# A World of Resources

**Objective: To discover that worldwide cooperation is necessary to make most products.**

### A Few Facts

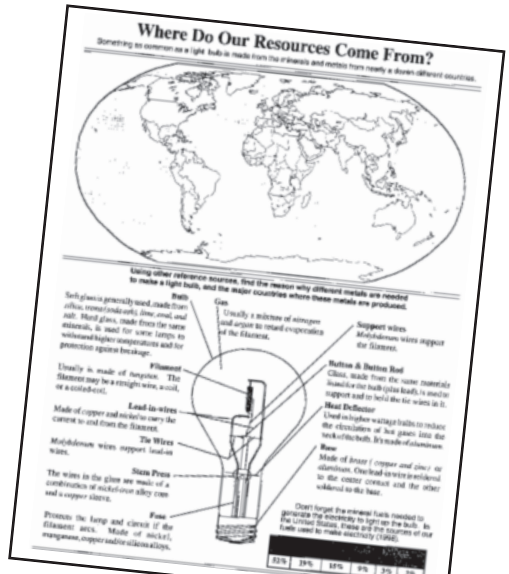
In today's world, no country is truly self-sufficient; not one can produce all of the different minerals needed to maintain its own economy and society. Larger countries (because of their size) come close to self-sufficiency, but none have achieved it yet.

The economics of entire nations can depend on mineral resources. Half of the world's known gold reserves are in South Africa; petroleum is in Arab nations, copper in Chile and other minerals and metals in Canada, Siberia and Peru.

The U.S. has to import:

- 100% of the bauxite needed to make aluminum
- 39% of the chromium needed to make stainless steel
- 63% of its tungsten (used in light bulbs and special steels)
- 100% of its graphite, manganese, strontium, and vanadium
- 80% of its tin (for cans and containers); 76% of its zinc (for food and medicine); 73% of its potash (a necessary fertilizer to grow food)
- 57% of its petroleum (to provide the energy we all use)

(sources: USGS and DOE)




Student Page

### Classroom Experience

Who comes closest to self-sufficiency?

Group students into six teams for the six main continents. Let each team explore and determine who controls the majority of the world's resources.

Is there a concentration of minerals in one major area of a continent?

In just one country?

On which countries does the U.S. most depend for minerals?

Assign different metals to the class to find out:

Why is more lead, gold and platinum recycled than aluminum?

Why doesn't the U.S. mine bauxite?

**Read More About It!**

Check out this book for your class:

- *In Coal Country* by Judith Headershot; Knopf

### Dig A Little Deeper

- What effect, if any, does the availability of natural resources have on your life-style? Has the need for resources ever caused war?
- What causes famine in some countries? Is it lack of food or politics?
- Can a country maintain its independence and quality of life without a dependable supply of natural resources? If yes, for how long? If no, what can that country do to continue its existence?

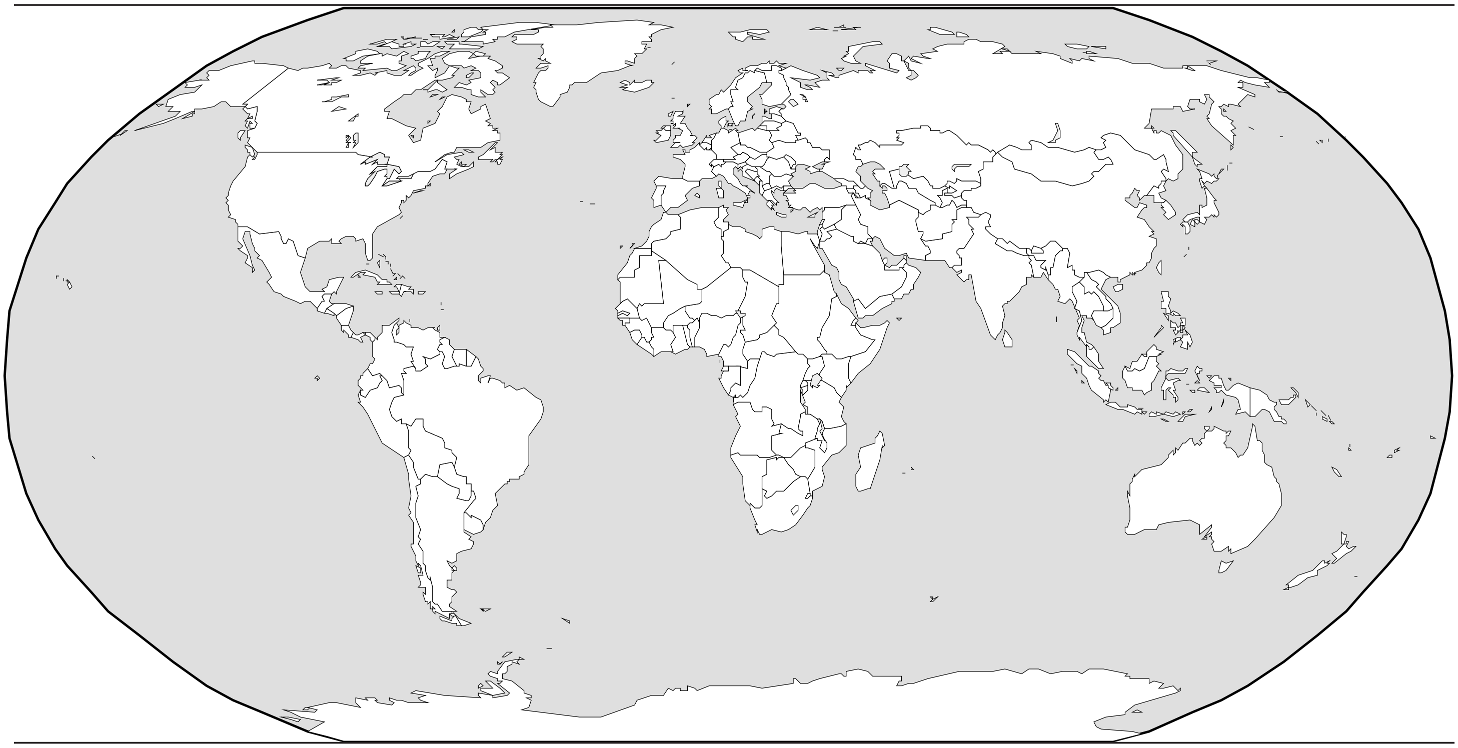
Note: Check any current event involving conflict. Does the scarcity of resources play a role? Remember, resources include the Earth's natural resources and man-made resources.

### Integrating the Curriculum

1. Explore how important it is to speak the language of those countries from which one wishes to buy natural resources.
2. What effect did the gold rush have on the settlement of the western frontier? On the United States? Some children might explore the origin of the word "sourdough" and then make sourdough bread.
3. What are the difficulties of extracting minerals from the Earth? Is it different in Alaska than it is in South Africa?
4. There is a feeling of brotherhood among people involved in producing resources. Suggest students discuss, role play or research why this might be so. (Note: farmers feel brotherhood, so do loggers and cowboys.)
5. Learn songs dealing with each of the resources. *Oklahoma!* (where the corn grows…), *Home on the Range*, etc.

# Where Do Our Resources Come From?

Something as common as a light bulb is made from the minerals and metals from nearly a dozen different countries.



Using other reference sources, find the reason why different metals are needed to make a light bulb, and the major countries where these metals are produced.

**Bulb**
Soft glass is generally used, made from *silica, trona (soda ash), lime, coal,* and *salt*. Hard glass, made from the same minerals, is used for some lamps to withstand higher temperatures and for protection against breakage.

**Filament**
Usually is made of *tungsten*. The filament may be a straight wire, a coil, or a coiled-coil.

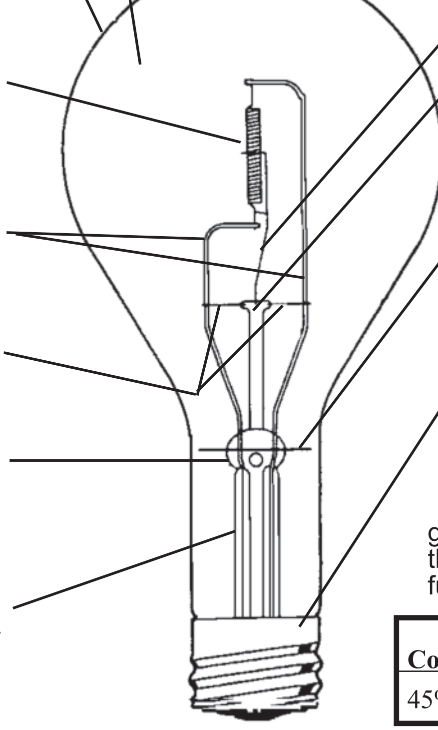
**Lead-in-wires**
Made of *copper* and *nickel* to carry the current to and from the filament.

**Tie Wires**
*Molybdenum* wires support lead-in wires.

**Stem Press**
The wires in the glass are made of a combination of *nickel-iron* alloy core and a *copper* sleeve.

**Fuse**
Protects the lamp and circuit if the filament arcs. Made of *nickel, manganese, copper* and/or *silicon* alloys.

**Gas**
Usually a mixture of *nitrogen* and *argon* to retard evaporation of the filament.



**Support wires**
*Molybdenum* wires support the filament.

**Button & Button Rod**
Glass, made from the same materials listed for the bulb (plus *lead),* is used to support and to hold the tie wires in it.

**Heat Deflector**
Used in higher wattage bulbs to reduce the circulation of hot gases into the neck of the bulb. It's made of *aluminum*.

**Base**
Made of *brass (copper and zinc)* or *aluminum*. One lead-in wire is soldered to the center contact and the other soldered to the base.

Don't forget the mineral fuels needed to generate the electricity to light up the bulb. In the United States, these are the sources of our fuels used to generate electricity.

| Coal | Nuclear | Hydro | Natural Gas | Oil | Other |
|---|---|---|---|---|---|
| 45% | 20% | 7% | 23% | 2% | 3% |

Source: Energy Information Administration

# Recycling Metals

**Objective: To appreciate our roles in producing and sharing our natural resources.**

### A Few Facts

In the U.S., 5,500,000 metric tons of aluminum are used each year, and 37% of that is made from recycled aluminum products.

But believe it or not, when it comes to recycled metals, aluminum is not the leader. The recycling of other metals isn't generally well-known because it's done by industry, not by consumers.

In 2004, the recycling rate for steel from automobiles was 102%. How can that be? It means more steel was recovered by recycling old automobiles than was used that year to make new autos.


Recycling Metals

It's More Than Aluminum Cans

Student Page

**Important Metals Used and Recycled in the U.S.**

| Kind of metal | % Recycled | Kind of metal | % Recycled |
|---|---|---|---|
| Aluminum | 43 | Magnesium | 48 |
| Aluminum in bev. cans | 54 | Nickel | 45 |
| Chromium | 36 | Tin | 25 |
| Copper | 32 | Titanium | 47 |
| Iron & steel | 71 | Zinc | 30 |
| Lead | 81 | | |

### Classroom Experience

What do minerals have to do with world development?

Track and research the economic, manufacturing and industrial developments and trends in mainland China and the former Soviet Union. Are the regions with more mineral resources being developed more rapidly? Will there be less natural famine, a higher standard of living, opportunities for a better education, etc.?

Debate the various uses for different metals – the benefits of one metal versus another for the same application.

With mapping exercises, help the students discover that bauxite mining does indeed occur close to the equator, while processing it into aluminum occurs not only in other countries, but on other continents as well.

### Dig A Little Deeper

Have your students form groups and research these questions:

- Why is aluminum used in beverage cans, storm window and door frames, bicycles and backpacks?
- If the price of aluminum increases, should we still use it to make beverage cans?
- Why is recycling aluminum so popular?
- Why can we make more 12-ounce cans today from a pound of aluminum than we could 20 years ago?
- How can people help recycle metals other than aluminum?

**Read More About It!**

Check out these books for your class:

- *Garbage Pizza, Patchwork Quilts and Math Magic* by Susan Ohanian; W.H. Freeman and Company
- *50 Simple Things Kids Can Do to Recycle*; Earth Works Group

### Integrating the Curriculum

1. Research the energy efficiency of automobiles required by Congress and the EPA and its effect on oil self-sufficiency. Are we producing a cleaner environment through efficiency and innovation? Can we recycle our way to self-sufficiency in minerals?
2. 54% of all aluminum beverage cans were recycled, yet aluminum represents about 2% of all recovered recyclables. Study your home or school trash to see what else can be recycled.
3. Help your students pick a project that supports the environment and develops community pride, such as using the proceeds from a recycling drive.

**Recycling Metals**

# It's More Than Aluminum Cans

Aluminum can recycling is now so efficient that it is possible for a beverage to be purchased at a grocery store, brought home and consumed, recycled into a new aluminum can, filled with a product, stocked on a grocery store shelf, and sold again–all within 90 days.

All aluminum cans are worth 6 to 20 times more than any other used packaging material. It is the only packaging material that more than covers the cost of its own collection and processing at recycling centers.

Aluminum recycling is popular because it involves a product that is common to a great many people; also because of the vast quantity of canned beverages that are consumed in the U.S.

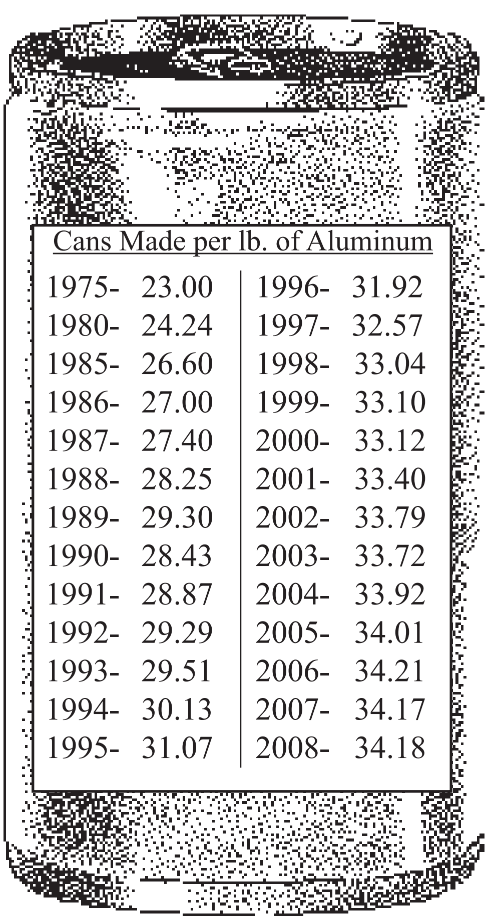
## Where does aluminum come from

Aluminum is the most abundant metal in the Earth's crust, but most of it occurs in minerals that are too expensive to process, except for the mineral *Bauxite*.

Bauxite deposits currently being mined are mainly found in a wide belt around the Equator. There is no bauxite mining in the United States, although small deposits exist in Georgia and Alabama.

Recycling one pound of aluminum can save eight pounds of bauxite, four pounds of chemical products, nearly 6.5 kilowatt-hours of electricity, and won't take up valuable space in a landfill.

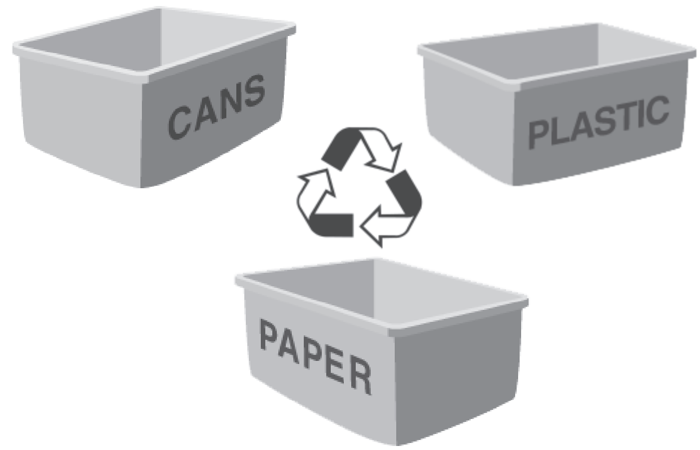
**Number of 12-ounce cans that can be made from one pound of aluminum.**



Cans Made per lb. of Aluminum

| | | | |
|---|---|---|---|
| 1975- | 23.00 | 1996- | 31.92 |
| 1980- | 24.24 | 1997- | 32.57 |
| 1985- | 26.60 | 1998- | 33.04 |
| 1986- | 27.00 | 1999- | 33.10 |
| 1987- | 27.40 | 2000- | 33.12 |
| 1988- | 28.25 | 2001- | 33.40 |
| 1989- | 29.30 | 2002- | 33.79 |
| 1990- | 28.43 | 2003- | 33.72 |
| 1991- | 28.87 | 2004- | 33.92 |
| 1992- | 29.29 | 2005- | 34.01 |
| 1993- | 29.51 | 2006- | 34.21 |
| 1994- | 30.13 | 2007- | 34.17 |
| 1995- | 31.07 | 2008- | 34.18 |

***Recycling is good for the environment and good for the economy.***




*Countries involved in providing aluminum, and their % of world production.*

**Bauxite ($Al_2O_3 \bullet H_2O$)**
is mined in

*More than 190 million tons of bauxite is mined worldwide, each year. Two to three tons of bauxite are required to produce one ton of alumina.*

| | |
|---|---|
| Australia | 34% |
| China | 17% |
| Brazil | 13% |
| Guinea | 7% |
| Jamaica | 7% |
| India | 7% |
| United States | 0.0% |
| Other countries | 16% |

and processed into
**Alumina ($Al_2O_3$)** in

*More than 70 million tons of Alumina is produced, worldwide. Two tons of alumina produces one ton of aluminium metal. NOTE: The U.S. mines no bauxite but produces 7% of the world's alumina.*

| | |
|---|---|
| Australia | 25% |
| China | 19% |
| Brazil | 9% |
| United States | 7% |
| Jamaica | 6% |
| Russia | 5% |
| 20 Other countries | 29% |

which is further processed (by electricity) into primary
**Aluminum (Al)** in

*More than 33 million tons of Aluminum Metal is produced, worldwide. NOTE: Norway mines no bauxite, produces no alumina, but provides 4% of the world's aluminum metal.*

| | |
|---|---|
| China | 18% |
| Russia | 12% |
| United States | 10% |
| Canada | 9% |
| Australia | 6% |
| Brazil | 5% |
| Norway | 4% |

# How Do We Use Our Land?

**Objective: To appreciate our roles in producing and sharing our natural resources.**

**A Few Facts**

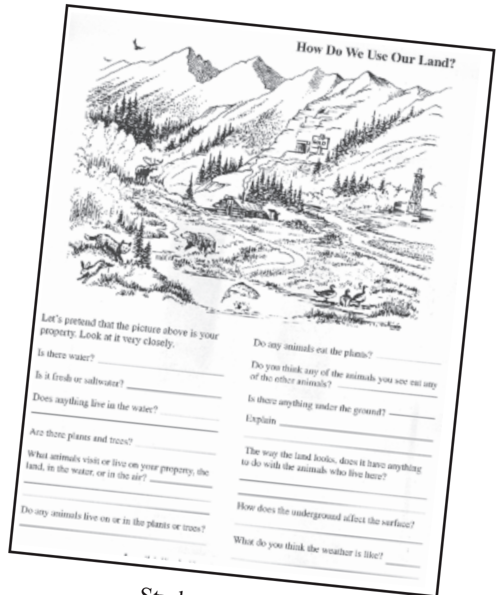
Almost all property in the United States and Canada is controlled by land use regulations. Invite your local land use official to visit your class to discuss local permit rules. Some interesting areas to explore are:

- Land use: zoning laws, building permits, sewage disposal permits, well permits and business licenses.
- Living off the land: hunting and fishing licenses, mining and lumbering permits, housing code approval.

How big is an acre? Unless you live in an agricultural community, acres and hectares are hard for most people to visualize, yet almost all land uses are related to these two measurements.

- 1 acre = 43,560 sq. feet    1 hectare = 107,600 sq. feet

A high school football field equals about an acre. A hectare equals about 2 1/2 football fields.


How Do We Use Our Land?

Let's pretend that the picture above is your property. Look at it very closely.

Is there water? ______

Is it fresh or saltwater? ______

Does anything live in the water? ______

Are there plants and trees? ______

What animals visit or live on your property, the land, in the water, or in the air? ______

Do any animals live on or in the plants or trees? ______

Do any animals eat the plants? ______

Do you think any of the animals you see eat any of the other animals? ______

Is there anything under the ground? ______

Explain ______

The way the land looks, does it have anything to do with the animals who live here? ______

How does the underground affect the surface? ______

What do you think the weather is like? ______

Student Page

**Classroom Experience**

Visit a football field with your class. Encourage them to measure it in many different ways. (They could measure it in time; it would take a 10-year-old nearly 3 minutes to run around one acre.) Estimate how many houses would fit in that space. How large should each house and yard be?

Cooperatively have the class decide what support space would be needed and shared, for roads, some open space, utility poles, etc. The class can then draw up a list of the people to be employed to develop the football field into housing.

Research and discuss: Not all land is suitable for all uses.

You need land (somewhere) for agriculture so you can eat.

You need land (somewhere) for houses so you have a place to live.

You need land (somewhere) for mining to make the things you need.

Our interdependence as a society relies on a limited amount of land and the need to have a continual supply of resources and different uses from that land. Is there a land use we can really do without?

**Read More About It!**

Check out these children's books for your class:

- *Sugaring Time* by Kathryn Lasky; Macmillan Children's Book Group
- *Cranberries* by William Jasperson; Houghton Mifflin
- *Farming* by Gail Gibbons; Holiday House
- *Reflections of a Black Cowboy* by Robert Miller; Silver Burdett Press
- *Luck of the Roaring Camp* by Bret Harte; Dover Publications

**Dig A Little Deeper**

- When the class has developed its plan for the football field (this can easily be done on a computer), ask a representative from the Planning and Zoning agency to come and discuss why – or why not – building permission would be given.
- Research the building of early frontier towns and the building of towns in the thirteen original colonies. Were housing problems different?
- After World War II, when England was rebuilding its cities, it provided for "green space" at specific distances throughout the city. What was the reason?

**Integrating the Curriculum**

1. Develop a plan for a new city, with all support services as well as transportation to other cities. Give the class a limited amount of space and have them discuss (and compromise on) use of land for athletic fields or a homeless shelter.
2. Borrow soil testing materials (and an expert if you can) from your local Soil Conservation Service. Test the soil around the school and discuss soil assays' role in land development. What soil makes the best ballpark? What soil supports a building best?
3. Read a report on the quarrels between ranchers and farmers in the settlement of the west. Suggest that your class construct and role-play a court case involving these two warring factions.
4. If a television tower needed to be put in your neighborhood, how would you feel? Why? What are the alternatives?

# How Do We Use Our Land? *Part I*


Let's pretend that the picture above is your property. Look at it very closely.

Is there water? ____________________

Is it fresh or saltwater? ____________________

Does anything live in the water? ____________________

____________________

Are there plants and trees? ____________________

What animals visit or live on your property, the land, in the water, or in the air? ____________________

____________________

____________________

Do any animals live on or in the plants or trees?

____________________

Do any animals eat the plants? ____________________

Do you think any of the animals you see eat any of the other animals? ____________________

Is there anything under the ground? ____________________

Explain ____________________

____________________

The way the land looks, does it have anything to do with the animals who live here?

____________________

____________________

How does the underground affect the surface?

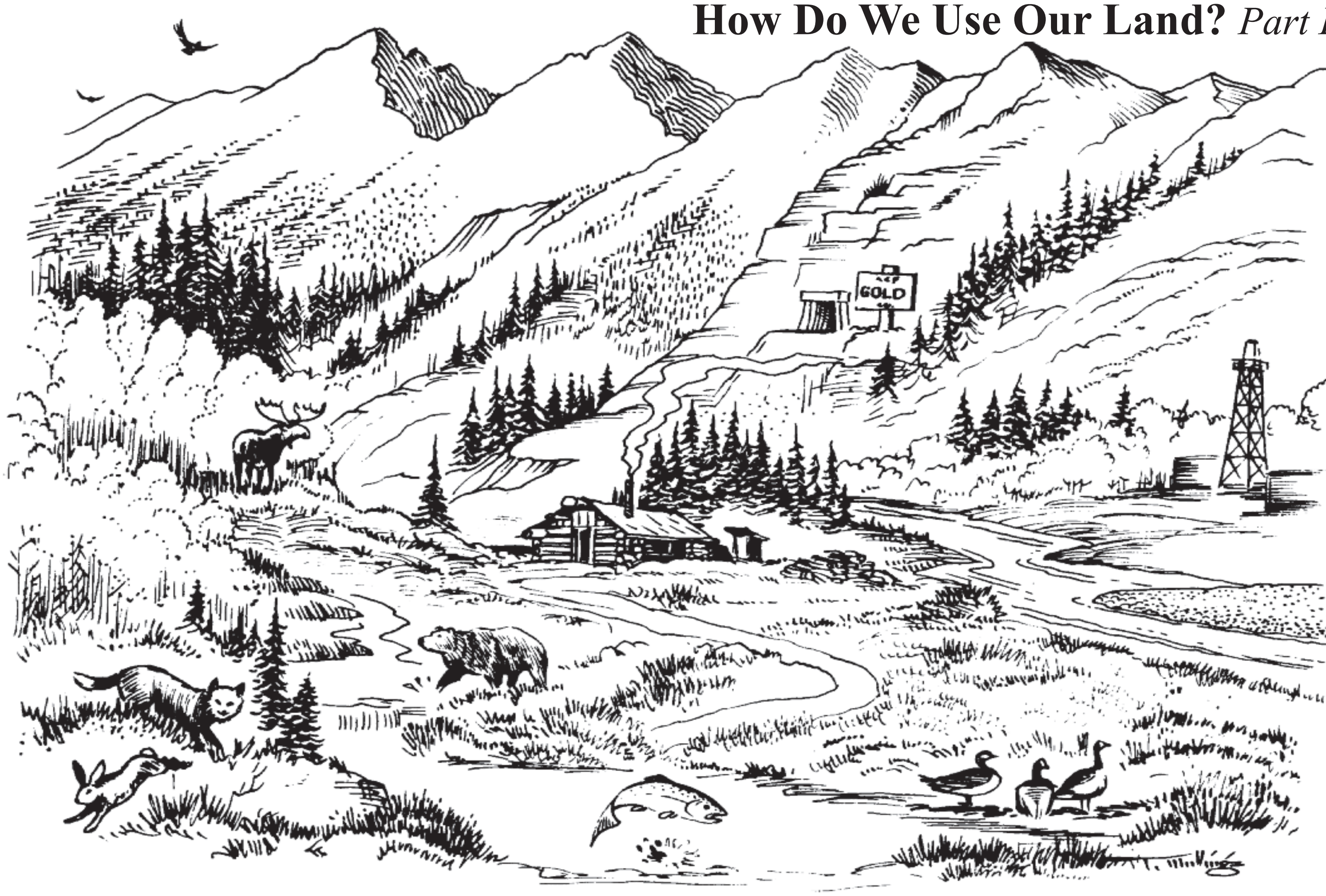
____________________

What do you think the weather is like? ____________________

____________________

*Source: Alaska Mineral and Energy Resource Education Fund (AMEREF)*

# How Do We Use Our Land? *Part II*




Look at the property again. Draw a picture of yourself in the middle of it.

What other questions would you ask?

______________________________________

______________________________________

______________________________________

How do you think you would like living here?

______________________________________

______________________________________

______________________________________

What do you like most about this place?

______________________________________

______________________________________

What kinds of things would you do when you are on your property? What kind of hobby could you have? ______________________

______________________________________

______________________________________

Name your property. Write a short story about how you spend a day there.

Imagine that this property has been owned by your family for many, many years. Although your family has always lived in the nearby town, most of the time in the past you have visited the property during vacation.

What will you do with the property in the next year? ______________________________

______________________________________

______________________________________

What could you do with the property in the next five years? How might you use it?

______________________________________

______________________________________

______________________________________

______________________________________

You have made a land use decision. You did this based on what you know about the land and how you feel about it.

As a land manager this was the first of many decisions you will make about your land.

*Source: Alaska Mineral and Energy Resource Education Fund (AMEREF)*

# **How Will You Use Your Land** *Part III*


Look at the picture again. Things have changed since you first received your land. Your family finds itself without a source of income. Your property is your only means of support. You must make a living from your property and provide food, shelter, and a cash income to provide for your other needs.

How could you provide your food? __________

______________________________________

______________________________________

How will you provide shelter for your family?

______________________________________

______________________________________

______________________________________

What resources on your property could you use to make money? How would you do so?

______________________________________

______________________________________

______________________________________

Remember, when you make decisions about how to use your resources, you are making an *economic* choice.

You have just made land management decisions based on your economic needs and wants. This is part of what a good land manager must do.

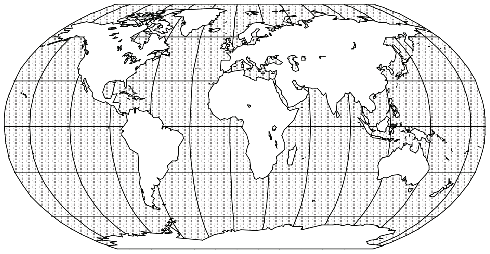
When you had to make decisions about your land, were you wishing you had more land? Maybe you wanted one piece of property with which to make money and another piece of land to enjoy. The problem you faced is the same one other landowners everywhere face. There is only so much land on our Earth from which we make our living and receive pleasure.

Being able to live off the land and also enjoy it, requires good problem solving and decision making skills. Many times, land can provide more than just one use.

*Note: What might happen if you and all your neighbors created hunting lodges or recreational resorts?*

*Source: Alaska Mineral and Energy Resource Education Fund (AMEREF)*

When a mine is finished, the land will be reclaimed
so it can be used again, whether by man or by nature, or both.



# Minerals Imported by the United States

In spite of its size and mineral wealth, the United States is not able to produce all of the minerals it needs to be self-sufficient. To maintain our lifestyle and provide all of the consumer products and infrastructure we use everyday, various amounts of the following minerals must be imported from foreign countries.

## United States Imports of Selected Nonfuel Minerals & Metals

50 percent

| Commodity | Percent | Major Import Sources (2005-08)[1] |
|---|---|---|
| ARSENIC (trioxide) | 100 | China, Morocco, Belgium, Hong Kong |
| ASBESTOS | 100 | Canada |
| BAUXITE and ALUMINA | 100 | Jamaica, Brazil, Guinea, Australia |
| CESIUM | 100 | Canada |
| FLUORSPAR | 100 | China, Mexico, South Africa |
| GRAPHITE (natural) | 100 | China, Mexico, Canada, Brazil |
| INDIUM | 100 | China, Japan, Canada, Belgium |
| MANGANESE | 100 | South Africa, Gabon, China, Australia |
| MICA, sheet (natural) | 100 | China, Brazil, Belgium, India |
| NIOBIUM (columbium) | 100 | Brazil, Canada, Germany, Estonia |
| QUARTZ CRYSTAL (industrial) | 100 | China, Japan, Russia |
| RARE EARTHS | 100 | China, Japan, France, Russia |
| RUBIDIUM | 100 | Canada |
| STRONTIUM | 100 | Mexico, Germany |
| TANTALUM | 100 | Australia, China, Brazil, Japan |
| THALLIUM | 100 | Russia, Germany, Netherlands |
| THORIUM | 100 | United Kingdom, France, Canada |
| VANADIUM | 100 | Czech Republic, Rep. of Korea, Canada, Austria |
| YTTRIUM | 100 | China, Japan, France |
| GALLIUM | 99 | Germany, Canada, China, Ukraine |
| GEMSTONES | 99 | Israel, India, Belgium, South Africa |
| ANTIMONY | 93 | China, Mexico, Belgium |
| BISMUTH | 90 | Belgium, China, United Kingdom, Mexico |
| GERMANIUM | 90 | Belgium, China, Germany, Russia |
| PLATINUM | 89 | South Africa, Germany, United Kingdom, Canada |
| BARITE | 80 | China, India |
| TIN | 80 | Peru, Bolivia, China, Indonesia |
| RHENIUM | 79 | Chile, Netherlands |
| DIAMOND (natural industrial stone) | 78 | Botswana, South Africa, Namibia, India |
| STONE (dimension) | 78 | Brazil, Italy, China, Turkey |
| ZINC | 76 | Canada, Peru, Mexico, Ireland |
| COBALT | 75 | Norway, Russia, China, Canada |
| POTASH | 73 | Canada, Belarus, Germany, Russia |
| TITANIUM MINERAL CONCENTRATES | 73 | South Africa, Australia, Canada, Ukraine |
| TITANIUM (sponge) | 67 | Kazakhstan, Japan, China, Ukraine |
| SILVER | 63 | Mexico, Canada, Peru, Chile |
| TUNGSTEN | 63 | China, Germany, Canada, Bolivia |
| PEAT | 60 | Canada |
| PALLADIUM | 47 | Russia, South Africa, United Kingdom, Belgium |
| NITROGEN (fixed), AMMONIA | 40 | Trinidad and Tobago, Canada, Russia, Ukraine |
| CHROMIUM | 39 | South Africa, Kazakhstan, Russia |
| VERMICULITE | 39 | China, South Africa |
| GARNET (industrial) | 37 | India, Australia, China, Canada |
| DIAMOND (dust, grit and powder) | 35 | China, Ireland, Russia, Republic of Korea |
| MAGNESIUM METAL | 35 | Canada, Israel, Russia, China |
| MAGNESIUM COMPOUNDS | 28 | China, Austria, Canada, Australia |
| SILICON (ferrosilicon) | 27 | China, Russia, Venezuela, Canada |
| COPPER | 24 | Chile, Canada, Peru, Mexico |
| PERLITE | 21 | Greece |
| GYPSUM | 19 | Canada, Mexico, Spain |
| SALT | 19 | Canada, Chile, Mexico, Peru |
| ALUMINUM | 18 | Canada, Russia, Brazil, Venezuela |
| NICKEL | 18 | Canada, Russia, Australia, Norway |
| MICA, scrap and flake (natural) | 11 | Canada, China, India, Finland |
| CEMENT | 8 | China, Canada, Republic of Korea, Thailand |
| IRON and STEEL SLAG | 8 | Japan, Canada, Italy, France |
| IRON and STEEL | 7 | Canada, European Union, China, Mexico |
| SULFUR | 4 | Canada, Mexico, Venezuela |
| PUMICE | 3 | Greece, Turkey, Iceland, Mexico |
| BERYLLIUM | 2 | Kazakhstan, United Kingdom, Kenya, Ireland |
| LIME | 2 | Canada, Mexico |
| STONE (crushed) | 2 | Canada, Mexico, The Bahamas |
| PHOSPHATE ROCK | 1 | Morocco |

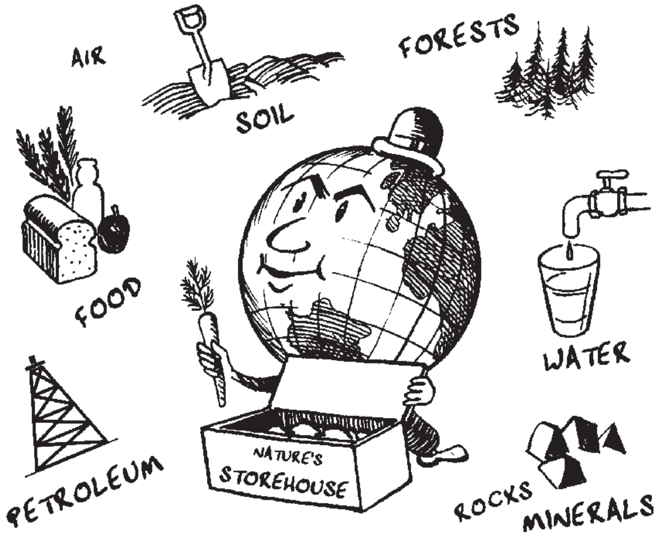
[1]In descending order of import share.

Source: U.S. Geological Survey, Mineral Information Team

# 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).

**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!

### HOW DOES THE USE AND SUPPLY OF RESOURCES DIFFER AMONG PEOPLE AND PLACES?

Mineral and energy resources are essential to everyone. A nation cannot enjoy prosperity without a reliable source. No country is entirely self sufficient when it comes to minerals and needs. Because of this interdependency, countries of the world need to cooperate.

The United States is one of the most highly industrialized nations in the world. We have a high standard of living because of our mineral and energy resource base. We have 5% of the world's population and 7% of the world's land area, but we use about 30% of the world's mineral resources. Our needs, which the consumer demands, are so large that we must buy many resources from other countries. This is called *importing*. The need for mineral and energy resources in the world continues to grow and is a major part of world trade.

### 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.

### DIG A LITTLE DEEPER

- What does the word *concentrate* mean? Why is it important to have minerals concentrated in one place rather than scattered all around? What processes help in concentrating mineral resources?
- Name at least 3 important natural resources that can be found in your state. Why are these important?
- Pick out your favorite clothes. Look at the tags sewn inside and learn if they are made from natural fibers, synthetic fibers or both. List the fibers used to make your clothes. How did minerals play a part in the making of your clothes? (Hint—Don't forget the *sewing machine*)

# GEOLOGY and NATURAL RESOURCE DEVELOPMENT

Geology is a study of the Earth and its history as recorded in the rocks. The study of geology involves understanding the relationship between the rocks of the crust of the Earth and envelopes of air and water. Geology is a study of processes—processes that form continents and ocean basins, mountains and oceanic deeps, glaciers and lakes, sand bars and rocky cliffs, and deposits of minerals, coal and oil and gas. Geologists study rocks to determine what the Earth was like thousands, millions, and billions of years ago. Geologists study volcanoes, lavas, earthquakes, and landslides. They discover how our mineral deposits formed. They give us theories on how the Earth was formed, how it developed, and what the core of the Earth is like. The Earth is about 4.5 billion years old. Geology tells us how the Earth has changed and continues to change. Hills are worn down to form lowlands that may be covered by the sea. Millions of years later, rocks from under the sea may be raised up to form high mountains. The Earth is the geologists' laboratory.

**WHY IS AN UNDERSTANDING OF GEOLOGY IMPORTANT TO ME?**

The Earth is where we live. We are dependent upon our Earth. Our water supply and our farm land formed by geologic processes. All our minerals, fuels, and construction materials come from the Earth's crust. The Earth will remain a nice place to live if we use our resources wisely and control our wastes and garbage. There are natural earth hazards like floods, landslides, earthquakes, and volcanic eruptions. The understanding of geology can lead us to the safest areas in which to build cities, dams, schools, or roads and tunnels. If we understand geologic processes we will know the best places to dispose of our wastes and garbage, and the best geologic environments for finding oil, gas, and coal.

If we understand geology we can learn ways to use the resources of the Earth and at the same time protect it from harm.

**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 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.

*In Canada, geologists have trained dogs to sniff out exploration clues. German Shepherds have been taught to use their excellent sense of smell to find sulfides of lead, zinc, copper, nickel, molybdenum, and silver.*

**HOW WERE MINERAL RESOURCES FORMED?**

As the Earth changes, different types of rocks are formed. There are three types of rocks: igneous, sedimentary, and metamorphic.

Igneous rocks are formed from magma (hot melted rock) as it cools and becomes solid. As hot magma cools, minerals such as chromite (chrome is used in stainless steel) and platinum (used in catalytic converters) form.

Sedimentary rocks are formed from particles of older rocks. The particles are deposited in a body of water, a valley, or a low plain. The collection of particles is known as sediment. After the particles are deposited, new sediment is deposited on top burying the earlier deposited materials. When sediments are buried, they become cemented to form sedimentary rock. Limestone (used to make cement and statues) and clay (used to make dishes) are examples of sedimentary rocks.

Metamorphic rocks are formed in the Earth where there is high temperature and great pressure. The heat and pressure change one kind of rock into another kind of rock. This process of change is known as metamorphism. You can think of the change from brownie dough to brownies as metamorphism. Marble (used in buildings) is metamorphosed limestone. A mineral from which tungsten (light bulb filaments are made of tungsten) is produced is formed by metamorphism. As igneous, sedimentary, and metamorphic rocks are made, minerals may be so concentrated as to become resources for us to use.

The Earth is always changing. Rocks are slowly worn down by the forces of weathering and erosion. Rocks can be lifted or pushed downward. They also can be moved sideways and tilted.

For example, dead trees and plants accumulate in bogs and later are buried between layers of clay and mud. The layers become sedimentary rock. The dead trees and plants are slowly changed to coal. We might say metamorphosed to coal. Oil and gas also formed in sedimentary rock, they came from decayed animals and plants.

Today, these processes continue. New coal beds are being formed in bogs and swamps, mineral deposits are being created on ocean floors by volcanic activity. Our Earth is, indeed, an exciting place to be!

## 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 risky 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.

### DIG A LITTLE DEEPER!

The word **geology** comes from Greek words. Find out what they are and their meaning.

There are many branches of geology, such as geochemistry, geophysics, and mineralogy. Do some research and find more branches of geology and find out what each branch studies.

If you were a geologist, what tools and equipment would you need? What qualifications do you need to become a geologist?

For a wonderful imaginary trip through the inside of the Earth read *How to Dig a Hole to the Other Side of the World* by Faith McNulty (Harper & Row, 1979).

Be a ROCKHOUND! Start collecting rocks and minerals. Identify your rocks by using reference books from the library. Maybe you can meet a geologist who will help you. Share your collection with the class.

Make a list of 10 rocks and minerals and, using a book from your school library, classify the rocks. Example: granite—igneous; limestone—sedimentary; marble—metamorphic.

Why can't we just find a mineral resource and use it as is instead of having to process it?

Choose one thing in your classroom or home that you like to use. Try to find what mineral resources it contains.

Find out more about the "Ages." Choose the Stone Age, Bronze Age, or Iron Age —and list at least five important facts about it.

Take a field trip through your neighborhood and record as many different uses of rocks and minerals as you can.

Some elements have strange sounding names. Look up molybdenum, vanadium, beryllium, selenium, and zirconium. What can you find out about each? In what products are they used?

# COPPER—THE ANCIENT METAL

Man's first use of the Earth's natural resources was in the form of grasses, trees, animals and stone. Tools and weapons were made from wood, bone and stone. Flint was one of the stones first because it is a hard, dense mineral. It is one of the purists native forms of silica. A steel knife, today, is no sharper than an obsidian knife or spear point. Obsidian is a hard, glassy rock that is formed by volcanic eruptions.

Ancient people were our first "geologists" and "miners." They not only determined which rocks were best to use, but they learned how to make them into tools, hunting spears, arrows, fishhooks and ornaments. Shaping the stone was done by flaking it with sharp blows on the edges using another stone or deer antlers.

*Stone-Age* people knew nothing of metal. Colorful minerals were used for decoration or for barter. When emerald-green **malachite** (a copper ore) or a rusty-red **hematite** iron ore were found, they would be ground to a powder and used as pigments to decorate the face and body. They also used these and other colorful minerals pigments to paint the walls of caves and protected coves. Today, many minerals are used for paint pigments.

Can you imagine how excited these people were when they found native copper? It could be formed into decorative shapes and tools more easily by pounding it with a stone on a hard surface. This was after 6000 B.C. and is known as the *Copper Age*.

Both methods—flaking and pounding— were society's first forms of manufacturing. Therefore, Earth's resources were converted for man's use! The island of Cyprus, from which the word copper is derived, was a major source of copper for the Roman empire.

Over 4,000 years ago, when it was discovered that minerals could be melted, curiosity led man to combine melted metals (alloys). By accident they made bronze by adding tin to copper (the *Bronze Age*). Another combination of zinc and copper made brass. Both bronze and brass are stronger than pure copper. They do not corrode in air or water. Without these combinations of minerals and man's knowledge of mining and separating them, we would not have enough copper to take care of our needs today.

When copper tarnishes, it turns green to black on the surface. Some of the biggest deposits of copper were found by accident when prospectors noticed greenish rock sticking out of the ground (this is called an outcrop). Many of these discoveries were huge mountains of copper ore that also contained other important minerals.

Throughout the thousands of years since native copper was discovered, man has made great use of this element. Copper has a chemical symbol, as do all elements. It is Cu. Minerals are seldom found in a pure state. They are found bonded together with other minerals.

Copper is one of the most useful of the metals, and probably the one first used by man. It is found native and in a variety of combinations with other minerals. It is often a by-product from silver and other mining. Copper has many colors from yellowish-to-reddish brown, red, pink, blue, green, and black. The colors are determined by the other elements (minerals) combined with the copper.

Copper is malleable, ductile and long lasting. Copper conducts heat and electricity better than any other metal except silver. It has a wide use in electric and electronic equipment. It is used for tubing and pipes for plumbing and can be made into sheets for roofing. Copper also is used in chemical compounds. Copper chemicals are used in plant sprays and to treat swimming pools to keep algae from growing. Copper and its alloys are important for parts of automobiles, airplanes, missiles and satellites.

Recycling of copper has been ongoing for many, many years. It is collected as scrap metal and separated from other metals and materials by smelting and refining. Recycled copper is called secondary copper and it is used at brass mills and made into new things for our use.

Since ancient man and his use of flint and obsidian we have learned a lot about our Earth and its many resources.

Each day, scientists learn more about the mineral wealth locked in our planets crust. More is learned about new mineral wealth being born through volcanic activity. Earthquakes sometimes take away ore deposits. And at other times earthquakes bring new mineral deposits closer to the Earth's surface.

Science and technology have shown us how to find, extract, process, and use mineral resources to the benefit of man. We are lucky to live in this time of history.

## COPPER FACTS

**Copper** is a *native element*. The crystal system of native copper is cubic. It has a metallic luster and a specific gravity of 8-9 with a hardness of 2-1/2 to 3 and can be easily scratched with a knife. Native copper has no cleavage and its fracture is hackly. This element is heavy, ductile and malleable. Native copper is copper red on fresh fracture but may be greenish or bluish or tarnished if weathered. It is often found with small amounts of arsenic, antimony, bismuth, iron, and silver.

### Copper Ores

**Malachite** (pronounced mala-kite) is usually a bright green color and has a nonmetallic luster. It has a light green streak and can always be scratched with a knife. Malachite, a copper carbonate, is an important ore of copper and is a good indicator of copper deposits. In its pure form it contains 57% copper, the rest is made up of carbonate and water.

**Azurite** also is a copper carbonate. It's streak is light blue. Malachite and azurite frequently occur together and are found in the upper weathered (oxidized) zones of copper ore bodies. Azurite is the scarcer of the two has a soft blue color.

**Chalcopyrite** is an iron-copper sulfide. It has a brass yellow color. It is distinguished from pyrite by being softer and yellower. Its golden glint when in small specks in quartz often is mistaken for gold. The glint will disappear when turned at certain angles to the light while gold appears the same at all angles. Chalcopyrite is the primary ore of copper and is prevalent wherever copper ore is being mined below the surface zone.

**Chalcocite** is a copper sulfide. It is one of the highest grade and most important ores of copper and is opaque with a dark lead gray to black color. Chalcocite is often associated with and shows alteration to azurite, bornite, covellite, malachite, and native copper. Important deposits are found in Arizona's Bagdad, Jerome, and Superior areas. Other localities include Bingham, Utah; Santa Rita, New Mexico; Ely, Nevada, and the Genesee Valley district in California.

**Bornite** is a copper-iron sulfide. Its color is a natural bronze, but on exposure it tarnishes to the varigated colors that have caused it to be nicknamed "Peacock ore." It is rarely found on the surface but is prevalent in deeper levels of copper mines.

**Turquoise** is a hydrous aluminum phosphate with copper. To be desirable for gems the color should be green blue. The color is due to the presence of copper and is found near the surface of copper deposits. Sometimes in may appear as an outcrop.

**Chrysocolla** has various shades of blue to green and is a hydrous copper silicate. It is often found with azurite and malachite. Although its color is attractive, it is too soft to make good gem stones. Be aware of this fact when buying jewelry. Sometimes chrysocolla is passed off as turquoise.

### The Sewing Machine—Its Story

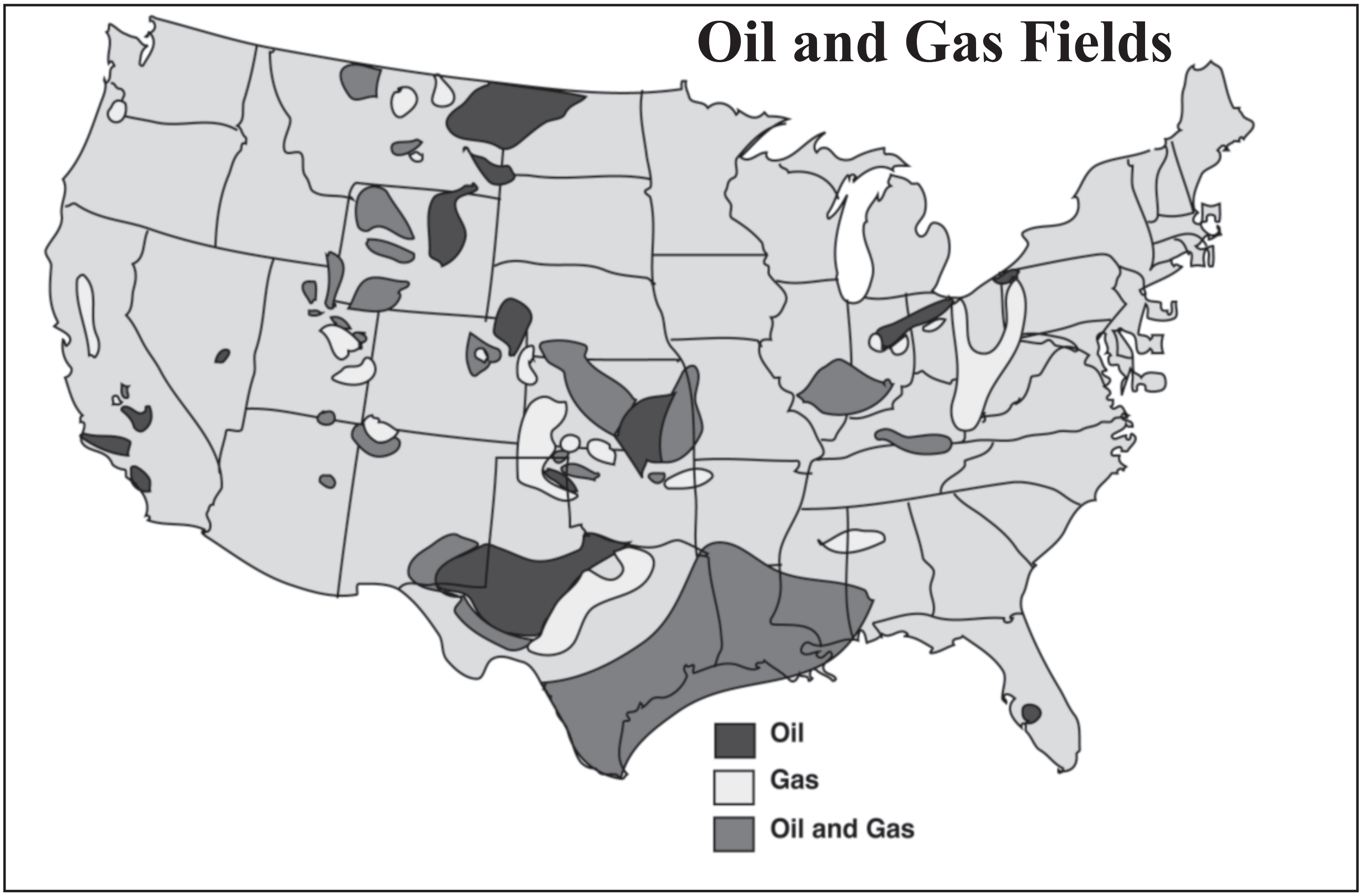
Attempts to invent a sewing machine date as far back as 1775. But not until 1830 was a practical machine invented. Its inventor was Bathelemy Thimmonier of France. It made a "chain stitch" with a hooked needle and was built out of wood.

Around 1848, Elias Howe (an American) invented the "eye needle" which made a "lock stitch" and had a small shuttle that carried the thread through the loop made by the needle. An improved sewing machine was developed in 1850 with the invention of a round bobbin and hook by Allen Benjamin Wilson. Both machines were hand operated. **Isaac Singer** invented the foot treadle and a presser foot that kept the fabric in place.

Today, electricity has replaced the foot treadle. Sewing machines have motors. Motors are powered by electricity—which is another gift from **copper**!

### DIG A LITTLE DEEPER

- What other elements are classified as *native*?
- Take the new words you have learned today and put them in a list. Now, use them to make a Word Search. Try your word search on a classmate or someone at home.
- If there is copper or another mineral in your area, is it being mined? If so, write a letter to the mining company to find out if they give school tours. Maybe the company has a speaker who would come to your class to tell you more. Ask!
- If you look around your classroom or your home you will find many things in which copper is used. Some are hidden — like the wiring inside a wall that brings electricity into your home or school. How many other uses can you discover?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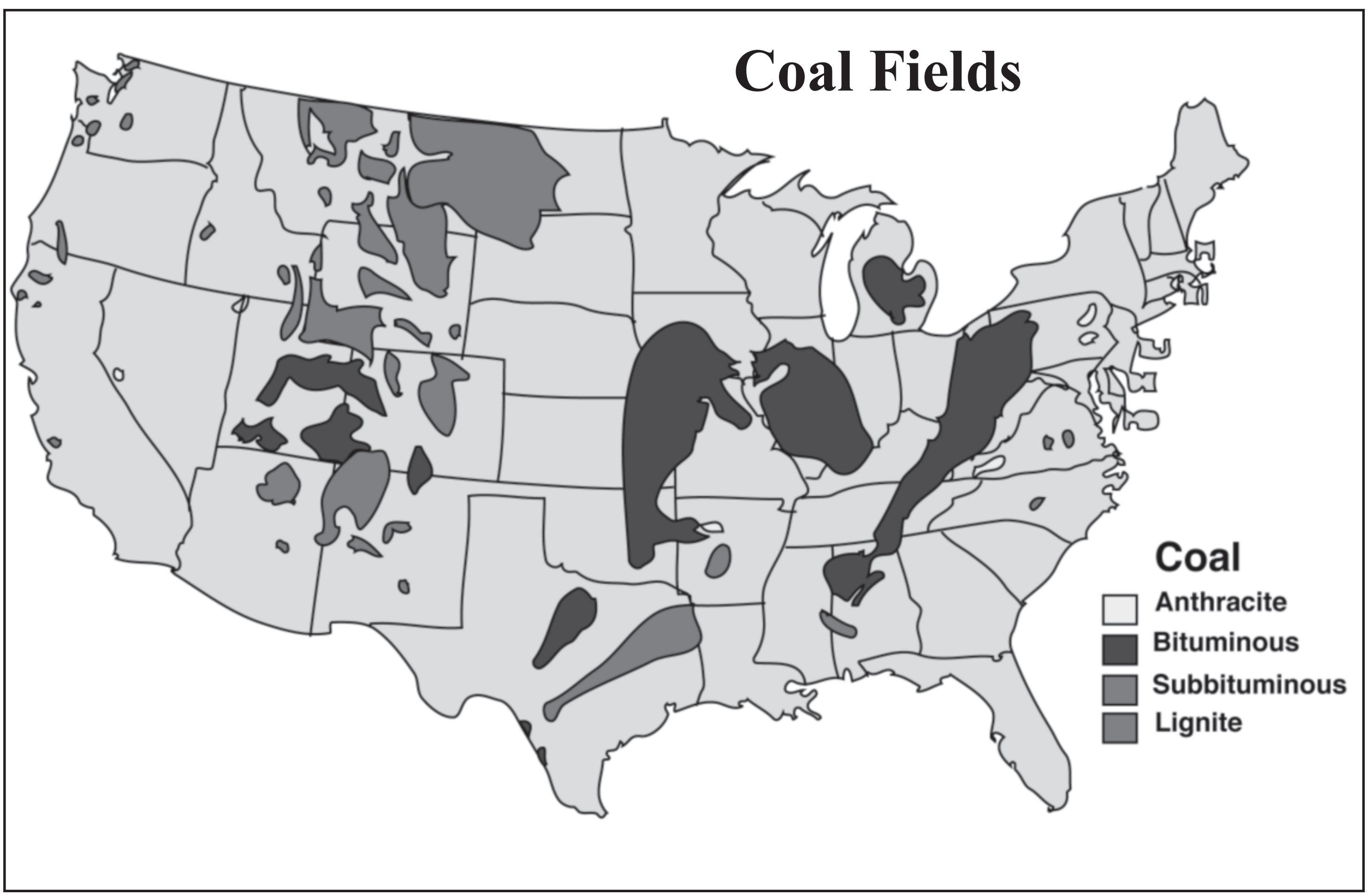
Oil and Gas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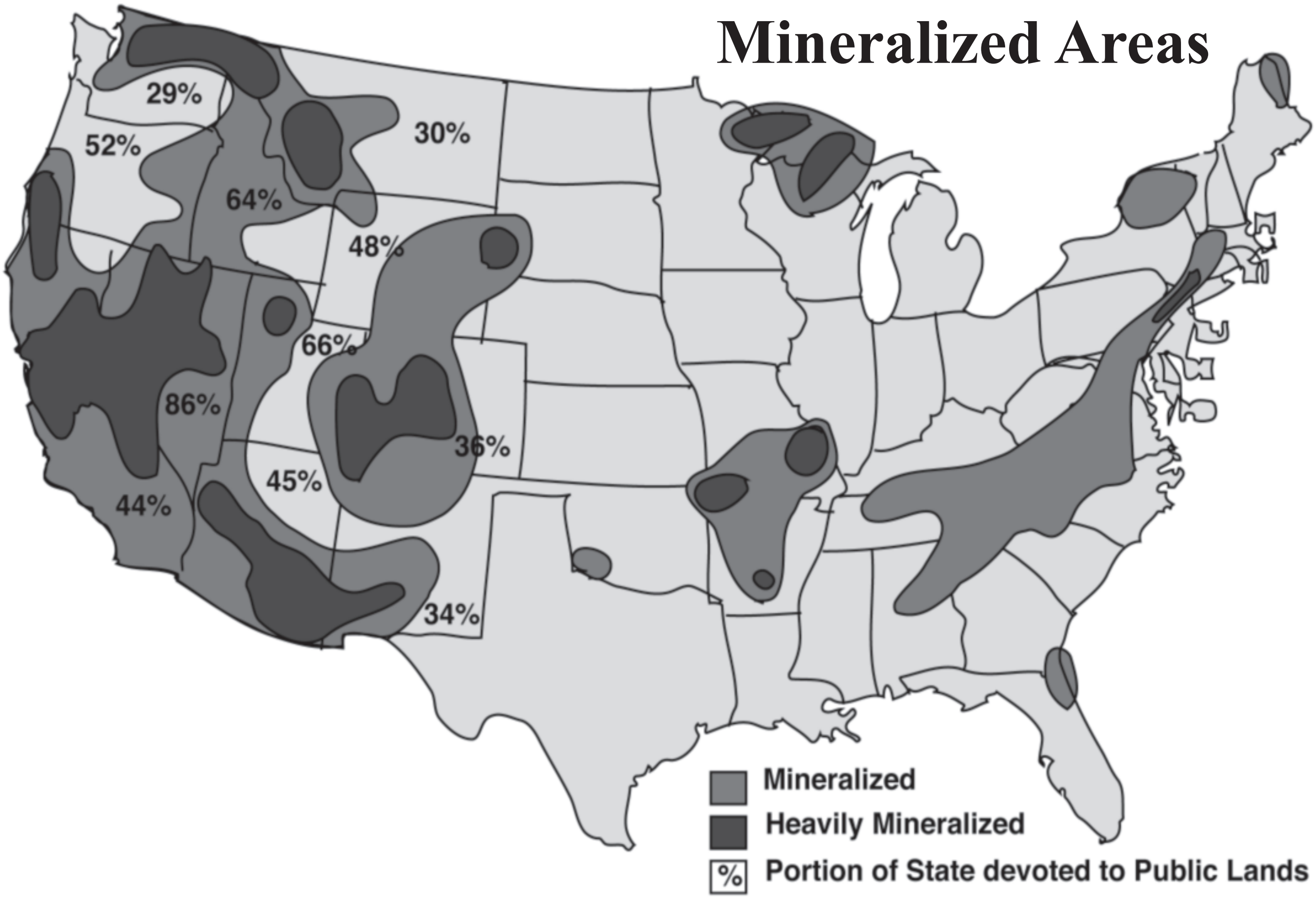
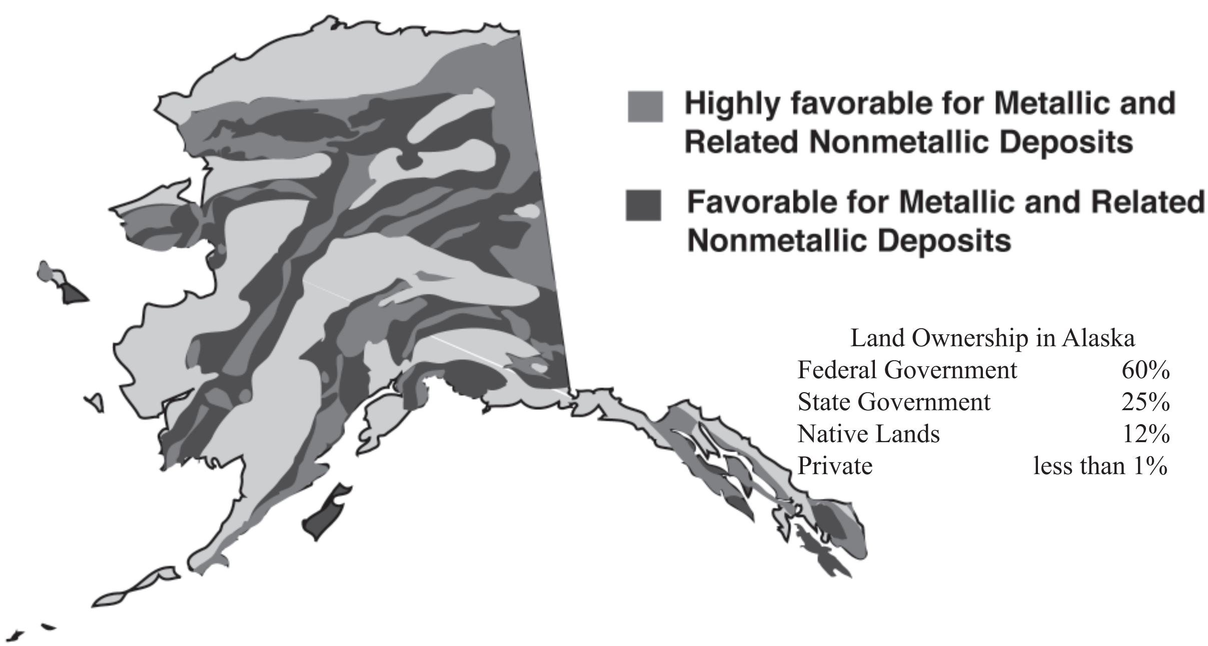
Lignite

# Mineralized Areas




# Alaska's Mineralized Zones

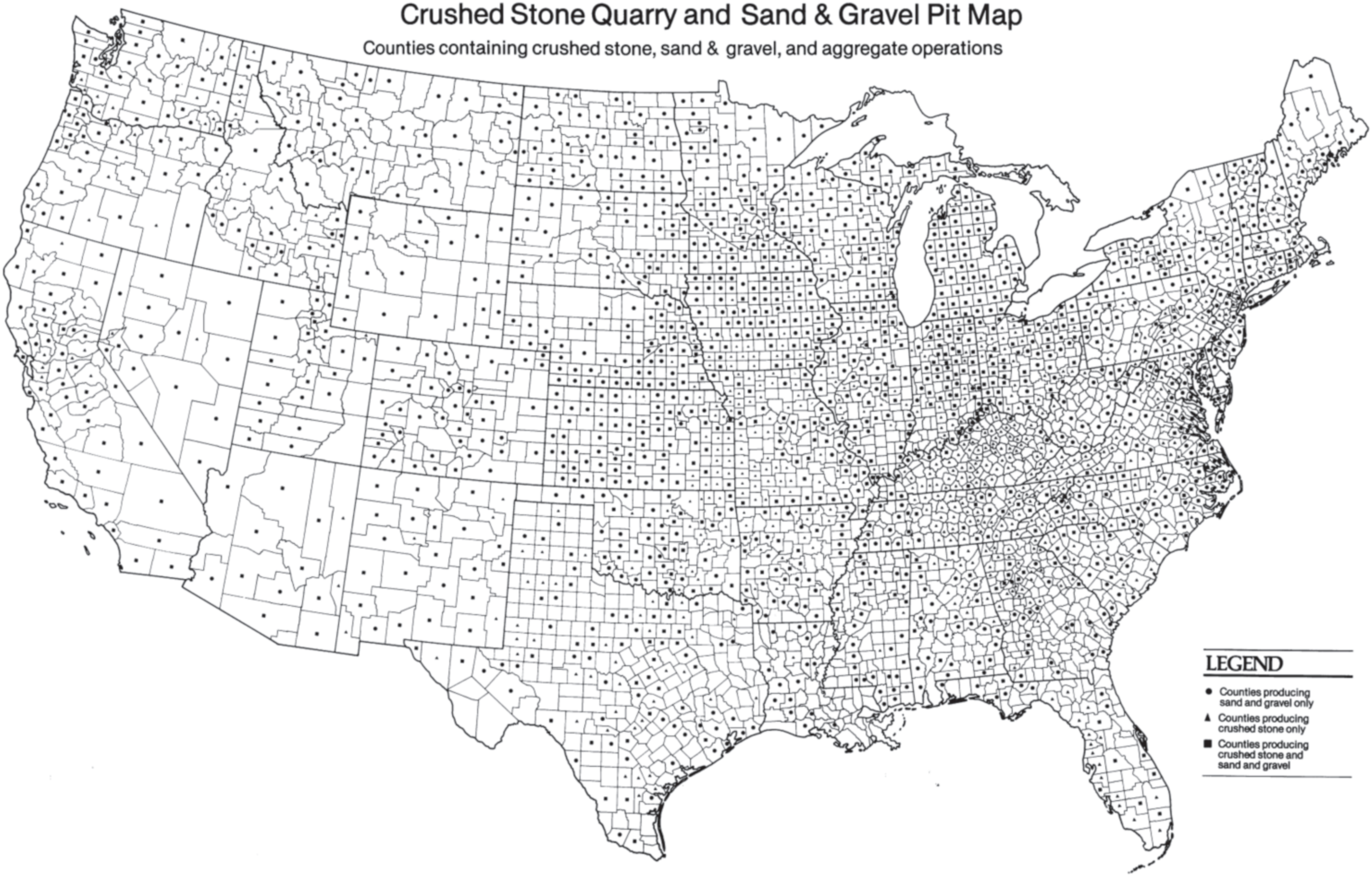



| Land Ownership in Alaska | |
|---|---|
| Federal Government | 60% |
| State Government | 25% |
| Native Lands | 12% |
| Private | less than 1% |

This Alaska map is to scale with the above map of the U.S.

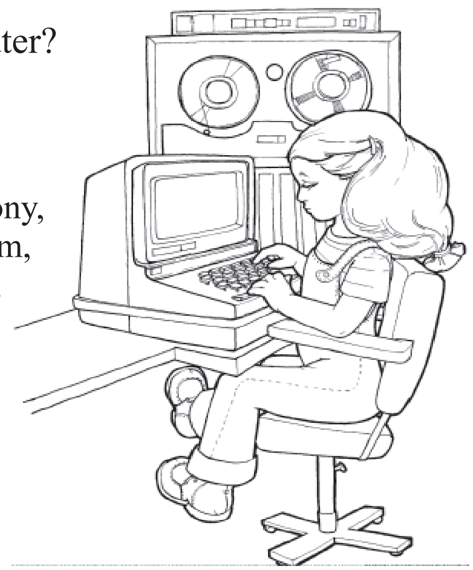
# Crushed Stone Quarry and Sand & Gravel Pit Map

Counties containing crushed stone, sand & gravel, and aggregate operations



# DID YOU KNOW

It takes more than 33 minerals and elements to make a computer?



List the minerals and elements used in computers and find out in which States they are found.

Those vital computer ingredients consist of: aluminum, antimony, barite, beryllium, cobalt, columbium, copper, gallium, germanium, gold, indium, iron, lanthanides, lithium, manganese, mercury, mica, molybdenum, nickel, platinum, quartz crystals, rhenium, selenium, silicon, silver, strontium, tantalum, tellurium, tin, tungsten, vanadium, yttrium, zinc, and zirconium.

And, we can't forget the petroleum industry's role in the computer. All the components are housed in plastic.

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CONTACT your State Geologist for a list of publications, maps, and services available to help you.

*Geologist: One engaged in geologic study or investigations; one versed in geology.*

A geologist—

- studies the physical nature, structure and history of the Earth's crust;
- conducts research into the formation and dissolution of rock layers;
- analyzes fossil and mineral content of layers and endeavors to fix historical sequence of development by relating characteristics to known geologic influences;
- studies dynamic processes that bring about changes in the Earth's crust: great internal pressure and heat; volcanic eruptions; earthquakes; and air, water, and glacial erosion;
- studies seismic, gravitational, electrical, thermal, and magnetic phenomena to determine structure and composition of the Earth's surface;
- employs theoretical knowledge and research data to locate mineral, oil and gas deposits, and determines the probable area, slope, and accessibility of ore deposits; and
- prepares reports, maps and diagrams of regions explored.

Geologists love their profession because of the challenge of solving complex scientific problems. They especially enjoy the out-of-doors field work. Geologists also gain great satisfaction when their knowledge benefits humanity by finding resources, recognizing geologic hazards, or providing data for land-use decisions.

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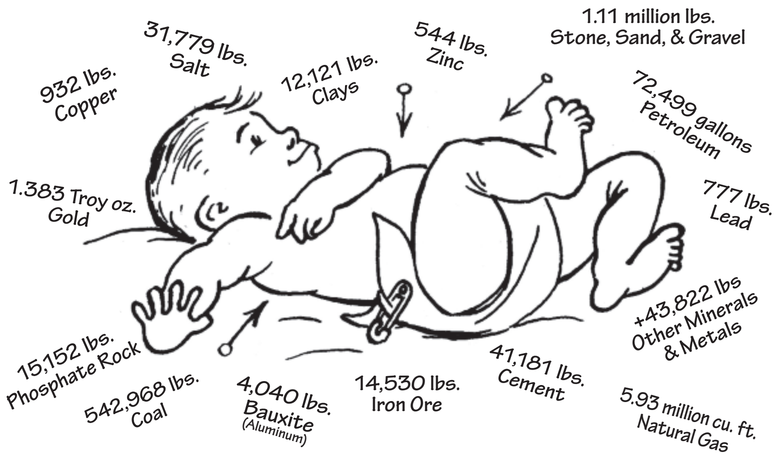
## Every American Born Will Need...




**2.9 million pounds of minerals, metals, and fuels in their lifetime**

# MINERAL USES 40 common minerals and metals Why Are They Important

**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. The United States uses about one-third of total world consumption. Cobalt resources in the U.S. 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, and Canada.

**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.

**Iron Ore:** used to manufacture steels of various types. Powdered iron: used in metallurgy products; magnets; high-frequency cores; auto parts; catalyst. Radioactive iron (iron 59): in medicine; tracer element in biochemical and metallurgical research. Iron blue: in paints, printing inks; plastics; cosmetics (eye shadow); artist colors; laundry blue; paper dyeing; fertilizer ingredient; baked enamel finishes for autos and appliances; industrial finishes. Black iron oxide: as pigment; in polishing compounds; metallurgy; medicine; magnetic inks; in ferrites for electronics industry. Major producers of iron ore include Australia, Brazil, China, and the former Soviet Union.

**Lead:** used in lead batteries, gasoline additives and tanks, and solders, seals or bearings; used in electrical and electronic applications; TV tubes, TV glass, construction, communications, and protective coatings; in ballast or weights; ceramics or crystal glass; tubes or containers, type metal, foil or wire; X-ray and gamma radiation shielding; soundproofing material in construction 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 is 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. Alaska and Nevada produce most of the U.S. silver. Largest silver reserves are found in Chile, Peru, Poland, Mexico and China.

**Sodium Carbonate** (Soda Ash or Trona): used in glass container manufacture; in fiberglass and specialty glass; also used in production of flat glass; in liquid detergents; in medicine; as a food additive; photography; cleaning and boiler compounds; pH control of water.

**Stibnite** (the main ore of Antimony): used for metal antifriction alloys, metal type, shot, batteries; in the manufacture of fireworks. Antimony salts are used in the rubber and textile industries, in medicine; and glass making.

**Sulfur:** used in the manufacture of sulfuric acid, fertilizers, chemicals, explosives, dyestuffs, petroleum refining; rubber; fungicides.

**Tantalum:** a refractory metal with unique electrical, chemical, and physical properties is used to produce electronic components; used for high-purity metals in products ranging from weapon systems to superconductors; capacitors; chemical equipment; dental and surgical instruments; rectifiers; vacuum tubes; furnace components; high-speed tools; catalyst; sutures and body implants; electronic circuitry; thin-film components. Used in optical glass and electroplating devices. There is no tantalum mined in the United States.

**Titanium:** a metal used mostly in jet engines, airframes, and space and missile applications; produced in the western 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 of vanadium. Large reserves are also found 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 alloying 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. mine production mostly comes from Tennessee, Missouri, New York and Alaska.

# MAJOR MINERAL and ENERGY OCCURRENCES - UNITED STATES

There are known reserves of the following mineral materials in nearly every state: construction sand and gravel, crushed stone, a variety of industrial minerals, and gemstones.

**Alabama:** Asphalt (At); Bauxite (Al); Clay (Cl); Coal (C); Iron Ore (Fe); Limestone (Ls); Marble (Mr); Mica (Mi); Salt (Na); and, Petroleum (O).

**Alaska:** Beryl (Be); Coal (C); Copper (Cu); Gold (Au); Iron Ore (Fe); Mercury (Hg); Molybdenum (Mo); Natural Gas (G); Petroleum (O); Platinum (Pt); Tungsten (W); Uranium (U), and, Zinc (Zn).

**Arizona:** Asbestos (Ab); Copper (Cu); Gold (Au); Gypsum (Gp); Lead (Pb); Mercury (Hg); Molybdenum (Mo); Silver (Ag); Uranium (U); Vanadium (V); and, Zinc (Zn).

**Arkansas:** Barite (Ba); Bauxite (Al); Bromine (Br); Clay (Cl); Coal (C); Diamonds (D); Gypsum (Gp); Marble (Mr); Natural Gas (G); Petroleum (O); Soapstone (Sp), and, Zinc (Zn).

**California:** Asbestos (Ab); Borax (Bx); Bromine (Br); Clay (Cl); Copper (Cu); Gold (Au); Gypsum (Gp); Iron Ore (Fe); Lead (Pb); Lithium (Lt) Magnesium (Mg); Marble (Mr); Mercury (Hg); Molybdenum (Mo); Natural Gas (G); Petroleum (O); Platinum (Pt); Potash (K); Rare Earths (RE); Salt (Na); Silver (Ag); Talc (Tc); Tungsten (W); and, Zinc.

**Colorado:** Beryl (Be); Clay (Cl); Coal (C); Copper (Cu); Fluorspar (F); Gold (Au); Iron Ore (Fe); Lead (Pb); Marble (Mr); Mica (Mi); Molybdenum (Mo); Natural Gas (G); Petroleum (O); Silver (Ag); Tungsten (W); Uranium (U); Vanadium (V); and, Zinc (Zn).

**Connecticut:** Clay (Cl), Mica (Mi).

**Delaware:** Marl (Greensand) and Magnesium (Mg+) Compounds (from sea water).

**Florida:** Clay (Cl); Limestone (Ls); Peat (Pe); Phosphates (P); Titanium (Ti); and, Zirconium (Zr).

**Georgia:** Barite (Ba); Bauxite (Al); Clay (Cl); Gold (Au); Granite (Gn); Iron Ore (Fe); Manganese (Mn); Marble (Mr); Mica (Mi); Slate (Sl); Talc (Tc); and, Titanium (Ti).

**Hawaii:** Clay (Cl). Volcanic activity is building unknown mineral wealth at this time.

**Idaho:** Antimony (Sb); Cobalt (Co); Copper (Cu); Gold (Au); Iron Ore (Fe); Lead (Pb); Mercury (Hg); Phosphates (P); Silver (Ag); Thorium (Th); Titanium (Ti); Vanadium (V); Tungsten (W); and, Zinc (Zn).

**Illinois:** Clay (Cl); Coal (C); Fluorspar (F); Lead (Pb); Limestone (Ls); Petroleum (O); and Zinc (Zn).

**Indiana:** Clay (Cl); Coal (C); Gypsum (Gp); Limestone (Ls); Natural Gas (G); and, Petroleum (O).

**Iowa:** Clay (Cl); Coal (C); Gypsum (Gp); and, Limestone (Ls).

**Kansas:** Clay (Cl); Coal (C); Gypsum (Gp); Helium (He); Lead (Pb); Limestone (Ls); Natural Gas (G); Petroleum (O); Salt (Na); and, Zinc (Zn).

**Kentucky:** Clay (Cl); Coal (C); Fluorspar (F); Limestone (Ls); Natural Gas (G); and, Petroleum (O).

**Louisiana:** Gypsum (Gp); Natural Gas (G); Petroleum (O); Salt (Na), and, Sulfur (S).

**Maine:** Clay (Cl); and, Mica (Mi).

**Maryland:** Clay (Cl); Coal (C); Limestone (Ls); and, Natural Gas (G).

**Massachusetts:** Granite (Gn); and, Limestone (Ls).

**Michigan:** Bromine (Br); Clay (Cl); Copper (Cu); Gypsum (Gp); Iron Ore (Fe); Limestone (Ls); Natural Gas (G); Peat (Pe); Petroleum (O); Potash (K); and, Salt (Na).

**Minnesota:** Clay (Cl); Cobalt (Co); Copper (Cu); Granite (Gn); Iron Ore (Fe); Limestone (Ls); Manganese (Mn); and Nickel (Ni).

**Mississippi:** Clay (Cl); Iron Ore (Fe); Natural Gas (G); and, Petroleum (O).

**Missouri:** Barite (Ba); Clay (Cl); Coal (C); Copper (Cu); Iron Ore (Fe); Lead (Pb); Limestone (Ls); Marble (Mr); Natural Gas (G); Silver (Ag); and, Zinc (Zn).

**Montana:** Copper (Cu); Gold (Au); Graphite (Gr); Gypsum (Gp); Lead (Pb); Manganese (Mn); Natural Gas (G); Petroleum (O); Palladium (Pd); Phosphates (P); Platinum (Pt); Silver (Ag); Thorium (Th); Tungsten (W); Vermiculite; and, Zinc (Zn).

**Nebraska:** Clay (Cl); Natural Gas (G); and Petroleum (O).

**Nevada:** Barite (Ba); Clay (Cl); Copper (Cu); Gold (Au); Gypsum (Gp); Lead (Pb); Lithium (Lt); Magnesium (Mg); Mercury (Hg); Molybdenum (Mo); Petroleum (O); Salt (Na); Silver (Ag); Sulfur (S); Tungsten (W); and, Zinc (Zn).

**New Hampshire:** Beryl (Be); Granite (Gn); Mica (Mi); Thorium (Th).

**New Jersey:** Clay (Cl); Titanium (Ti); and, Zinc (Zn).

**New Mexico:** Coal (C); Copper (Cu); Gold (Au); Gypsum (Gp); Lead (Pb); Marble (Mr); Molybdenum (Mo); Natural Gas (G); Petroleum (O); Potash (K); Salt (Na); Silver (Ag); Uranium (U); Vanadium (V); and, Zinc (Zn).

**New York:** Clay (Cl); Emery (Em); Garnet (Gt); Gypsum (Gp); Iron Ore (Fe); Lead (Pb); Limestone (Ls); Natural Gas (G); Petroleum (O); Salt (Na); Sandstone (Ss); Silver (Ag); Slate (Sl); Talc (Tc); Titanium (Ti); and, Zinc (Zn).

### Find Out

- How far the sand and gravel must be transported to make your sidewalks?
- How many miles of crushed stone must be transported to be used as road-fill for the road in front of where you live?
- How much more does it cost to make the sidewalks, driveways, and house foundations when the sand and gravel has to be transported greater distances? Investigate!

**North Carolina:** Asbestos (Ab); Clay (Cl); Copper (Cu); Gold (Au); Granite (Gn); Lithium (Lt); Marble (Mr); Mica (Mi); Phosphates (P); Talc (Tc); and, Tungsten (W).

**North Dakota:** Clay (Cl); Lignite (Lg); Natural Gas (G); Petroleum (O); Salt (Na); and, Uranium (U).

**Ohio:** Clay (Cl); Coal (C); Gypsum (Gp); Limestone (Ls); Natural Gas (G); Petroleum (O); Salt (Na); and, Sandstone (Ss).

**Oklahoma:** Coal (C); Copper (Cu); Gypsum (GP); Helium (He); Lead (Pb); Limestone (Ls); Natural Gas (G); Petroleum (O); and, Zinc (Zn).

**Oregon:** Gold (Au); Mercury (Hg); Silver (Ag); and, Uranium (U).

**Pennsylvania:** Clay (Cl); Coal (C); Cobalt (Co); Iron Ore (Fe); Limestone (Ls); Natural Gas (G); Petroleum (O); Sandstone (Ss); Slate (Sl); and, Zinc (Zn).

**Rhode Island:** Sand and Gravel (SG) and Crushed Stone (CS)

**South Carolina:** Clay (Cl); and, Mica (Mi).

**South Dakota:** Beryl (Be); Gold (Au); Granite (Gn); Mica (Mi); Petroleum (O); Silver (Ag); Uranium (U); and, Vanadium (V).

**Tennessee:** Clay (Cl); Coal (C); Copper (Cu); Iron Ore (Fe); Limestone (Ls); Marble (Mr); Phosphates (P); Pyrites (S); Sandstone (Ss); and, Zinc (Zn).

### What's The Difference

**mineral** An inorganic substance occurring in nature, though not necessarily of inorganic origin, which has (1) a definite chemical composition or, more commonly a characteristic range of chemical composition, and (2) distinctive physical properties or molecular structure.

**metal** An opaque, lustrous, elemental, chemical substance that is a good conductor of heat and electricity and, when polished, a good reflector of light.

**industrial mineral** Rocks and minerals not produced as sources of the metals but excluding mineral fuels.

**Texas:** Asphalt (At); Clay (Cl); Granite (Gn); Graphite (Gr); Gypsum (Gp); Helium (He); Iron Ore (Fe); Limestone (Ls); Natural Gas (G); Petroleum (O); Salt (Na); Silver (Ag); Sulfur (S); Talc (Tc); and, Uranium (U).

**Utah:** Asphalt (At); Beryllium (Be); Clay (Cl); Coal (C); Copper (Cu); Gallium (Ga); Germanium (Ge); Gold (Au); Gypsum (Gp); Iron Ore (Fe); Magnesium (Mg); Molybdenum (Mo); Natural Gas (G); Petroleum (O); Phosphates (P); Potash (K); Salt (Na); Silver (Ag); Uranium (U); and, Vanadium (V).

**Vermont:** Asbestos (Ab); Granite (Gn); Marble (Mr); Slate (Sl); and, Talc (Tc).

**Virginia:** Clay (Cl); Coal (C); Gypsum (Gp); Lead (Pb); Limestone (Ls); Slate (Sl); Soapstone (Sp); Titanium (Ti); and, Zinc (Zn).

**Washington:** Clay (Cl); Coal (C); Copper (Cu); Gold (Au); Gypsum (Gp); Lead (Pb); Magnesium (Mg); Marble (Mr); Silver (Ag); Talc (Tc); Uranium (U); Tungsten (W); and, Zinc (Zn).

**West Virginia:** Clay (Cl); Coal (C); Limestone (Ls); Natural Gas (G); Petroleum (O); and, Salt (Na).

**Wisconsin:** Copper (Cu); Iron Ore (Fe); Lead (Pb); Limestone (Ls); and, Zinc (Zn).

**Wyoming:** Clay (Cl); Coal (C); Diamonds (D); Iron Ore (Fe); Natural Gas (G); Petroleum (O); Phosphate (P); Uranium (U); and, Vanadium (V).

### Suggested Activities

Can you and your class identify other mineral resources found in your state?

With this listing, identify the minerals that are scarce within the geographical boundaries of the United States. Use a map to plot your findings.

Plot on a map the states that have mineral resources like those found in your state.

Does your state have wind power? Solar power? Geothermal power? Hydropower? Coal-fired plants?

FROM: ISOP External Affairs

TO: Routing Below

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Government Document

Ref. 1 ebd 3977-64F



Project Vadar

For Your Eyes Only

**ROUTING**

| | |
|---|---|
| **White House** | **UN Security** |
| **Pentagon** | **National Palace** |
| **Prime Minister** | **NASA-Cape Canaveral** |
| **NASA-Houston** | **Project Team** |

**Acknowledge Receipt**__________________

**TOP SECRET**

AA Clearance Document: Divulging this information is illegal and considered treasonous, punishment as NAA Class 1 Offense.

On February 4, astronomers at Kitt Peak Observatory in Arizona accidentally sighted a giant comet about to enter our solar system. The comet was observed and its position carefully plotted over a period of two months. Initial calculations indicated that the comet would pass very, very close to Earth and, in fact, with the estimated experimental errors, a collision with Earth was deemed highly possible. Because of this possibility and because of the apparent size of the comet, North American government officials have declared a **consolidated national emergency** (Priority A-1). Public disclosure is being deferred until a later date.

The gravity of the situation was considered to be sufficient for the North American Alliance governments to provide priority funding for a study of the comet. That study was completed last week. The report states: "We have firmly established that Comet Vadar is on a collision course with Earth. We have also firmly established that the mass and velocity of Vadar are sufficiently large to cause the collision to be fatal. The collision will change the Earth’s axis of rotation by more than 2 degrees. At a minimum, this will result in massive tidal waves, extremely high velocity winds and abrupt and severe weather changes. The effect on orbit is unknown. Collision will occur 227 days from today’s date."

The decision has been made not to inform the peoples of the world of these facts until a well thought out program has been established. (Outstanding psychologists, psychiatrists, members of the clergy, scientists, sociologists, government officials and selected U.N. representatives will draw up the plan.)

In the meantime, the governments of the North American Alliance have decided to undertake a project to colonize Mars. Mars was selected in that it is the closest object now known that can, with some ingenuity, support life as we know it. It was also decided that because of the psychological barriers involved in such a project, both a team of scientists and a team of lay people would be engaged to work on the project. You are gathered here today because you have been selected as members of the lay person team. If you choose to accept that assignment, you are to begin immediately on the first item—the selection of materials and participants for the mission. The world’s combined availability of space craft will limit you to sending 10 rockets with two passengers and a payload of 100,000 pounds each.

It has tentatively been determined that the first launching will begin in approximately eight months. All ten rockets are to be launched in a period of time not to exceed one month. Public announcement of the exact nature of this project and of the Earth’s situation will be made no less than two weeks after the last rocket is launched and no more than 2 months before Vadar strikes Earth.

Today you are to make preliminary decisions on two critical questions. You will then meet with the scientists and finalize the selections. Final decisions are to be made in two weeks. The NASA ecosystem analysis (attached to this document) will help you in these decisions.

Of utmost importance is the need to establish a sustainable, permanent colony. There is no return and opportunities for resupply appear unlikely.

Project Vadar:

A Voyage To Mars

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**ROUTING**

| | |
|---|---|
| White House | UN Security |
| Pentagon | National Palace |
| Prime Minister | NASA-Cape Canaveral |
| NASA-Houston | Project Team |

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# Decision Document

- What are the names or skills of the 20 people who will make the trip with you?
- What are the ten most important items you will need to bring life from Earth to Mars, and to sustain that life?

| Characteristic: | Earth | Mars |
|---|---|---|
| EQUATORIAL DIAMETER (EARTH = 1 OR 7,926.4 MILES | 1 | 0.53 |
| MASS (EARTH = 1) | 1 | 0.11 |
| VOLUME (EARTH = 1) | 1 | 0.15 |
| DENSITY (WATER = 1) | 5.52 | 3.95 |
| EQUATORIAL SURFACE GRAVITY (EARTH = 1) | 1 | 0.38 |
| ROTATION ON AXIS (EARTH = 1 day) | 1 day | 1.03 days |
| REVOLUTION AROUND SUN (EARTH TIME) | 1 year | 1.88 years |
| WATER COVER | 71% | No liquid water, but polar ice caps and appears to have ground water. |
| ATMOSPHERE | 78% = $N_2$, 21% = $O_2$<br>1% = $CO_2$, A & others | 95% = $CO_2$, 3% = $N_2$<br>>1% $O_2$ |
| MAGNETIC FIELD | Yes | Weak |
| LAND SURFACE | Chiefly Silicates | A typical weathered volcanic soil. |
| TEMPERATURE | moderate variations<br>min. = -127° F<br>max. = 136° F | At the equator: mostly below zero<br>min. = -150° F<br>max. = 80° F |
| LIFE | Abundant, many forms, heavily depending on liquid water, and in most cases, oxygen. | Little protection against the sun's radiations that UV would quickly kill any unprotected Earth organisms. |
| SOLAR INPUT (at surface) | $\cong 1000 \frac{\text{watts}}{m^2}$ | $\cong 500 \frac{\text{watts}}{m^2}$ |

# Per Capita Mineral Usage

## **Every year—** 37,687 pounds of new minerals must be provided for every person in the United States to make the things we use every day

8,343 lbs. **Stone** used to make roads, buildings, bridges, landscaping, and for numerous chemical and construction uses

5,937 lbs. **Sand & Gravel** used to make concrete, asphalt, roads, blocks & bricks

530 lbs. **Cement** used to make roads, sidewalks, bridges, buildings, schools and houses

187 lbs. **Iron Ore** used to make steel— buildings; cars, trucks, planes & trains; other construction; containers

409 lbs. **Salt** used in various chemicals; highway deicing; food & agriculture

195 lbs. **Phosphate Rock** used to make fertilizers to grow food; and as animal feed supplements

156 lbs. **Clays** used to make floor & wall tile; dinnerware; kitty litter; bricks & cement; paper

52 lbs. **Aluminum (Bauxite)** used to make buildings, beverage containers, autos, and airplanes

12 lbs. **Copper** used in buildings; electrical & electronic parts; plumbing; transportation

10 lbs. **Lead** 75% used for transportation— batteries, electrical, communications and TV screens

7 lbs. **Zinc** used to make metals rust resistant, various metals & alloys, paint, rubber, skin creams, health care and nutrition

44 lbs. **Soda Ash** used to make all kinds of glass; in powdered detergents; medicines; as a food additive; photography; water treatment

3 lbs. **Manganese** used to make almost all steels for construction, machinery and transportation

403 lbs. **Other Nonmetals** have numerous uses: glass, chemicals, soaps, paper, computers, cell phones

19 lbs. **Other Metals** have the same uses as nonmetals but also electronics, TV & video equipment, recreation equipment, and more

### Plus These Energy Fuels

- 933 gallons of **Petroleum**
- 6,988 lbs. of **Coal**
- 76,319 cu. ft. of **Natural Gas**
- 1/4 lb. of **Uranium**

To generate the energy each person uses in one year— equivalent to 300 people working around the clock for each of us.

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

To maintain our standard of living requires the continual production of raw materials.

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

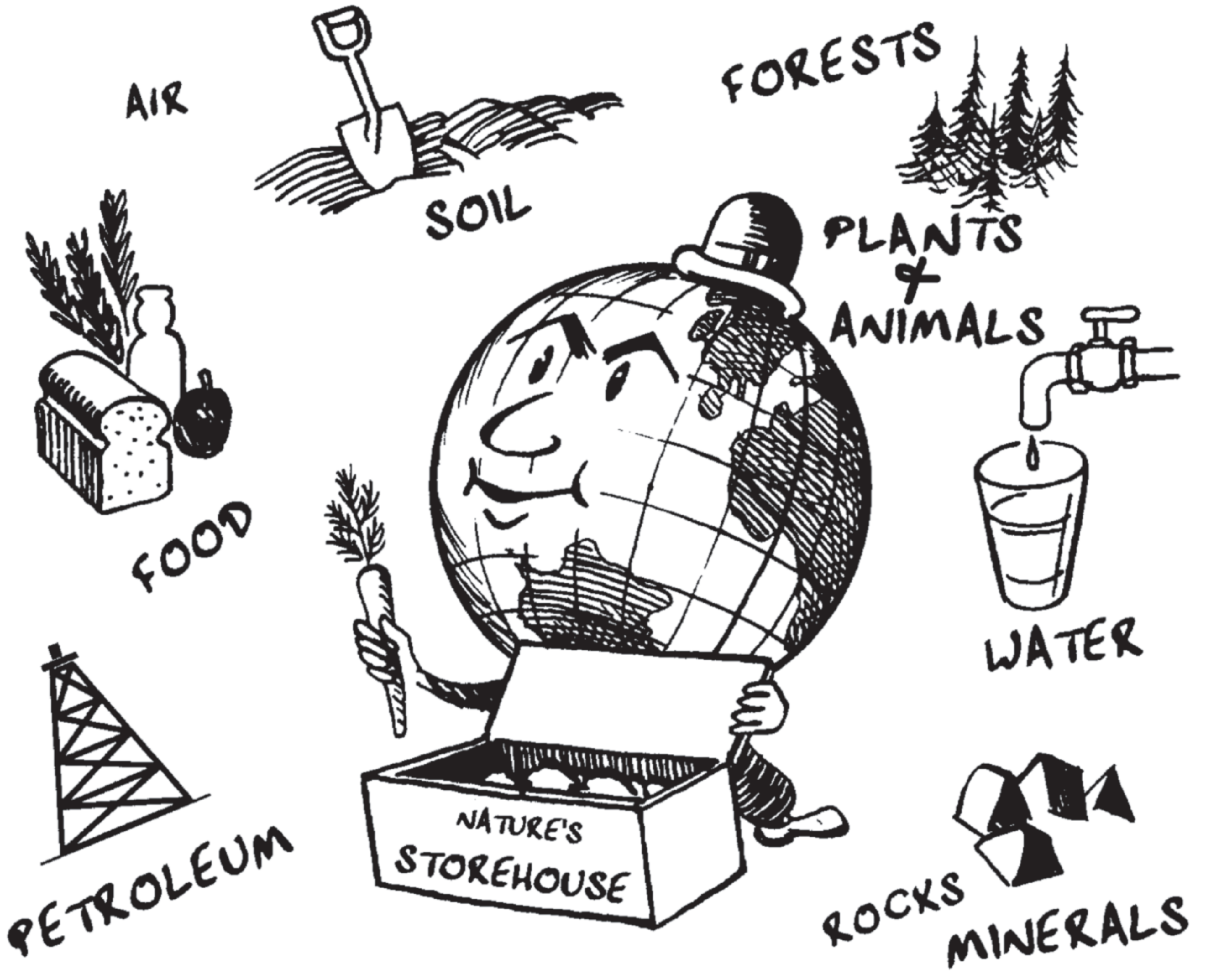
In 1776, when America became independent, people's needs were more simple, requiring fewer natural resources. Most people never travelled more than 20 miles from their birthplace in their entire lifetime.

Think about your life style today compared with living more than 200 years ago. List things that are different.

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

| | 1776 | 2010 |
|---|---|---|
| Aluminum (bauxite) | 0 | 52 |
| Cement | 12 | 530 |
| Clay | 100 | 156 |
| Coal | 40 | 6,988 |
| Copper | 1 | 12 |
| Iron Ore | 20 | 187 |
| Lead | 2 | 10 |
| Phosphate | 0 | 195 |
| Potash | 1 | 22 |
| Salt | 4 | 409 |
| Sand, gravel & stone | 1,000 | 14,280 |
| Sulfur | 1 | 73 |
| Zinc | 0.5 | 7 |
| All Others | 18.8 | 14,766 |
| **Total** pounds/capita/year | 1,200 | 37,687 |

Sources: USGS, Nat'l Mining Assoc., Energy Information Admin., US Census


AIR
SOIL
FORESTS
PLANTS & ANIMALS
FOOD
WATER
NATURE'S STOREHOUSE
PETROLEUM
ROCKS
MINERALS