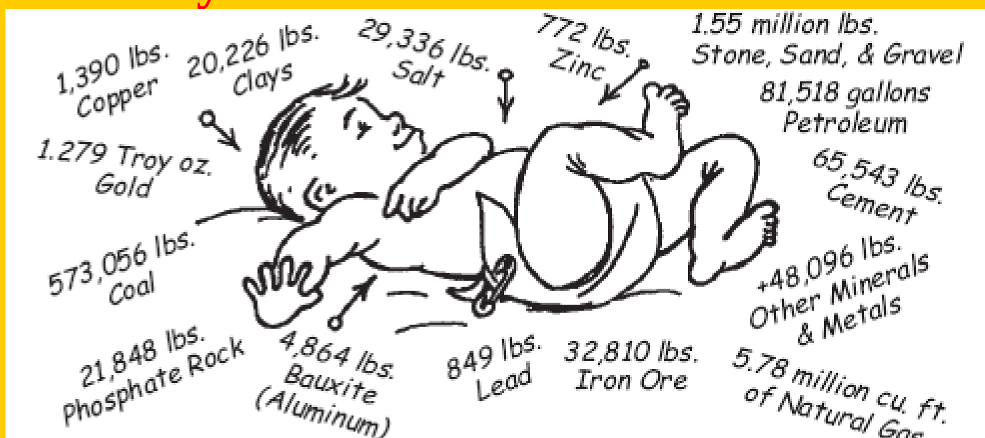
MINING AND MINERAL RESOURCES

Every American Born Will Need . . .



3.5 million pounds of minerals, metals, and fuels in a lifetime

PREPARED FOR

SOUTH CAROLINA STUDIES

8th GRADE CURRICULUM SUPPLEMENT

Unit 5 – Resources of the Coastal Plain

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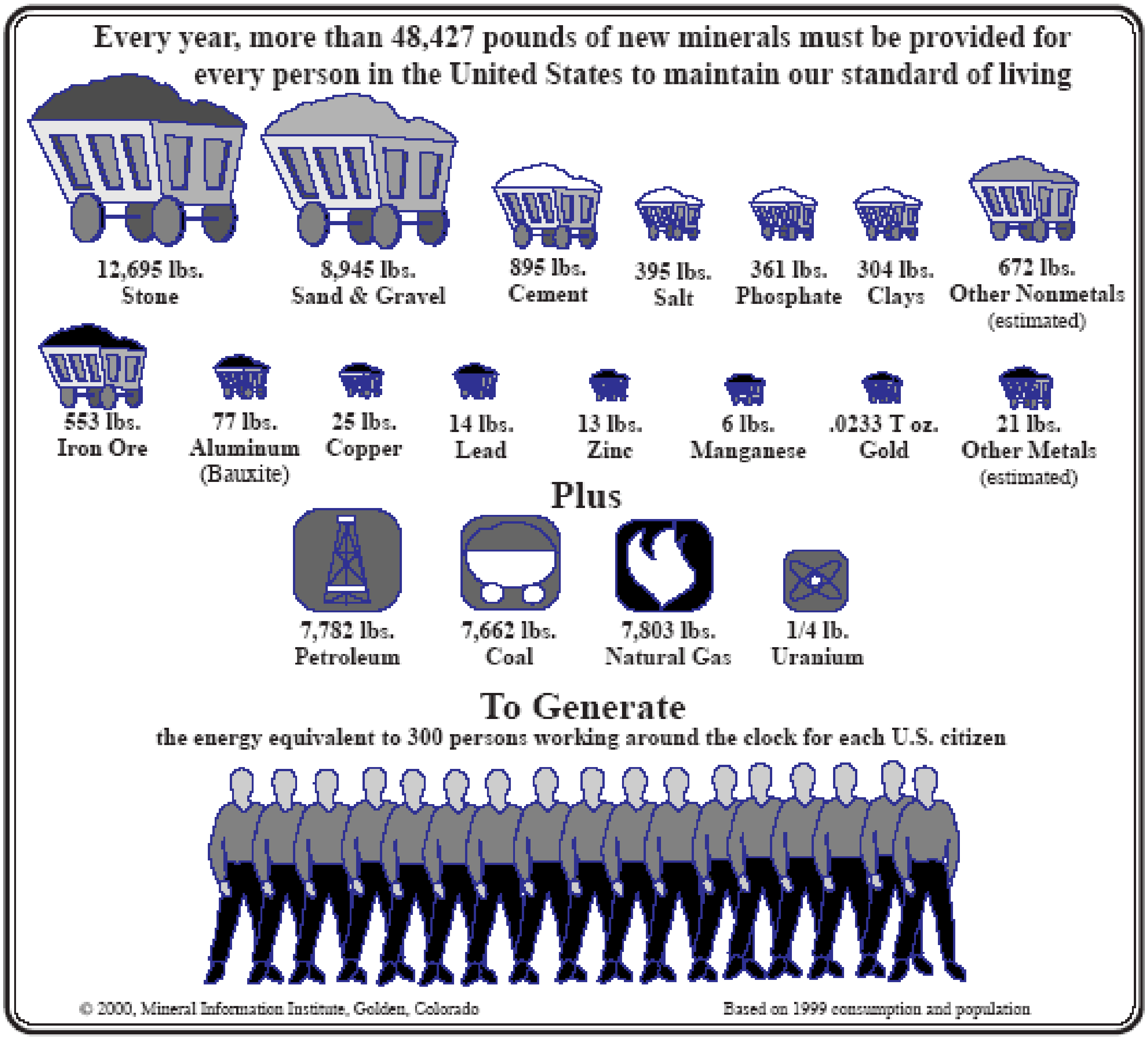


What's the difference between today and 200 years ago?

To maintain our standard of living requires the continual production of raw materials. In fact, it requires the production of 48,000 pounds of new minerals, metals, and energy fuels every year, for every person in the United States.

Those minerals provide our food, our homes, schools, hospitals, and factories, and the equipment and energy to make them operate.

Every day we are surrounded by minerals that help make our lives a little easier.

In 1776, when America became independent, people's needs were more simple, requiring fewer natural resources. Most people never travelled more than 20 miles from their birthplace in their entire lifetime.

Pounds of minerals and metals used every year by the average American

	1776	1999
Aluminum	0	77
Cement	12	895
Clay	100	304
Coal	40	7,662
Copper	1	25
Glass	1	150
Iron Ore	20	553
Lead	2	14
Phosphate	0	340
Potash	1	44
Salt	4	395
Sand, gravel, stone	1,000	21,640
Sulfur	1	111
Zinc	0.5	13

Survey Your Students—What do they think they must have, or can do without.

For the average, middle-class American child born in the 1990s, here's the personal toll of common products they will consume during his or her lifetime:

- Drive 700,000 miles in a dozen cars, using more than 28,000 gallons of gasoline.
- Read and throw away 27,500 newspapers, a rate of seven trees a year.
- Add 110,250 pounds of trash to the nation's garbage heap.
- Wear and throw away 115 pairs of shoes.

Source: Life's Big Instruction Book

Must Have

In polling 1,000 Americans, an MIT study found these *essential inventions* that people said they could not do without.

Automobile	63%
Light bulb	54%
Telephone	42%
Television	22%
Aspirin	19%
Microwave oven	13%
Hair-dryer	8%
Personal computer	8%

GAIN AN APPRECIATION FOR ALL THE THINGS EACH OF US USE, EVERY DAY, AND THE DEMAND THIS PUTS ON OUR NATURAL RESOURCES

In One Day

In order to maintain our standard of living, every day:

- 18,000,000 tons of raw material must be mined, cut or harvested to meet the demands of U.S. citizens (about 150 pounds for every man, woman and child);
- 640 acres (one square mile) of carpeting is woven using barite and limestone/dolomite;
- 9,700,000 square feet of plate and window glass (about 223 acres) are used, enough to cover 200 football fields, using silica sand and trona;
- 2,750 acres of pavement are laid, enough concrete and asphalt to make a bicycle path 7 feet wide from coast to coast using sand, gravel, stone aggregate, and limestone;
- 4,000,000 eraser-tipped pencils are purchased (enough erasers to correct all mistakes from 1,500 miles of notebook paper - about 129 acres of "goofs") using graphite, kaolin, pumice, copper and zinc;
- 426 bushels of paper clips (35,000,000) are purchased. Seven million are actually used, 8-9 million are lost and almost 5 million are twisted up by nervous fingers during telephone conversations, all using iron, clay, limestone, trona and zinc;
- 164 square miles of newsprint is used to print 62.5 million newspapers (enough to line a bird cage 12 miles wide and 13 miles long) using trona and kaolin;
- 400 acres of asphalt roofing are nailed down, utilizing silica, borate, limestone, trona, feldspar, talc, and silica sand;
- 187,000 tons of cement are mixed (enough to construct a four foot wide sidewalk from coast to coast) using limestone, sand, gravel, and stone aggregate;
- 36,000,000 light bulbs are purchased, all made from tungsten, trona, silica sand, copper and aluminum;
- 10 tons of colored gravel is purchased for aquariums;
- 80 pounds of gold are used to fill 500,000 dental cavities;
- 50,000 pounds of toothpaste (2.5 million tubes) are used (enough to fill a small jet liner) requiring calcium carbonate, zeolites, trona, clays, silica and fluorite;
- 1,000,000 photographs are snapped (more than 29 acres of wallet sized photos) using silver and iodine.

Statistics based on (approximately) 1995 information.

Credited to: *"All Just In One Day! Who Says We Do Not Need Minerals!" adapted* from the April, 1996, "Blaster's Newsletter"
Tom Parker, author of *In One Day*.
Peter Harben and Jeanette Harris, *Mined It!*

Minerals and YOU

You wake up in the morning and switch on the light. You wash your face, brush your teeth, and get dressed. You turn on the radio and eat breakfast—a bowl of cereal, a glass of juice, perhaps some toast and a cup of coffee or tea. You look out the window, then head for the door—ready to start the day.

And almost everything you've done so far—and everything you'll do for the rest of the day—would be impossible without minerals.

Water pipes and electric wiring; refrigerator, radio, toaster, lamp, and light bulb; sheets, towels, and clothing; soap and toothpaste; window, cereal bowl, juice glass, coffee cup; water faucet, spoon, doorknob—all were made from or with minerals. Even breakfast reached your table with the help of minerals.

Minerals and the Modern World

Minerals touch our lives in hundreds of ways each day. Life as we know it would not exist without them. Everything that cannot be grown—that's neither plant nor animal—is a mineral or made from minerals.

Agriculture, construction, manufacturing, transportation, electronics, art, science—almost every area of human activity depends in some way on minerals. The raw materials we take out of the ground are as critical to our way of life—and life itself—as food and water.

We consume minerals in amounts that range from billions of tons of sand and gravel a year to only thousands of pounds of rhenium—a metal used in producing lead-free gasoline. In the United States alone, it takes more than 2 billion tons of minerals each year to maintain our way of life. That's about 10 tons of minerals for every man, woman, and child. From those minerals we get the products we need to live and those that make life more comfortable.

Agriculture

Our dependence on minerals begins with the most basic requirement for life—food. Minerals are essential to the many activities involved in putting food on our tables. Fertilizers made from potash, phosphate rock, sulfur, and nitrogen help plants grow. Farmers use metal tractors and combines to plant and harvest crops. They ship fruit, vegetables, grain, and livestock to market in trucks, railroad cars, and airplanes—all made of metal. Food processors use metal machines and equipment; they package food in metal cans and other containers made from or with minerals.

In addition, like all plants and animals, we need mineral nutrients to keep us alive and well. The foods we eat supply iron, calcium, phosphorus, magnesium, copper, zinc; we even take vitamins containing minerals to make sure we get enough.

Construction

Minerals provide the building blocks for the houses and apartment buildings we call home; for the towns and cities where we live, work, and play; and for the roads, highways, and bridges that connect them.

We find the products of pits, quarries, and mines from basement to attic, from parking garage to penthouse. Our houses, apartment buildings, offices, and factories have walls of brick, stone, concrete . . . roofs made from asphalt and gravel . . . concrete foundations and gypsum wallboard . . . metal air conditioners, furnaces, and ventilation ducts . . . and a network of copper pipes, wires, and cables that bring water, light, and power.

Other minerals and mineral-based materials used in construction include cement, sand, clay, tile, lime, glass, aluminum, iron and steel, lead, and zinc.

Manufacturing

Many of the goods and products we use each day are made from minerals. Stoves, TVs, refrigerators, microwave ovens, washing machines, radios, and dishwashers contain steel, aluminum, and other metals. Aluminum pots and stainless

Distributed by Women In Mining Education Foundation

U.S. Bureau of Mines, Office of Public Information (1992) steel kitchen utensils . . . brass doorknobs and picture frames . . . plates and porcelain vases made from China clay . . . metal tools, bolts, screws, and nails . . . soaps and detergents made from boron, phosphates, soda ash . . . toothpaste, aspirin tablets, lipstick, eye shadow and other cosmetics containing clay—we find mineral products in every room, closet, and cabinet.

Many materials that are not in themselves minerals could not be made without them. We use sand, selenium, silicon, soda ash, and other minerals to manufacture glass. Making paper may require clay, lime, or sodium sulfate. Minerals like titanium, lead, and cadmium help give paints their color, white talc, mica, and clay help them last longer.

Minerals actually make possible the manufacture of almost every product bought and sold today. The machines used in factories, plants, mills, and refineries are made from steel and other metals. The processes involved in refining petroleum, making steel, and producing textiles, paper, glass, plastics, and fertilizers depend on chemicals made from minerals.

Transportation

In the modern world, minerals take us wherever we want to go—from the local shopping center to the moon. If we want to move people and materials, we need minerals. Cars, trucks, and buses; trains, subways, and the rails they run on; barges, ships, and the cranes that unload them—all are made from metal.

Cars, for example, contain iron and steel, manganese, chromium, lead, zinc, platinum, copper, and aluminum. We drive them on streets, highways, and bridges made from asphalt, sand, gravel, and concrete. Road crews use sand and salt to keep them from skidding on snow and ice. Even the gas in their tanks was prepared using mineral-based chemicals.

Minerals carry us into the air and beyond the atmosphere. Jets made of aluminum, chromium, cobalt, columbium, tantalum, and titanium take off by the thousands each day. Satellites, missiles, and space orbiters depend on the permanence, strength, reliability, and corrosion resistance of these metals. Gold used in the space suits of astronauts and as thin coatings on equipment protects both from the deadly radiation and heat of the sun.

Electronics

The advances in electronics and computer technology that made possible the exploration of space and hundreds of other technical achievements would be inconceivable without minerals.

Copper, for example, transformed the way we live. Its ability to conduct electricity not only gave us new ways to light and heat our homes, but opened the way to a world of machines that can do almost anything except think. And today's computer scientists are working on that.

Directly or indirectly, the electronics and computer industries use almost every mineral mined today.

It takes 42 different minerals, for example, to make something as seemingly simple as a telephone handset. From aluminum and beryllium to yttrium and zinc—minerals put light, power, communication, information, and entertainment at our fingertips.

Art and Science

Minerals provide the materials for men and women to express and explore themselves and the world. Painters and sculptors use mineral products—pigments, clay, marble. The photographer and movie maker would have no art without silver—the metal that makes it possible to record images on film. Symphony orchestras, brass bands, and rock superstars make music with instruments made from metal; listening to recorded music would be impossible without equipment made of a wide range of minerals.

The instruments of science—from microscopes and supercomputers to test tubes and beakers—also depend on minerals. With these instruments, scientists have explored the world from cell to solar system, discovering new treatments for disease, new sources of energy, even new galaxies.

Less positively, minerals have been a part of human warfare since the first caveman cast the first stone. Yet, today, that too is changing—minerals are being used in almost every aspect of our efforts to ensure world peace.

As long as civilization as we know it endures, minerals will be there, playing an essential part in our daily lives.

Industrial Materials Used Around the House

Carpet—Calcium carbonate, limestone
Glass/Ceramics—Silica sand, limestone, talc, lithium, borates, soda ash, feldspar
Linoleum—Calcium carbonate, clay, wollastonite
Glossy paper—Kaolin clay, limestone, sodium sulfate, lime, soda ash , titanium dioxide
Cake/Bread—Gypsum, phosphates
Plant fertilizers—Potash, phosphate, nitrogen, sulfur
Toothpaste—Calcium carbonate, limestone, sodium carbonate, fluorite
Lipstick—Calcium carbonate, talc, mica
Baby powder—talc
Hair cream—Calcium carbonate
Counter tops—Titanium dioxide, calcium carbonate, aluminum hydrate
Household cleaners—Silica, pumice, diatomite, feldspar, limestone
Caulking—Limestone, gypsum
Jewelry—Precious and semi-precious stones
Kitty litter—Attapulgite, montorillonite, zeolites, diatomite, pumice, volcanic ash
Fiberglass roofing—Silica, borates, limestone, soda ash, feldspar
Potting soil—Vermiculite, perlite, gypsum, zeolites, peat
Paint—Titanium dioxide, kaolin clay, calcium carbonate, mica, talc, silica, wollastonite
Concrete—Limestone, gypsum, iron oxide, clay
Wallboard—Gypsum, clay, perlite, vermiculite, aluminum hydrate, borates
Spackling—Gypsum, mica, clay, calcium carbonate
Carbon paper—Bentonite, zeolite
Ink—Calcium carbonate
Microwaveable container—Talc, calcium carbonate, titanium dioxide, clay
Sports equipment—Graphite, fiberglass
Pots and pans—Aluminum, iron
Optical fibers—Glass
Fruit juice—Perlite, diatomite
Sugar—Limestone, lime
Drinking water—Limestone, lime, salt, fluorite
Vegetable oil—Clay, perlite, diatomite
Medicines—Calcium carbonate, magnesium, dolomite, kaolin, barium, iodine, sulfur, lithium
Porcelain figurines—Silica, limestone, borates, soda ash, gypsum
Television—35 different minerals and metals
Automobile—15 different minerals and metals
Telephone—42 Different minerals and metals

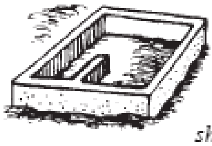
Mining Association of South Carolina

Mining in South Carolina has been one of the state's most valuable industries for over 200 years. Mining companies contribute more than $138 million in the state annually through payroll and taxes alone. South Carolina is ranked 25th in the United States in total mineral value, and is 13th among the 26 Eastern states. The state is ranked second nationally in the production and sales of kaolin, and first in cement. Our state is the only gold producer east of the Mississippi.

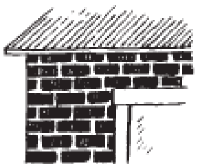
Presently there are 13 minerals being extracted from 485 active mines in South Carolina. The estimated raw mineral production value at the lip of the mine is in excess of $483 million annually. South Carolina minerals are surface-mined. Surface mining involves the removal of unwanted rock and soil prior to the extraction of the mineral. The three types of surface mines in our state are: open pit mining, strip mining and dredging. Areas previously mined are later reclaimed to grass and woodlands, ponds, lakes and pastures, residential developments and farm lands. The mining industry of South Carolina is a dynamic and productive industry, making a major contribution to the economic well-being and quality of life available to South Carolinians.

http://www.scmines.com/

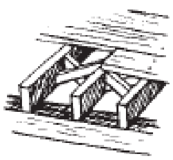
Your House Comes From A Mine



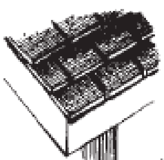
The **foundation** and **sidewalk** are probably concrete *(limestone, clay, shale, gypsum and aggregate)* and the **driveway**—concrete or asphalt *(petroleum and aggregate)*.



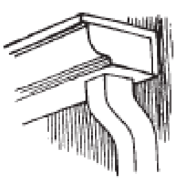
The **exterior walls** may be of *concrete* block, brick *(clay)*, *stone* or *aluminum* siding, all provided by mining.



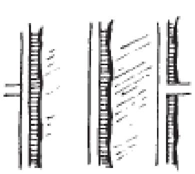
The lumber in the walls, roof and **floor** will be fastened together with nails and screws *(iron ore & zinc)*.



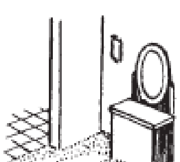
The **roof** may be covered with asphalt shingles *(petroleum* and a variety of colored *silicates*), fiberglass *(silica sand)*, clay, or corrugated *iron*.



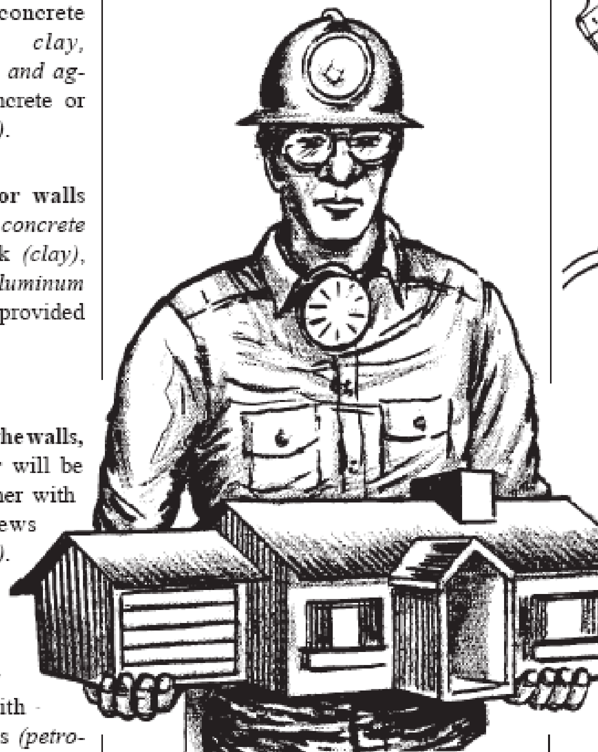
The **gutters** can be made of galvanized steel *(iron and zinc)*, aluminum *(bauxite)*, or plastic *(petroleum)*.

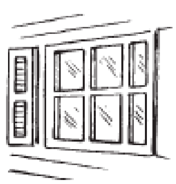


The **insulation** in the walls may be glass wool *(silica, feldspar, trona)* or expanded *vermiculite* (available from mining).

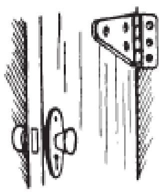


The interior walls are usually wallboard, made of *gypsum*.

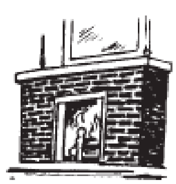




Your **windows** are made of glass *(trona, silica, sand and feldspar)*.

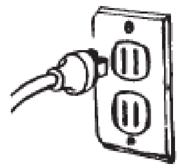


Your **door knobs, locks** and **hinges** are brass or steel *(copper, zinc, iron ore, & alloys)*.

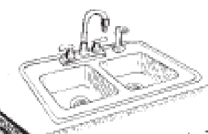


Your **fireplace** may be made of *rock, brick,* or you may have a wood/coal burning **stove** *(steel, iron, alloys, etc.)*. Your **furnace** is made of steel *(iron and alloys)*.

If your house is painted, **paint** is manufactured with *mineral fillers* and *pigments*.

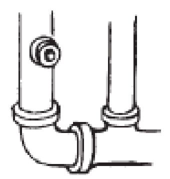


Your **electrical wiring** is of *copper* or *aluminum* (bauxite).

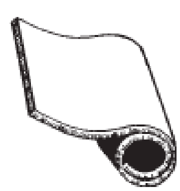


Your **plumbing fixtures** may be made of brass *(copper & zinc)* or stainless steel *(iron, nickel & chrome)*.

Your **toilets, sinks** and **bathtubs** are made of porcelain *(clay)* over *iron*, or plastic *(petroleum)*.



Your **sewer system** is made of *clay* or *iron* pipe (plastic pipes are made from *petroleum*); if you have a **septic tank** it is *concrete* and the leach field is filled with *sand and gravel*.



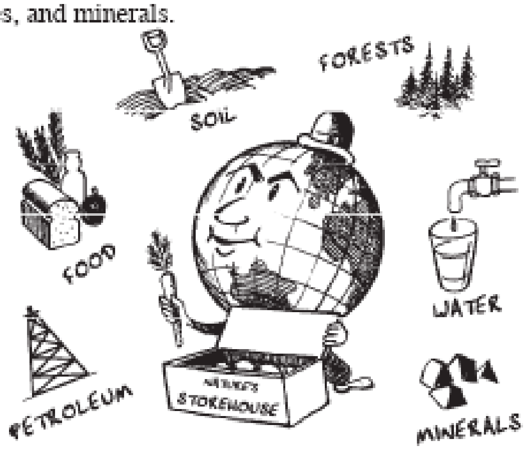
The **carpet** in you home is made from synthetic fibers *(petroleum)*. The back is filled with *limestone*, even if your carpet is made of wool.

And finally, your **mortgage** or **rental contract** is written on paper made from wood or cloth fibers. The fibers are filled with *clay* and *other minerals* to determine its color and texture.

THE EARTH—NATURE'S STOREHOUSE

The Earth is a huge storehouse. It holds the water and food that plants need to grow. It has a great supply of other natural materials. Materials people use are called natural resources.

Natural resources are useful materials found on and under the Earth's surface. You use a variety of natural resources everyday. Food is a natural resource—so is water. Other resources include soil, trees, and minerals.



WHAT ARE MINERAL RESOURCES?

Mineral resources are found on and in the Earth's crust. More than 3,500 different minerals have been identified. We will study three classes of mineral resources—metals, nonmetals, and fuels. Copper, nickel, gold, silver, and iron are examples of metallic mineral resources. Common materials like sand, gravel, clay, limestone, and salt are examples of nonmetallic mineral resources. Nonmetallic minerals are often called *industrial minerals*. Minerals used for fuel are oil, gas, and coal. They are called *fossil fuels*. Uranium is a *metallic fuel*.

Minerals are everywhere around us. For example, it is estimated that more than 70 million tons of gold is in the ocean waters. It would be much too expensive to recover because it is so scattered. Minerals need to be concentrated into deposits by Earth's natural processes to be useful to us.

Some of Earth's natural processes concentrate mineral resources into valuable deposits. Moving water places sand and gravel along stream and river banks and ocean beaches. Water erodes gold-bearing rock from upland mountains and deposits gold in gravels along some rivers and streams.

Inside the Earth, rocks are melting and cooling. Melting and cooling can concentrate metals such as copper, molybdenum, nickel, and tin in a rock mass along with other common minerals like quartz and feldspar.

On the surface of the Earth, dead plants accumulated in swamps millions of years ago. Through time, heat and pressure—that plant material has become today's coal. Oil and natural gas have come from algae, spores, and plant material. Minerals may be everywhere, but only in a few places are they concentrated enough to make them valuable to us.

Mineral resources such as oil and gas, coal, copper, and tin, are called nonrenewable resources. Once they are removed from the Earth, they will not be replaced in our lifetimes. However, new mineral wealth is being created by such natural forces as volcanic activity and earthquakes.

HOW ARE MINERAL RESOURCES DISTRIBUTED THROUGHOUT THE EARTH?

Minerals are not evenly distributed in the Earth's crust. Concentrations of mineral resources profitable to extract are found in just a few small areas. Mineral deposits are really freaks of nature. In other words, a special set of circumstances happened in or on the Earth to create mineral deposits. There had to be a supply of certain elements available in the Earth, a process to concentrate them, and a host rock to trap the mineral or minerals. Many minerals like to be together, such as: quartz and gold; molybdenum, tin and tungsten; copper, lead and zinc; platinum and palladium—to name a few.

The signs of a mineral deposit are often small and difficult to recognize. Locating deposits requires the experience and knowledge of a trained geologist. Geologists search for years before finding an economic mineral deposit. Deposit size, its mineral content, extracting efficiency, and costs—ALL determine if a mineral resource can be profitably developed.

HOW ARE MINERAL RESOURCES USED TO SUPPLY FOOD?

Our food supply depends on mineral and energy resources. Farming starts with seeds in the ground and ends with food for us to eat. Plants come directly to us as fruits and vegetables—or—indirectly as food from animals that supply dairy products and meat. Growing plants get food (nourishment) from minerals in the soil. Fertilizers—such as potash, phosphate, nitrogen, and sulfur—are necessary to produce abundant crops.

That is just a start. The farmer's truck, tractor, and other machines are made from steel and other metal products. Power to operate the equipment is provided by fossil fuels such as gasoline and diesel fuel. The food products from the farm are shipped to processors or to markets in trucks, railway cars, and airplanes—all made from iron, manganese, nickel, molybdenum, and aluminum and many other minerals. The roads, highways, railroads, and airports used for food transportation are made using other mineral resources. Food is processed using equipment made from metal. Food packaging commonly is made of metal or containers made from petroleum products (such as plastic).

Mineral Information Institute Golden, Colorado www.mii.org

WHAT PRODUCTS ARE MADE FROM MINERAL RESOURCES?

Nearly ALL of the products we need to make our life more comfortable are made from mineral resources. Our society as we know it today could not function without a large and varied supply of minerals.

All products used at home, at play, and at work come from the Earth. Food, shelter, water supply, clothing, health aides, transportation, and communication all depend on mineral resources. We can see products made from minerals in the kitchen and on the dining room table. Stoves, refrigerators, dishwashers, toasters, forks, knives are good examples.

Nickel, copper, stainless steel, aluminum, and silver are necessary in cooking and eating. These products are more convenient and long-lasting and are more beneficial to our safety and health than wooden spoons, ice boxes, and dishpans.

HOW DO MINERAL RESOURCES CONTRIBUTE TO THE HOME AND INDUSTRY?

The raw materials of Earth are used to make equipment and consumer products. They are sometimes used by themselves, copper for example, or in combination with other minerals, for example: chrome, carbon and iron to make stainless steel. The output of our mines and wells makes almost every other product possible. We depend on mineral resources—they are the "building blocks" of civilization.

At home, we have instant clean water by turning on the faucet. The water treatment plant and the chemicals used for purification, the pipes and plumbing parts which bring us our water, and our waste disposal systems—are made entirely from mineral resources.

Our clothing depends on the production of mineral resources. Natural fibers grown with the aid of fertilizers are made into cloth with tools and machines made from minerals. Some textiles are made from coal and petroleum. They are called *synthetic materials*. Many coloring dyes come from minerals. Not only are these dyes used in our clothing, but are used in paints—both for household and industrial usage and works of art.

Homes, apartments, office buildings and factories are built using minerals. The structures use steel beams, gypsum for wallboard, copper wiring for telephones and electricity, and in equipment such as elevators. Zinc-coated heating ducts prevent corrosion (or rusting). The buildings sit on concrete foundations made of sand, gravel, and cement in which reinforced steel rods are embedded.

When we begin to think and investigate, we find the use of minerals is more dramatic and exciting than one can realize.

HOW ARE MINERALS USED IN TRANSPORTATION AND COMMUNICATIONS?

We now travel more and faster. We communicate by telephone, radio, and television. What has made this possible? Technology!

Aren't we glad that someone in our past invented the train? (It sure beats the horse and buggy or the wagon train.) The train, made of steel and wood, was fired by coal (eventually converted to diesel-fueled engines) that made it the transportation mode of the day. Today, we have airplanes as well as trains and automobiles.

The airplane—all of its components come from the raw materials of Earth—the same as the train and car! But, what makes it fly? What fuels it?—A highly refined kerosene made from petroleum, giving it power. It is made of light weight metals (aluminum, and specialty steels called alloys), and plastics that come from petroleum products. Its speed, because it is lightweight, makes it possible for us to travel from one coast to another in 6-1/2 hours or less.

The telephone—sure beats smoke signals! A review of history tells how exciting it was to listen to the radio and to call a friend instead of writing a letter. Today, radios, telephones, and television sets command your attention. None of these conveniences could have been made, except "someone" was interested in the advancement of society and knew how to use minerals. An understanding of minerals—the connectors so vital in today's communications—is important. As you work with your classroom computers remember that it was just a few years ago that they were made available to your school. And who could have imagined what a quartz crystal could do? But that quartz crystal (silicon chip) could not work alone if other minerals were not used at the same time. We are lucky!

WHAT IS THE FUTURE OF MINERAL RESOURCES IN THE WORLD?

The growing use of mineral and energy resources throughout the world creates several important questions. Will we reach a time when our resources are gone? It is doubtful because we are so creative and continue to develop new technology that makes minerals we use go further. We also have learned, and continue to learn, how to use our resources more efficiently and how to recycle and conserve them. Will technological development, economic factors, and conservation methods overcome fears of running out of our mineral and energy resources? Will we someday mine the ocean and resources in outer space? The answers to these questions will help determine our way of life in the future. You will be challenged to develop new ideas and new technology in the years ahead.

PEOPLE AND EARTH'S MINERALS

Ancient people used **minerals** that came from the Earth. They used **chert**, **flint**, **jasper**, **obsidian** and **quartzite** for tools and weapons which they shaped by using deer antlers (which are shed every year) or other hard-pointed sticks or rocks. Ancient people used **clay** to make pots for cooking, and jars to hold water or store food. Some minerals and **gems**, such as **agate**, **jade**, **opal**, and **turquoise**, were prized possessions and were often used for trading and bartering. Ancient people learned how to mix soil and water to make **mud**. Straw and grass were added to the mud to make it stronger. This mixture was then formed into brick-like shapes and dried. The bricks, called adobe, could be stacked and stuck together with more mud. Today, bricks are made of clay. Modern people have an easier way of life than the ancient people because of advances in **science** and technology. All of the products we use today also come from the Earth. The raw materials used to make the products we need have to be mined. **Mining** for minerals is done in many ways. Some minerals are found near the surface of the Earth. They can be mined by the open pit or strip mining method. Minerals that are hidden deep in the Earth are extracted by digging a deep shaft straight down. Horizontal drifts are mined off certain levels of the shaft. All mining depends on where economic concentration of minerals (**ore**) are found.

When economic amounts of a mineral are found it is called an **ore body**. As an example, **halite** (salt) is found in almost pure form in the state of Kansas. Halite is usually mined underground by the room-and-pillar mining method. This method is also used to mine trona and **potash**. Potash is used as a fertilizer. **Marble** (the metamorphic form of limestone) is mined by the **quarry** method. It is taken out of the ground in big blocks and is used for buildings, flooring, and for art works such as statues. An ore body may contain a combination of metals such as **tin**, **titanium**, **lead**, **zinc**, **tungsten**, **gold**, and **silver**. When more than one mineral is found in an ore body a scientist (metallurgist) has to decide which processes will be needed to recover each mineral. Processing several metals/minerals can be expensive. To determine the size and value of an ore body, geologists drill holes in the Earth. The drill they use is called a core drill. The entire core is brought to the surface where the geologist inspects its mineral content. Geologists call this core "**drill core**". The **logging** (recording) of the drill core is very important. The geologist records the depth at which the core was taken and the amount of mineral present. **Assays** by a chemist are made to determine the quantity and quality of the mineral or metals present. Sometimes many holes have to be drilled to show the outline of the ore body. After the drilling data is plotted on a map the geologist can determine whether the ore body is large enough to mine at a profit.

GEOLOGY and NATURAL RESOURCE EEVELOPMENT

HOW DOES GEOLOGY RELATE TO MINERAL RESOURCES AND THEIR DEVELOPMENT?

Mineral resources are those minerals and other earth materials that supply the things we need and want. Look around you. Things made from mineral resources are in plain sight. Some are obvious, others are less obvious. Obviously, metal paper clips and building stone come from the Earth. Some things are not so obvious. Toothpaste, hair combs, chalk, cups and glasses also come from the Earth. All plastics and many fibers of which our clothes are made come from coal or oil.

Mineral resources are so important to us that we count stages of history by them. We had the *Stone Age*, the *Bronze Age*, and the *Iron Age*. By examining different kinds of rock formations and by studying the Earth.s surface, geologists know the geologic environments in which mineral resources may be found. For a long time people were able to find enough mineral resources on the surface of the Earth. This is not the case with many mineral resources today. Once a vein of silver or a bed of coal has been mined, it cannot be replaced. This means we must plan well ahead to look for new mineral deposits. Today, geologists use a variety of tools and instruments to help locate mineral resources. Airplanes and helicopters with photographic equipment are used by geologists. They also use magnetic and gravity-detecting equipment. This equipment gives information about the Earth's subsurface. Geologists sometimes use pictures taken from satellites in their search for hidden mineral resources.

What is Mineral Resource Development?

Mineral resource development is finding, removing, and processing valuable mineral resources from our Earth. Mineral resources may be solid (coal or copper), liquid (petroleum), or gaseous (natural gas). When a mineral resource is developed, it is taken from the Earth and changed into a usable form. All the work involved in doing this has one aim: to provide us with the products we need or want in our everyday lives. A mineral resource is developed only when enough of it is found concentrated in one location and its removal and processing can be done profitably. Exploration for mineral resources is a very risky business and much of it is unsuccessful. Mineral resources are scarce and difficult to find. Great sums of money are spent for years before any money is ever made by a company on its mining or drilling operations. Mineral resources can be developed only if their extraction can pay for the investment, labor and machinery, and taxes. If there is no profit left over, there is no reason to invest in such a business.

What Must Happen To A Mineral Resource Before It Becomes Useful?

Mineral and energy resources are the ingredients in nearly all of the products we use everyday. These resources must go through a number of steps or processes before usable items can be produced. We call these steps the journey from prospect to production.

EXPLORATION. First, the mineral and energy resources must be found! The people who look for these resources are called geologists. They explore the Earth to find deposits or wells that can be produced.

EXTRACTION. After the resources are located, they must be removed from the Earth. This process is called extraction. People build surface or underground mines to extract mineral resources. To get oil, holes are drilled deep into the Earth. Mining and drilling are two ways we extract and produce mineral resources.

PROCESSING. Valuable minerals are in ordinary looking rock when they are taken from the Earth. They are often hidden as tiny particles in the rock. The valuable minerals are removed from the rock and concentrated. This is called processing or crushing, grinding, and milling.

REFINING. Some minerals have to be smelted and refined before they can be made into useful products. When oil is pumped from the Earth, it is in crude form.

The crude oil is sent to a refinery where it is processed into oils, solvents, fuels, and petrochemicals.

MANUFACTURING. After the mineral and energy resources are refined, these raw materials are made into products. Their transformation into consumer products is almost limitless. Products ranging from fertilizers to plastic; from bicycles to airplanes are made by man and machinery. This is called manufacturing.

MARKETING. Once the products are made, they are sold or marketed. When you need a product, you usually go to a store. Marketing is when some product is sold to someone. The mineral and energy resource company sells the mineral resource to a manufacturer. The manufacturer makes a product and sells it to stores. The stores then sell the product to us.

Aluminum: The most abundant metal element in the Earth's crust. Bauxite is the main source of aluminum. Aluminum is used in the United States in packaging (31%), transportation (22%), and building (19%). Guinea and Australia have 46 percent of the world's reserves. Other countries with major reserves include Brazil, Jamaica, and India.

Antimony: A native element; antimony metal is extracted from stibnite and other minerals. Antimony is used as a hardening alloy for lead, especially storage batteries and cable sheaths; also used in bearing metal; type metal; solder; collapsible tubes and foil; sheet and pipes; and, semiconductor technology.

Asbestos: because this group of silicate minerals can be readily separated into thin, strong fibers that are flexible, heat resistant, and chemically inert, asbestos minerals are suitable for use in fireproof fabrics, yarn, cloth, paper, paint filler, gaskets, roofing composition, reinforcing agent in rubber and plastics, brake linings, tiles, electrical and heat insulation, cement, and chemical filters.

Barium: used as a heavy additive in oil-well-drilling mud; in the paper and rubber industries; as a filler or extender in cloth, ink, and plastics products; in radiography ("barium milkshake"); as getter (scavenger) alloys in vacuum tubes; deoxidizer for copper; lubricant for anode rotors in X-ray tubes; sparkplug alloys. Also used to make an expensive white pigment.

Bauxite: a general term for a rock composed of hydrated aluminum oxides; it is the main ore of alumina to make aluminum; also used in the production of synthetic corundum and aluminous refractories.

Beryllium: used in the nuclear industry and in light, very strong alloys used in the aircraft industry. Beryllium salts are used in fluorescent lamps, in X-ray tubes and as a deoxidizer in bronze metallurgy. Beryl is the gem stones emerald and aquamarine.

Chromite: 99 percent of the world's chromite is found in South Africa and Zimbabwe. Chemical and metallurgical industries use 85% of the chromite consumed in the U.S.

Cobalt: used in superalloys for jet engines; chemicals (paint driers, catalysts, magnetic coatings); permanent magnets; and cemented carbides for cutting tools. Principal cobalt producing countries include Zaire, Zambia, Canada, Cuba, and the former Soviet Union. Cobalt resources in the United States are low grade and production from these deposits is not economically feasible.

Columbite-tantalite group (columbium is another name for niobium): the principal ore of niobium and tantalum, used mostly as an additive in steel making and in superalloys; used in metallurgy for heat-resistant alloys, rust-proofing (stainless steel), and electromagnetic superconductors. Brazil and Canada are the world's leading producers.

Copper: used in electric cables and wires, switches, plumbing, heating; roofing and building construction; chemical and pharmaceutical machinery; alloys (brass, bronze, and a new alloy with 3% beryllium that is particularly vibration resistant); alloy castings; electroplated protective coatings and undercoats for nickel, chromium, zinc, etc. The leading producer is Chile, followed by the U.S., the former Soviet Union, Canada, Zambia, and Zaire.

Feldspar: a rock-forming mineral; industrially important in glass and ceramic industries; pottery and enamelware; soaps; abrasives; bond for abrasive wheels; cements and concretes; insulating compositions; fertilizer; poultry grit; tarred roofing materials; and as a sizing (or filler) in textiles and paper.

Fluorite (fluorspar): used in production of hydrofluoric acid, which is used in the pottery, ceramics, optical, electroplating, and plastics industries; in the metallurgical treatment of bauxite, which is the ore of alumina; as a flux in open hearth steel furnaces and in metal smelting; in carbon electrodes; emery wheels; electric arc welders; toothpaste; and paint pigment.

Gold: used in dentistry and medicine; in jewelry and arts; in medallions and coins; in ingots as a store of value; for scientific and electronic instruments; as an electrolyte in the electroplating industry. South Africa has about half of the world's resources. Significant quantities are also present in the U.S., Australia, Brazil, Canada, China, and the former Soviet Union.

Gypsum: processed and used as prefabricated wallboard or as industrial or building plaster; Used in cement manufacture; agriculture and other uses.

Halite (Sodium chloride—Salt): used in human and animal diet, food seasoning and food preservation; used to prepare sodium hydroxide, soda ash, caustic soda, hydrochloric acid, chlorine, metallic sodium; used in ceramic glazes; metallurgy; curing of hides; mineral waters; soap manufacture; home water softeners; highway deicing; photography; herbicide; fire extinguishing; nuclear reactors; mouthwash; medicine (heat exhaustion); in scientific equipment for optical parts. Single crystals used for spectroscopy, ultraviolet and infrared transmission.

Iron Ore: used to manufacture steels of various types. Powdered iron: used in metallurgy products; magnets; high-frequency cores; auto industry; and ammunition. The U.S. is the world's largest producer and consumer of lead metal. Other major mine producers include Australia, Canada, and the former Soviet Union.

Lithium: lithium compounds are used in ceramics and glass; in primary aluminum production; in the manufacture of lubricants and greases; rocket propellants; vitamin A synthesis; silver solders; underwater buoyancy devices; batteries.

Manganese: essential to iron and steel production. The U.S., Japan, and Western Europe are all nearly deficient in economically minable manganese. South Africa and the former Soviet Union have over 70% of the world's reserves.

Mica: micas commonly occur as flakes, scales, or shreds. Sheet muscovite (white) mica is used in electronic insulators (mainly in vacuum tubes); ground mica in paint, as joint cement, as a dusting agent, in well-drilling muds; and in plastics, roofing, rubber, and welding rods.

Molybdenum: used in alloy steels (47% of all uses) to make automotive parts, construction equipment, gas transmission pipes; stainless steels (21%) used in water distribution systems, food handling equipment, chemical processing equipment, home, hospital, and laboratory requirements; tool steels (9%) bearings, dies, machining components; cast irons (7%) steel mill rolls, auto parts, crusher parts; super alloys (7%) in furnace parts, gas turbine parts, chemical processing equipment; chemicals and lubricants (8%) as catalysts, paint pigments, corrosion inhibitors, smoke and flame retardants, and as a lubricant. As a pure metal, molybdenum is used because of its high melting temperatures (4,730 °F.) as filament supports in light bulbs, metalworking dies and furnace parts. Major producing countries are Canada, Chile, and the U.S.

Nickel: vital as an alloy to stainless steel; plays key role in the chemical and aerospace industries. Leading producers include Australia, Canada, Norway and the former Soviet Union. Largest reserves are found in Cuba, New Caledonia, Canada, Indonesia, and the Philippines.

Perlite: expanded perlite is used in roof insulation boards; as fillers, filter aids, and for horticultural.

Platinum Group Metals (includes platinum, palladium, rhodium, iridium, osmium, and ruthenium): they are among the scarcest of the metallic elements. Platinum is used principally in catalysts for the control of automobile and industrial plant emissions; in catalysts to produce acids, organic chemicals, and pharmaceuticals. PGMs used in bushings for making glass fibers used in fiber-reinforced plastic and other advanced materials, in electrical contacts, in capacitors, in conductive and resistive films used in electronic circuits; in dental alloys used for making crowns and bridges; in jewelry. The former Soviet Union and South Africa have nearly all the world's reserves.

Potash: a carbonate of potassium; used as a fertilizer; in medicine; in the chemical industry; used to produce decorative color effects on brass, bronze, and nickel.

Pyrite: used in the manufacture of sulfur, sulfuric acid, and sulfur dioxide; pellets of pressed pyrite dust are used to recover iron, gold, copper, cobalt, nickel, etc..

Quartz (Silica): as a crystal, quartz is used as a semiprecious gem stone. Cryptocrystalline forms may also be gem stones: agate, jasper, onyx, carnelian, chalcedony, etc. Crystalline gem varieties include amethyst, citrine, rose quartz, smoky quartz, etc. Because of its piezoelectric properties quartz is used for pressure gauges, oscillators, resonators, and wave stabilizers; because of its ability to rotate the plane of polarization of light and its transparency in ultraviolet rays it is used in heat-ray lamps, prism, and spectrographic lenses. Used in the manufacture of glass, paints, abrasives, refractories, and precision instruments.

Rare Earth Elements: industrial consumption of rare earth ores was primarily in petroleum fluid cracking catalysts, metallurgical additives, ceramics and polishing compounds, permanent magnets, and phosphors. Rare earth elements are lanthanum, cerium, praseodymium, neodymium, promethium, samarium, europium, gadolinium, terbium, dysprosium, holmium, erbium, thulium, ytterbium, and lutetium.

Silica: used in manufacture of glass and refractory materials; ceramics; abrasives; water filtration; component of hydraulic cements; filler in cosmetics, pharmaceuticals, paper, insecticides; rubber reinforcing agent, especially for high adhesion to textiles; anti-caking agent in foods; flatting agent in paints; thermal insulator.

Silver: used in photography, chemistry, jewelry; in electronics because of its very high conductivity; as currency, generally in some form of an alloy; in lining vats and other equipment for chemical reaction vessels, water distillation, etc.; catalyst in manufacture of ethylene; mirrors; electric conductors; batteries; silver plating; table cutlery; dental, medical, and scientific equipment; electrical contacts; bearing metal; magnet windings; brazing alloys, solder. Silver is mined in 56 countries. Nevada produces over 30% of the U.S. silver. Largest silver reserves are found in the U.S., Canada, Mexico, Peru, and the former Soviet Union.

Titanium: a metal used mostly in jet engines, airframes, and space and missile applications; produced in the westerns and central U.S., the United Kingdom, China, Japan, and the former Soviet Union.

Tungsten: used in metalworking; construction and electrical machinery and equipment; in transportation equipment; as filament in light bulbs; as a carbide in drilling equipment; in heat and radiation shielding; textile dyes, enamels, paints, and for coloring glass. Major producers are China, Korea, and the former Soviet Union. Large reserves are also found in the U.S., Bolivia, Canada, and The Federal Republic of Germany.

Vanadium: used in metal alloys; important in the production of aerospace titanium alloys; as a catalyst for production of maleic anhydride and sulfuric acid; in dyes and mordants; as target material for X-rays. The former Soviet Union and South Africa are the world's largest producers. Large reserves in the U.S. and China.

Zeolites: used in aquaculture (fish hatcheries for removing ammonia from the water); water softener; in catalysts; cat litter; odor control; and for removing radioactive ions from nuclear plant effluent.

Zinc: used as protective coating on steel, as die casting, as an allying metal with copper to make brass, and as chemical compounds in rubber and paints; used as sheet zinc and for galvanizing iron; electroplating; metal spraying; automotive parts; electrical fuses; anodes; dry cell batteries; fungicides; nutrition (essential growth element); chemicals; roof gutters; engravers' plates; cable wrappings; organ pipes; in pennies; as sacrificial anodes used to protect ship hulls from galvanic action; in catalysts; in fluxes; in phosphors; and in additives to lubricating oils and greases. Zinc oxide: in medicine, in paints, as an activator and accelerator in vulcanizing rubber; as an electrostatic and photoconductive agent in photocopying. Zinc dust: for primers, paints, sherardizing, precipitation of noble metals; removal of impurities from solution in zinc electrowinning. Zinc is mined in over 50 countries with Canada the leading producer, followed by the former Soviet Union, Australia, Peru, and China. In the U.S. most production comes from Tennessee, Missouri, New York and Alaska.