. These include processes applied before, during and after combustion, and also involve those that change coal into a gas or liquid.

coal resources: Total coal deposits, both identified and undiscovered. The World Energy Conference estimated there may be as much as 14 trillion short tons of coal worldwide; the United States is estimated to have 4 trillion tons of coal resources by the USGS.

coal seam: A bed or stratum of coal. Usually applies to a large deposit.

coke: A hard, dry carbon substance produced by heating coal to a very high temperature in the absence of air. Coke is used in the manufacture of iron and steel.

concentrate: The result of separating ore or metal from its containing rock or earth.

continuous mining: Underground mining in which the continuous mining machine cuts coal from the face (see "face") and loads it onto conveyors or into shuttle cars in a continuous operation. Often these machines are highly automated and can be operated by remote control. Accounts for about 45 percent of U.S. underground coal production.

conventional mining: A deep mining method that includes inserting explosives in a coal seam, blasting the seam and removing the coal onto a conveyor or shuttle car. Accounts for less than 5 percent of total underground coal production.

core: The sample of rock obtained through the use of a hollow drilling bit, which cuts and retains a section of the rock penetrated, usually to determine the interior composition or the hidden condition.

deep mine: An underground mine.

demonstrated reserves: Coal deposits that are potentially minable on an economic basis with existing technology. The U.S. has an estimated 481 billion tons of demonstrated reserves.

deposit: A natural occurrence or accumulation of mineral material, coal, iron ore, oil or gas.

dragline: A large excavating machine used in the surface mining process to remove overburden (see "overburden"). The dragline has a large bucket suspended from the end of a huge boom, which may be 275 feet long or larger. The bucket is suspended by cables and capable of scooping up huge amounts of overburden as it is dragged across the excavation area. The dragline, which can "walk" on huge pontoon-like "feet," is one of the largest land-based machines in the world.

drift mine: A coal mine entered directly through a horizontal opening drilled into the side of a hill or mountain. This mining method is used in hilly or mountainous areas.

electrostatic precipitator: An electrical device used in removing particles (see "fly ash") from combustion gases prior to release from a power plant's stack.

excavator: A large number of power-operated digging and loading machines, used increasingly in open-pit mining and quarrying.

exploration: The search for coal, mineral or ore by geological surveys, prospecting, GPS or satellite location, or use of tunnels, drifts or boreholes.

face: The exposed area of a coalbed from which coal is extracted.

flotation: Separating minerals from other materials by floating away materials of lower specific gravity, while heavier materials sink.

fluidized-bed combustion: A clean coal technology process to remove sulfur from coal combustion, as well as limit the formation of nitrogen oxides. The process involves suspending crushed coal and limestone in the bottom of a boiler by an upward stream of hot air. While the coal is burned in this liquid-like mixture, sulfur from combustion gases combines with the limestone to form a solid compound recovered with the ash.

fly ash: The finely divided particles of ash entrained in gases resulting from the combustion of fuel. At coal-fired power plants, fly ash is captured by special equipment, usually either electrostatic precipitators or baghouses. Fly ash and other forms of coal ash are useful by-products — about 25 million tons are used each year in major concrete engineering projects, such as highway construction.

formation: Any rock unit conspicuously different from adjacent rock units.

fossil fuel: Fuel such as coal, crude oil or natural gas, formed from the fossil remains of organic material.

Frasch sulfur deposit: Native sulfur mined by the Frasch hot water process, in which superheated water is forced into the sulfur deposit for the purpose of melting the sulfur. The molten sulfur is then pumped to the surface.

gasification: Any of various processes by which coal is turned into low, medium or high-Btu gas.

General Mining Law: The primary statute that governs the right to mine locatable minerals on unappropriated public domain lands. Though enacted in 1872, it has been amended many times.

grade: 1. The classification of an ore according to the desired material in it or according to value. 2. In surveying, the gradient of a traveling way, sluice, slope, etc.

hardrock minerals: Locatable minerals that are neither leasable minerals (coal, oil, phosphate, etc.) nor saleable mineral materials (sand and gravel, etc.). Hardrock minerals include copper, lead, zinc, magnesium, nickel, tungsten, gold, silver, bentonite, barite, feldspar, fluorspar and uranium.

haulageway: The main transportation tunnel for deep mines in which rail tracks have been laid for mine cars.

highwall: Unexcavated face of exposed overburden and coal in a surface mine or in a face or bank on the uphill side of a contour mine excavation.

hopper cars: Open freight cars with a floor sloping to one or more hinged doors for discharging bulk materials.

***in situ* gasification:** The gasification of underground coal deposits through partial combustion.

jumbo drill rig: A drill carriage on which several drills of drifter type are mounted. Drills are cutting tools designed to form a circular hole in rock, metal, wood or other material. In mining, drills are used for exploration core drilling, holes for explosives, etc.

leaching: The action of percolating liquid through ore to remove the soluble parts.

lignite: See "ranks of coal."

liquefaction: The process of converting coal into a synthetic liquid fuel, similar in nature to crude oil and/or refined products, such as gasoline.

locatable minerals: Those minerals – primarily metallics – that can be claimed and mined on public lands under the General Mining Law; these do not include minerals such as coal, oil, phosphate sodium, sulfur, or sand and gravel.

lode deposit: An ore deposit, usually referring to a vein or veins of ore that can be mined as a unit. Can also refer to a tabular deposit of a valuable mineral confined within definite boundaries.

longwall miner: A deep mining machine that uses a steel plow or rotating drum that is pulled mechanically back-and-forth across a long face of coal. The loosened coal falls onto a conveyor for removal from the mine. Longwall mining is highly productive and accounts for about 50 percent of total U.S. underground coal production.

man car: A vehicle used to transport miners to the working sections of a deep mine.

metallic minerals: Minerals with a high specific gravity and metallic luster, such as gold, silver, copper, titanium, rutile, tungsten, uranium, tin, lead, iron, etc. In general, the metallic minerals are good conductors of heat and electricity.

metallurgical coal: Various grades of coal suitable for carbonization to make coke for steel manufacture.

methane: A gas formed naturally from the decay of vegetative matter, similar to that which formed coal. The principal component of natural gas, methane is frequently encountered in underground coal mining operations and is kept within safe limits through the use of extensive mine ventilation systems. In recent years, coalbed methane has been recognized as an important energy resource, and its production for this purpose has increased.

mine mouth power plant: A steam-electric power plant built close to a coal mine. Because of this proximity, the coal is often delivered to the plant by tramway or covered conveyor.

minerals: Scientifically, a naturally formed inorganic solid (element or chemical compound) with a limited range in chemical composition and with an orderly internal atomic arrangement that determines crystalline structure and physical properties. Legally, an organic or inorganic substance occurring naturally, with characteristics and economic uses that bring it within the purview of mineral laws; a substance that may be obtained under the applicable laws from public lands by purchase, lease or claim.

mining claim: That portion of the public mineral lands that a person may claim for mining purposes in accordance with the General Mining Law, as amended. There are four types of mining claims: lode, placer, millsites and tunnel sites.

Mohs' hardness scale: Quantitative units by which the scratch hardness of a mineral is determined. The units of hardness are expressed in numbers ranging from 1 (talc) to 10 (diamond).

mountaintop mining: A method of surface mining practiced in the Appalachian coal fields of the eastern United States. Mountaintop mining allows the mine operator to remove layers of dirt and rock covering a coal seam, making the entire deposit economical and safer for extraction. Valley fills — a critical component of mountaintop mining are carefully constructed to ensure the safe deposit of rock and dirt from the surface mine into adjacent valleys. Valley fills are not unique to mining. Hundreds of valley fills were constructed throughout the country during the building of the Interstate Highway System.

multiple use: The standard for federally managed land. A combination of balanced and diverse resource uses that takes into account the long-term needs of future generations for renewable and non-renewable resources, including recreation, range, timber, minerals, watershed, and wildlife, along with natural scenic, scientific and historical values.

non-metallic minerals: Minerals (carbon, diamond, coals, bitumen, asphalt, boron, sulfur, rock salt, etc.) that lack the properties of the metallic minerals.

non-renewable resources: Resources that are not replaced or regenerated naturally within a reasonable period of time, such as fossil fuels or minerals.

open pit: A mine or excavation open to the surface. Refers primarily to mines of metal ores; distinguished from coal surface mines.

ore: Rock that contains important minerals, including metals.

outcrop: Coal that appears at or near the surface.

overburden: Layers of earth and rock covering a coal seam or mineral deposit.

patent: A government deed; a document that conveys legal title to public lands to the patentee.

placer deposit: An alluvial marine or glacial deposit resulting from the crumbling and erosion of solid rocks, and often containing valuable minerals.

portal: Any entrance to a mine.

preparation plant: A facility, usually located on a mine site, that crushes, sizes and washes coal prior to shipment.

ranks of coal: The classification of coal by degree of hardness, moisture and heat content. The major ranks, from lowest to highest quality, are lignite, subbituminous, bituminous and anthracite. For more information, see the "Resources" chapter.

reclamation: The restoration of land and environmental values to a mining site. Reclamation operations are sometimes started where the coal or mineral has already been taken from a mine, even as production operations are taking place elsewhere at the site. This process commonly includes recontouring or reshaping the land to its approximate original appearance, restoring topsoil and planting native grasses, trees and ground covers. Mining reclamation is closely regulated by both state and federal law.

recoverable reserves: The amount of coal that can be recovered from the Demonstrated Reserve Base. The recovery factor for underground coal mines is about 60 percent and for surface mines about 80-90 percent.

reserves: Known identified resources from which a usable mineral commodity can be technologically, economically and legally extracted at the time of determination.

resources: A broad term for discovered or still undiscovered concentrations of minerals in such form that a usable commodity can be extracted now or in the future.

GLOSSARY

roof bolting: A method of supporting the ceilings of underground mines by inserting long steel bolts into holes bored into the strata forming the roof.

rotary drill: A drill machine that rotates a rigid, tubular string of rods to which is attached a bit for cutting rock to produce boreholes.

scrubber: Any of several forms of chemical/physical devices that remove sulfur compounds formed during coal combustion. Technically known as flue gas desulfurization systems, they combine the sulfur in gaseous emissions with another chemical medium to form an inert sludge.

shaft: A narrow, deep excavation used for finding or mining ore or coal. The term is often applied to vertical shafts, as distinguished from a decline or inclined shaft.

shortwall: A deep mining method in which small areas are worked by a continuous miner in conjunction with longwall-like hydraulic roof supports. Accounts for less than one percent of total underground coal production.

shuttle car: A self-discharging truck, usually with rubber tires or caterpillar-type treads, used for receiving coal or ore from the loading or mining machine and transferring it to an underground crusher loading point, mine railway or belt conveyor system.

slurry pipeline: A pipeline similar to that used by the petroleum and natural gas industries, designed for transporting pulverized coal in a liquid medium. Water is usually used, although research is focusing on other compounds, such as oil, liquid methane and carbon dioxide.

slope mine: A mine with an opening that slopes upward or downward to the seam. It must also have adjoining vertical shafts for air ventilation and emergency use.

smelter: A furnace in which the raw materials are melted, and metals are separated from impurities.

steam coal: Coal used by electric power plants and industrial steam boilers to produce electricity.

stope: An excavation from which ore has been removed in a series of steps.

strategic minerals: Those minerals considered essential for a country's economic and defense needs, such as metals for defense weapons, satellite communications, automobile parts and medical instruments.

subbituminous coal: See "ranks of coal."

surface mine: A mine in which the coal lies near the surface and can be extracted by removing the covering layer of overburden. About 66 percent of total U.S. coal production comes from surface mines.

tailings: The waste material left after hardrock mining and milling processes have been completed.

tipple: A surface processing structure for cleaning and sizing coal and automatically loading it onto rail cars or trucks for movement to market.

tunnel: A horizontal underground passage that opens to the surface at both ends.

turbine: A machine in which rotating vanes are driven by a steam generator to produce electricity.

underground mine: Also known as a deep mine. Usually located several hundred feet below the earth's surface, an underground mine's coal is removed mechanically and transferred by shuttle car or conveyor to the surface. Most underground mines are located east of the Mississippi River and account for about 34 percent of total annual U.S. coal production.

unit train: A long train of between 60 and 150 or more hopper cars, carrying only coal between a single mine and destination. A typical unit train can carry at least 10,000 tons of coal in a single shipment.

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