

Rocks and Minerals



Make Up Your World

Rock and Mineral 10-Specimen Kit Companion Book

Presented in Partnership by:

Pittsburgh Section



NIOSH
Pittsburgh Research Laboratory



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TABLE OF CONTENTS

	Page
I. INTRODUCTION	3
II. MINERALS IDENTIFICATION	5
PHYSICAL PROPERTIES	5
III. FUELS	9
BITUMINOUS COAL	11
ANTHRACITE COAL.....	12
IV. BASE METAL ORES	13
IRON ORE	15
COPPER ORE.....	16
V. PRECIOUS METAL ORE	17
GOLD ORE.....	18
VI. ROCKS AND INDUSTRIAL MINERALS.....	19
GYPSUM	22
LIMESTONE.....	23
MARBLE	24
SALT	25
ZEOLITE	26

INTRODUCTION

This mineral kit is made possible through the generosity of the mining companies who are listed with the minerals samples they supplied. If you have any questions or comments about this kit please contact the SME Pittsburgh Section Chair at www.smepittsburgh.org.

Minerals are essential for standard of living. **Every day** -

- 18,000,000 tons of raw material must be mined, cut or harvested to meet the demands of U.S. citizens (about 150 pounds for every man, woman and child);
- 640 acres (one square mile) of carpeting is woven using barite and calcium carbonate;
- 9,700,000 sq. ft. (about 223 acres) of plate and window glass are used, enough to cover 200 football fields, using silica and trona;
- 2,750 acres of pavement are laid, four times as much surface area as is mined and enough concrete and asphalt to make a bicycle path 7 feet wide from coast to coast using sand, gravel, stone aggregate and limestone;
- 4,000,000 eraser tips are purchased (enough to correct all mistakes from 1,500 miles of notebook paper- - about 129 acres of goofs) using graphite, kaolin and pumice;
- 426 bushels of paper clips (35,000,000) are purchased. Seven million are actually used, 8-9 million are lost and almost 5 million are twisted up by nervous fingers during telephone conversations, all using iron, clay, limestone and trona;
- 164 sq. miles of newsprint is used to print 62.4 million newspapers (enough to line a bird cage 12 miles wide and 13 miles long) using trona and kaolin;
- 400 acres of asphalt roofing are nailed down utilizing silica, borate, limestone, trona, feldspar, talc and silica sand;
- 187,000 tons of cement are mixed (enough to construct a four foot wide sidewalk from coast to coast) using limestone, sand, gravel and stone aggregate;
- 36,000,000 light bulbs are purchased; all made from tungsten, trona, silica, sand, copper and aluminum;

- 10 tons of colored gravel for aquariums is purchased;
- 80 pounds of gold are used to fill 500,000 dental cavities;
- 50,000 pounds of toothpaste (2.5 million tubes) are used (enough to fill a small jet liner) requiring calcium carbonate, zeolites, trona, clays and silica;
- 1,000,000 photographs are snapped (more than 29 acres of wallet sized photos) using silver and iodine.

While there are over hundreds of minerals used in the United States regularly for defense, industrial, agricultural, residential, medical and cosmetic purposes, the minerals provided in this kit are a small cross-section of the fuel and non-fuel minerals that each American takes for granted each day as we learn, work and relax.

It is convenient when we discuss minerals to place them in different categories. The information on the minerals in your kit has been categorized in the following manner:

Fuels
Base Metals
Precious Metals
Industrial Rocks and Minerals

A section follows for each of this categories. The geographic areas of the country where these minerals are found are identified. For each of the minerals and rocks in your kit, additional details are provided.

Please Note: This handout is designed to be a compliment to the rock and mineral samples found in your kit. This booklet discusses the 10 rock and mineral samples in your kit. There may be variations in the kit due to the availability of particular rock and mineral samples.

MINERALS IDENTIFICATION

It is important to note the difference between a mineral and a rock. Rocks are essential building materials of which the earth is constructed. Minerals are individual substances that make up rocks. Most rocks are, therefore, aggregates of two or more minerals. Ore is a mineral or mineral aggregate containing precious or useful metals that are commercially profitable. It takes some form of physical or chemical processing to extract or separate the commercially profitable minerals from the ore. Some of the samples in your kit are ore samples.

More than 3,500 minerals have been identified in the earth's crust. Each mineral can be identified by its distinctive physical and chemical properties.

Physical Properties:

- Luster
- Hardness
- Color
- Streak
- Cleavage (the way it splits)
- Fracture (the way it breaks)
- Specific gravity
- Other mineral properties

Chemical Properties:

- Atomic structure
- Chemical composition

Most minerals can be identified by physical properties alone. Minerals that cannot be identified by their physical properties must be identified by sophisticated tests to determine their chemical composition or optical properties. The following describes the basic methods used to identify minerals utilizing physical properties.

Physical Properties

Luster - Luster is determined by the way light is reflected from a mineral. Luster is the sheen or gloss of a mineral's surface. The general appearance of the surface, the reflectivity, the scattering of light by microscopic flaws or inclusions, the depth to which light penetrates — these and many other features are responsible for luster. A few descriptive examples of luster follows.

Metallic. Has the luster of a typical metal, such as gold, silver, lead, copper, aluminum, etc (opaque). When crushed they yield a powder which is black or darker in color than the mineral itself (streak).

Non-metallic: More complex. Luster may be glassy, greasy, dull or adamantine; the powder is whiter or lighter in color than the mineral when streaked. Examples include, diamonds, talc, limestone, etc.

Hardness - Hardness is one of the most characteristic and useful property of a mineral. Hardness can be defined in many ways with each a measure of the mineral's resistance to a mechanical force. Some of these forces are: scratching (Mohs), indentation (Knoop), abrasion (Pfaff), and grinding (Rosiwal). Testing resistance to scratching is a popular way of determining hardness because it requires no special equipment. Hardness was given a level of precision in 1822 by the Australian mineralogist Mohs who proposed the following scale

MOHS SCALE OF HARDNESS

- | | |
|-------------------|-----------------------|
| 1. Talc (softest) | 6. Orthoclase |
| 2. Gypsum | 7. Quartz |
| 3. Calcite | 8. Topaz |
| 4. Fluorite | 9. Corundum |
| 5. Apatite | 10. Diamond (hardest) |

Each of these minerals will scratch those minerals lower in the scale, and will in turn, be scratched by those higher in the scale. Some quick hardness tests with familiar objects.

- 2 ½ = Fingernail
- 3 = Copper coin
- 5 ½ = Knife blade, Window glass
- 6 ½ = Steel file

Minerals that are under a hardness of 2 ½ will leave a mark on paper, those under a hardness of 5 ½ can be scratched by a knife. Minerals over a hardness of 5 ½ will scratch glass.

Color - Minerals are so variable in color we scarcely rely upon color as a satisfactory means of recognizing them. Color should always be noted on a freshly broken surface, because staining and corrosion may alter the appearance of an older surface. Some minerals are reasonably consistent in color such as, sulfur (yellow), gold, and silver, but many minerals have chemical elements that are minor impurities that influence color. For example, quartz occurs in almost every color imaginable.

Streak - Streak an important, simple test that can be used to identify some minerals. The color of a powdered mineral is called its streak, and it is usually obtained by rubbing the mineral against a piece of unglazed porcelain called a streak plate. Keep in mind that the color of a mineral's streak maybe different than the mineral itself. An example of this is a mineral called hematite. Hematite

is black in color, but its streak is indian-red, such came the nick name "bloodstone".

Cleavage - Crystalline minerals are said to cleave or have cleavage when they break in a defined direction along a smooth surface. The property is the result of a precise pattern of atoms in regular layers, whose cohesion is weaker in certain directions than others. For example, mica, will flake into thin sheets because it has cleavage in a single direction. However, diamonds have cleavage in eight directions (octahedral), this property is used by diamond cutters to shape and remove flaws or impurities.

Fracture - Minerals that break in irregular directions are said to fracture. The fracture properties are based on a freshly broken pattern. For example, fracturing quartz has a series of arcs, similar to patterns seen in sea shells, called "conchoidal" fracture. This same pattern is characteristic of chipped glass. Metals however, have a "hackly" fracture, which has the characteristics of a jagged surface which is uncomfortable to the touch. Common words are often used to describe the appearance of mineral fractures such as: uneven, splintery, blocky, and prismatic.

Specific gravity - Specific gravity is the relative weight of a mineral which is a number that is a direct comparison to the weight of an equal volume of water. Water is given a specific gravity of 1 and the specific gravity of minerals are compared to it. Minerals vary in density. Some minerals are heavy for their size while others are light for their size. For example, lead or granite is very heavy for its size, while salt or talc is light for its size. Experience and judgment on handling minerals will help you to determine the general specific gravity of minerals.

Other mineral properties - Some family of minerals have physical properties that are not characteristic of all minerals, but can be useful in mineral recognition.

Fizz - Some minerals "fizz" or react to an acid or household vinegar. The fizz is the escape of carbon dioxide gas in a mineral. Calcite is an example of a mineral that fizzes.

Striations - Parallel straight lines on a smooth surface of a mineral such as pyrite and striations.

Flexible - Some minerals can be bent and remain bent, such as chlorite.

Elastic - Some minerals will snap back to their original position if they are stretched (not broken). Mica has elastic properties.

Malleable - Most metal minerals have malleable properties. Malleable means the mineral can be hammered flat without falling to powder.

Magnetic- Some minerals are attracted by a magnet. Examples include, magnetite and pyrrhotite.

Fluorescence - Some minerals glow in the dark when they are exposed to ultraviolet light. The mineral that comes to mind in connection to fluorescence is fluorite, from which the term is derived. Many diamonds are fluorescent. Minerals that glow after the light is turned off are said to be phosphorescent.

Radioactive - Radioactive minerals occur when atoms of a mineral give off energy as they disintegrate. Pitchblende (uraninite) and carnotite are a few of the more common types of minerals that are radioactive.

Table 1. – Summary of the Physical Properties of the Rocks and Minerals in Your Kit								
ROCK OR MINERAL	PHYSICAL PROPERTIES							
	Luster	Hardness	Color	Streak	Cleavage	Fracture	Specific Gravity	Other ¹
Bituminous Coal	Dull to Oily		Black			Cleats		Rock
Anthracite Coal	Glassy		Jet Black			Conchoidal		Rock
Iron Ore	Metallic	4.0 - 5.0	Gray Black	Gray	None	Hackly	7.3 - 7.8	Magnetic
Lead Ore	Metallic	2.5 - 2.8	Gray	Dark Gray	Perfect	None	7.2 - 7.6	Heavy & Soft
Gold Ore	Metallic	2.5 - 3.0	Gold Yellow	Brown	None	Hackly	15.6 - 19.3	Very malleable
Gypsum	Vitreous	2.0	Colorless	White	Perfect	None	2.3	Soluable
Limestone			Varies					Rock
Marble			Varies					Rock
Salt	Greasy	2.5	Colorless	White	Good	None	2.1	Taste
Zeolite	Vitreous	4.0 - 5.0	Colorless	White	Perfect	None	2.2	Light Fragile

¹For a more descriptive explanation for the rocks and minerals, refer to the main text.

FUELS

The fuel type minerals included in your Kit are bituminous and anthracite coal. Coal is a fossil fuel composed mostly of carbon, with traces of hydrogen, nitrogen, sulphur and other elements. Coal is far more plentiful than domestic oil or natural gas. Coal is removed from the earth by a process called mining. Mining occurs in both surface and underground operations. In 1998, there were 2,493 coal mines operating in the United States. The map below shows where the mines are located.

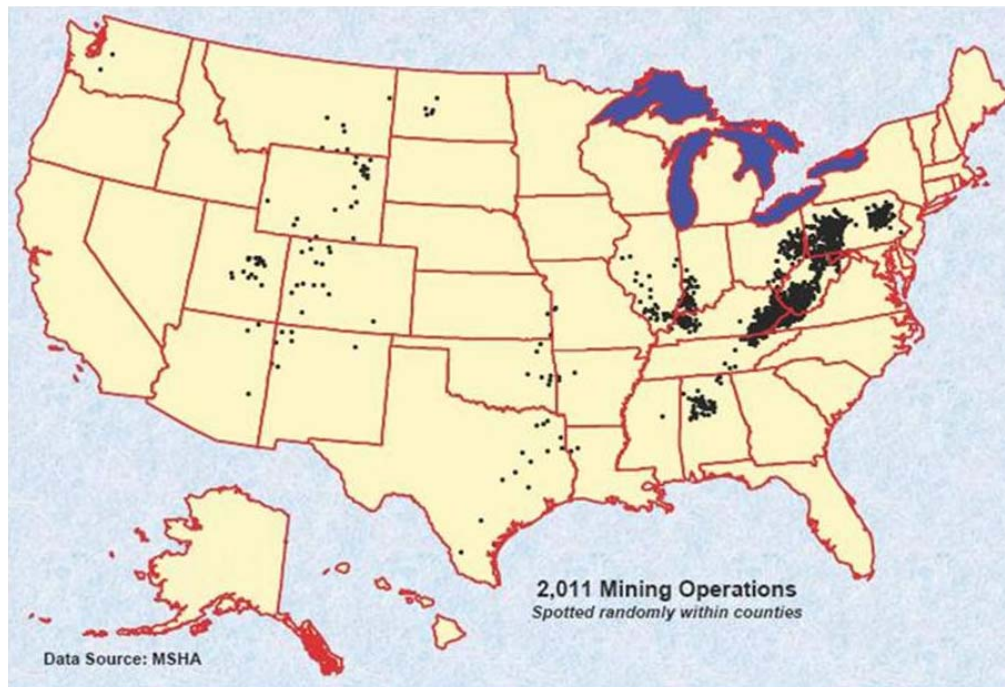


Figure 1. - Location of coal mines (includes both surface and underground operations).

Coal is sedimentary rock deposited in layers or beds with other sedimentary rock. All coal once existed as growing plants which died, partly decayed, and were then preserved by burial. The oldest coal forming period, about 345 to 280 million years ago, produced some of the world's major coal deposits. The lush vegetation during the Carboniferous Period (Mississippi & Pennsylvania periods), included ferns the size of today's trees and bushes nearly 90 feet tall. There were 3,000 different species of plant life identified during that period. The dead plants were transformed into coal by a process called "coalification". This process results in a chemical change induced by pressure and heat due to deep burial. The dead plants first change into peat, then as more pressure and heat is applied, moisture and gases are forced out and the buried material becomes depleted in most elements except carbon. In general, there are four stages of coal development:

- 1 Peat - Partly decomposed vegetation; about 50% carbon;
- 2 Lignite - Light brown soft coal, about 70% carbon;
- 3 Bituminous - Brittle black coal, well jointed, blocky, about 88% carbon; and
- 4 Anthracite - Hard jet black coal, high luster, exhibiting conchoidal fractures, about 92% carbon.

The wide range of coal development results in a wide range of physical and chemical properties. Coals can be classified by their behavior during heating. This classification relies on measurements of moisture, volatile matter (portions that are given off during heating), and fixed carbon. Coal with lower fixed carbon content, higher volatile matter and moisture content is a low rank coal. Coal with higher fixed carbon content and lower volatile and moisture content is a high rank coal. High rank coals provide more heat when they are burned. The usage of mined coal depends mostly on its behavior during burning and the mineral impurities that could produce pollutants.

In America, coal provides 56% of electricity nationwide, more than double any other fuel source and five times more than gas, oil, or hydro-electric power.

Electricity in the U.S. is the cheapest in the world and powers the tools and appliances vital for everyday living -- air conditioners, televisions, computers, home appliances, dryers, and life-saving equipment in hospitals.

There are 1.1 million Americans whose jobs directly depend on the coal industry. Approximately 110,000 coal miners produce about 1 billion tons of coal per year and create jobs in transportation, management, manufacturing and support industries.

Coal is America's most economically reliable asset; during the past 20 years, the average price of coal has increased only 4%. The price of natural gas has increased 211%; crude oil has increased 51%. Coal exports put over \$4 billion per year on the positive side of the U.S. trade balance. For every \$1 billion of coal production, about \$19 billion worth of electricity is generated.

Bituminous Coal

GENERAL: Bituminous coal is an intermediate ranking coal.

SAMPLE LOCATION: Bailey Mine, Consol Energy, Washington Co., PA

PHYSICAL PROPERTIES*:

Texture, Color, and Other properties - Coal is a rock and it is more commonly identified by its carbon content rather than its physical properties. Bituminous coal is black and sometimes has a dull to oily sheen and breaks readily into irregular blocks. Bituminous coal is usually stratified or banded with alternating thin shiny and dull layers. It is also common for bituminous coal to have vertical fractures (called cleats) oriented perpendicular to one other.

GEOLOGIC ENVIRONMENT: Eastern U.S. coal formed from the remains of plant life that existed about 300 million years ago. The ideal environment for coal formation is a swamp. As the plants die and fall into the swamp environment, they become waterlogged and sink. Eventually, the dead plant material turns into peat. Through time, oxygen supplies in the water are used up until eventually the bacteria can no longer continue to decay the plant matter. Valuable coal deposits only occur if the swamp basin slowly sinks and mud or similar material and buries the dead plants. Bituminous coal is one of the stages of the coal forming process.

USAGE:

- Fuel source to generate electricity
- Fuel source for industries
- Chemicals:
 - perfume
 - billiard balls
 - saccharin

[Physical properties presented above are based on averages and/or purer minerals than in your kit.]*

Anthracite Coal

GENERAL: Anthracite coal or hard coal is the highest ranking coal. It is an ideal fuel because its high carbon content allows it to burn slowly, cleanly (smoke free and odorless), maximizing heat output. It is so clean that the U.S. Environmental Protection Agency has exempted anthracite coal from many of the requirements it imposes on other fuels.

SAMPLE LOCATION: L.C.N. Mine, LeHigh Coal & Navagation Co.,
Tamaqua, PA

PHYSICAL PROPERTIES*:

Texture, Color, and Other Properties - Coal is a rock and it is more commonly identified by its carbon content rather than its physical properties. Anthracite coal is hard, jet black, and glassy looking. It does not break easily. It does not have the dominate fracture system (cleats) that bituminous coal has and it breaks into curved or irregular conchoidal fractures. It also lacks the stratified or banded characteristics so common in bituminous coal.

ORIGIN: Eastern U.S. coal formed from the remains of plant life that existed about 300 million years ago. The ideal environment for coal formation is a swamp. As the plants die and fall into the swamp environment, they become waterlogged and sink. Eventually, the dead plant material turns into peat. Through time, oxygen supplies in the water are used up until eventually the bacteria can no longer continue to decay the plant matter. Valuable coal deposits only occur if the swamp basin slowly sinks and mud or similar material and buries the dead plants. Anthracite coal forms in the later stage of the coal forming process. It is more commonly associated with folded strata which produces the additional heat and pressure to transform the coal to the higher rank.

USAGE:

- Fuel source
- Mixed with other coals
- Purifier for water

[Physical properties presented above are based on averages and/or purer minerals than in your kit.]*

BASE METAL ORES

The base metal ores included in your kit contain the following minerals:

- Iron Ore
- Copper Ore

The geographic areas of the Country where base and precious metals deposits are produced can be seen on the map below:

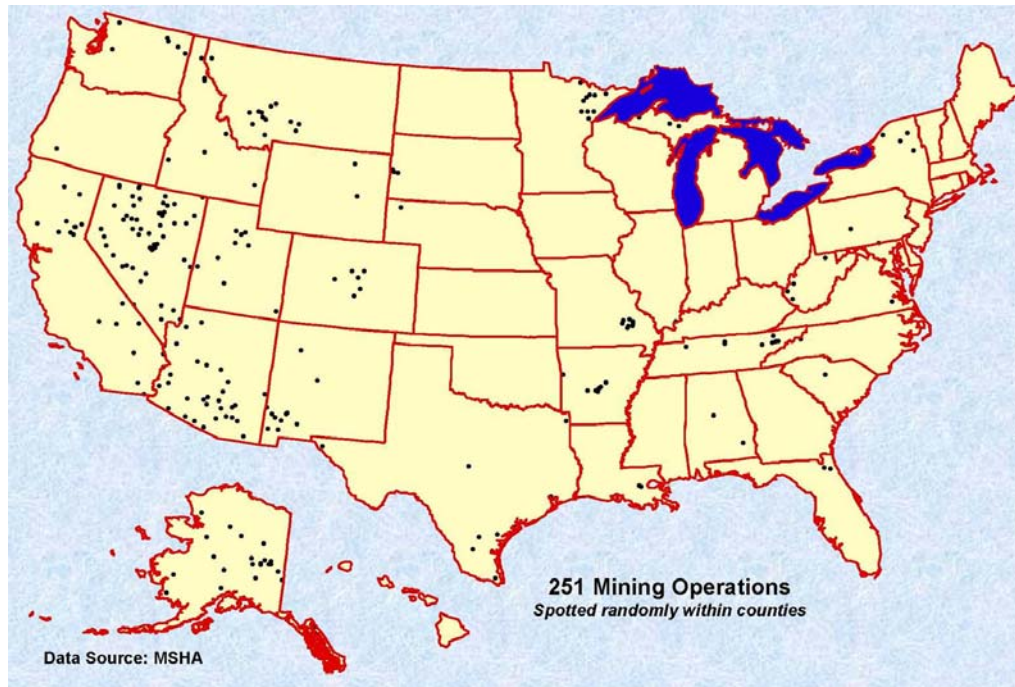


Figure 2. - U.S. Base and Precious Metal Producing areas. Includes gold (lode and placer), copper ore, iron ore, lead and/or zinc ore, uranium, silver ores, alumina (mill), aluminum ore, manganese, molybdenum, rare earths, titanium, nickel, uranium - vanadium ores, platinum group, zircon, tungsten, vanadium, beryl, and tin ore.

It is the versatile properties of metals that make them invaluable for our technological applications. Metals are malleable, ductile, and are high thermal and electrical conductors. Metals directly impact the distribution of electricity; telegraphic, radio, and television communication; aeronautics; rocketry; and nuclear power.

The United States, with approximately six percent of the world's population, consumes a much larger percentage of the world production of not only metals but most mineral commodities. This consumption reflects our standard of living as compared to the rest of the world. One of the most obvious examples of our improved standard of living, is the utilization of copper in the electrical industry.

All the metals include in your kit, (except for Iron) are scarce metals that are defined as less than 0.1% of the earth crust. Many experts believe that these resources will be the first group of resources to develop shortages in the future, which will pose a challenge to technology development.

Iron, on the other hand, is in abundance in the earth's crust (approximately 5%). It is the second most abundant metal; aluminum is the first most abundant metal in the earth's crust. However, iron accounts for approximately 90% of all metal consumed.

Iron Ore

GENERAL: Taconite is a term used to describe all the iron bearing formations in the Lake Superior Region. This iron ore contains iron and other siliceous and carbonate minerals. Iron is considered the backbone of civilization. Iron is used to make steel and as an alloy when iron is not suitable for certain uses. Iron is the second most abundant metal on earth. Iron's natural state prevented it from being used earlier than other metals, such as copper, lead, etc.

SAMPLE LOCATION: Minntac Mine, USX, Mountain Iron, MN

PHYSICAL PROPERTIES*:

Texture, Color and Other Properties - The essential minerals of taconite are quartz or chert, silicates, magnetite, siderite, carbonates, and hematite. Taconite deposits are generally distinguished into four types of deposits: cherty taconite, silicate taconite, slaty taconite, and mottled taconite.

Cherty Taconite A massive deposit without bands or slaty layers. It is grayish to brownish sometimes reddish, with a granular texture. The matrix of the granules consists of mostly chert.

Silicate Taconite The main difference between silicate and cherty taconite is color. Silicate taconite is light grayish green. The matrix of the granules are chiefly chert and iron oxides.

Slaty Taconite Has a banded or layer characteristics similar to slate. It has sparkling grains of magnetite or hematite. The individual bands may be very thin or reach one-inch thickness. The colors of the bands may be yellow, red, purple, green, gray, or black.

Mottled Taconite Has a spotted or mottled appearance. The spots range from one-sixteenth to one-half inch in diameter. The spots are generally light color chert with a surrounding matrix of gray or brownish iron oxides.

ORIGIN: Most of the iron deposits are found in igneous and sedimentary formations. Iron forms in intrusive and extrusive igneous rocks. It is also commonly found in banded sedimentary deposits. Rarely is iron found in hypothermal veins.

USAGE:

- Over 99% of iron ore makes iron and steel
- Magnets
- Nutritional supplement in foods
- Vitamins

[Physical properties presented are based on averages and/or purer minerals than in your kit.]*

Copper Ore

GENERAL: The Roman Empire obtained most of its copper from the island of Cyprus. In fact, the word copper comes from the Latin word cuprum, which means "from the island of Cyprus. Archaeological evidence suggests that people have been using copper for at least 11,000 years. Today, copper is primarily obtained from the ores cuprite (Cu_2O), tenorite (CuO), malachite ($\text{Cu}_2(\text{OH})_2\text{CO}_3$), chalcocite (Cu_2S), covellite (CuS) and bornite (Cu_5FeS_4). Large deposits of copper ore are located in the United States, Chile, Zambia, Zaire, Peru and Canada. Copper is obtained by smelting, leaching, and electrolysis of the copper sulfides, oxides, and carbonates. Copper is commercially available at a purity of 99.999+ %.

SAMPLE LOCATION: Chino Mine, Phelps Dodge, Hurley, New Mexico

PHYSICAL PROPERTIES*: Copper is soft and has a Moh's hardness of 2.5 to 3. The surface has a bright metallic luster. Copper is malleable, that is, it can be bent and shaped without cracking, when either hot or cold. Copper also is ductile and can be drawn out into thin wire. Copper is second only to silver in its ability to conduct electricity, but silver is too expensive for this sort of use. Bronze and brass, however, do not conduct electricity as well as pure copper. Besides electricity, copper also is an excellent conductor of heat. Copper is resistant to corrosion and it will not rust. If the air around it often is damp, it will change from its usual reddish orange color to reddish-brown. Eventually, it is coated with a green film called a "patina" that stops all further corrosion.

ORIGIN: Copper has the same crystal structure as gold and silver and forms a complete solid solution series with gold. It is much more reactive and is easily attacked by acids and sulfur. It occurs as a native metal in only a few places, notably the Keweenaw Peninsula of Michigan. Here copper is found as cavity fillings in old lava flows, as intergranular cement in sandstones and in veins. Most of the world's copper is mined from large copper sulfide deposits.

USAGE: Copper is widely used in the electrical industry. In addition to many other uses, copper is used in plumbing, for cookware and jewelry. Brass and bronze are two important copper alloys. Copper compounds are toxic to invertebrates and are used as algicides and pesticides. Since it resists corrosion from the air, moisture and seawater, copper has been widely used in coins. Although once made nearly entirely from copper, American pennies are now made from zinc that has been coated with copper. Used in large amounts by the electrical industry in the form of wire, copper is second only to silver in electrical conductance.

*[*Physical properties presented above are based on averages and/or purer minerals than in your kit.]*

PRECIOUS METALS

The precious metal mineral included in your kit is gold ore.

The most common usages of precious metals are currency and jewelry. However, it is the versatility of the precious metals that make them more and more attractive to industrial usage. Similar to the base metals, silver and gold are malleable, ductile and high in thermal and electrical conductivity. Silver for example is being consumed by the photographic and electrical industry. Gold is not as attractive to the industry as silver is because it is more scarce and more expensive. However, gold is so resistant to corrosion that it is almost indestructible. Most of the gold mined is still available, having been used and reused many times over.

As mentioned in the base metals discussion, the United States consumes most of the worlds gold and silver production.

Gold (Ore)

GENERAL: The gold ore sample in your kit is either basalt, latite, shale/siltstone, or breccia. Man's quest for gold has been occurring since ancient times. Gold has been prized as an ornament, indication of wealth, and a bartering tool. The search for gold, played a major role in the exploration and discovery. Much of the gold produced today is disseminated in microscopically small particles.

SAMPLE LOCATION: Golden Sunlight Mine, Golden Sunlight Mine Co., Whitehall, MT

PHYSICAL PROPERTIES*:

Basalt	Dark (black) rock with abundant small light colored feldspar phenocrysts and green olivine crystals.
Latite	Light (white) rock with abundant white feldspar phenocrysts in grey groundmass.
Shale/siltstone	Grey rock that may contain hematitic staining on fractures.
Breccia	Mixture of latite, shale, and sometimes sandstone. It is usually a clast support breccia with abundant pyrite, calcite, sericite, and feldspar in the matrix. In some cases the matrix is composed of latite.

ORIGIN: Gold reserves are found in notable amounts in hydrothermal veins (volcanic activity) and placer deposits. Placer deposits are areas of gold accumulation due to weathering and/or erosional processes. The weathering and erosional process separates the gold mineral from other minerals. This resistance to erosion accounts for the widespread tiny deposits (placer) throughout the world.

USAGE:

- Mostly jewelry and monetary
- Computers
- Communication equipment
- Spacecraft
- Jet aircraft engines
- Art

[Physical properties presented above are based on averages and/or purer minerals than in your kit.]*

ROCKS AND INDUSTRIAL MINERALS

The rock and industrial minerals included in your kit are:

Gypsum
Salt
Limestone

Zeolite
Marble

The geographic areas of the Country where nonmetal mining operations are located can be seen on the maps below:

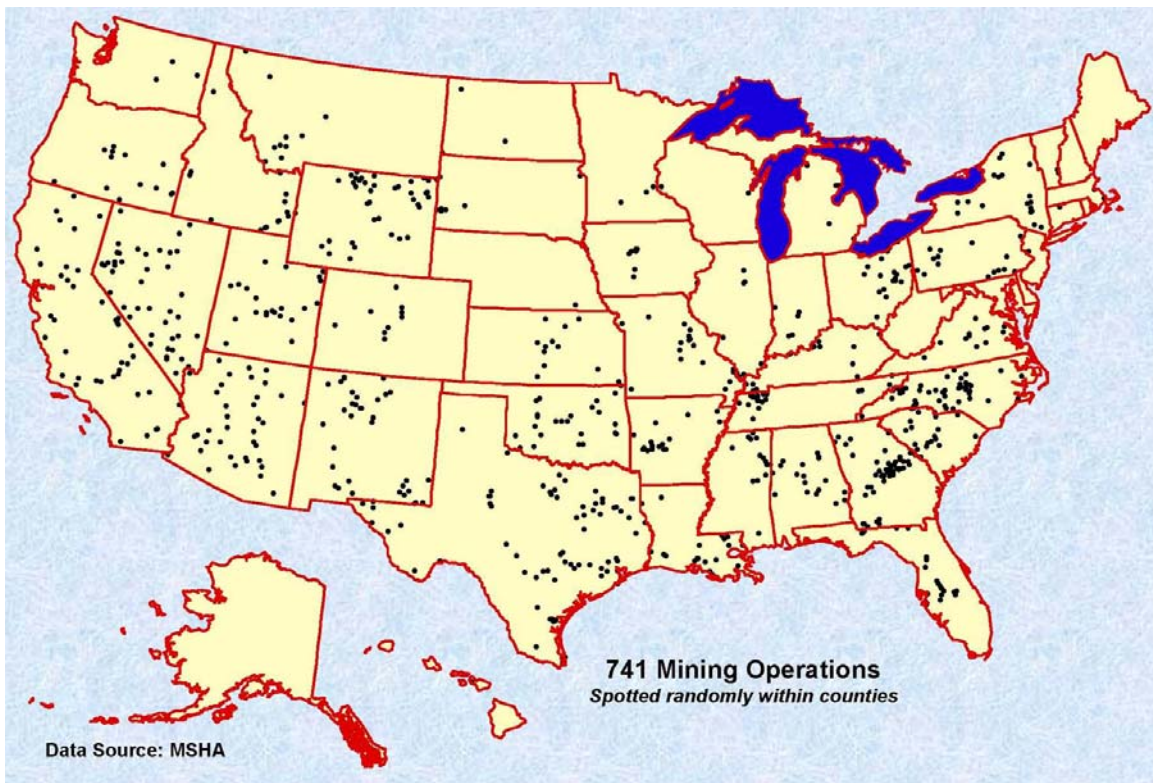


Figure 3. - U.S. nonmetal mining operations (includes clay, gypsum, shale, pumice, talc, soapstone and pyrophyllite, barite, phosphate, perlite, feldspar, salt, mica, trona, potash, boron materials, vermiculite, leonardite, kyanite, magnesite, gilsonite, fluorspar, asbestos, oil sand, aplite, borate minerals, and lithium).

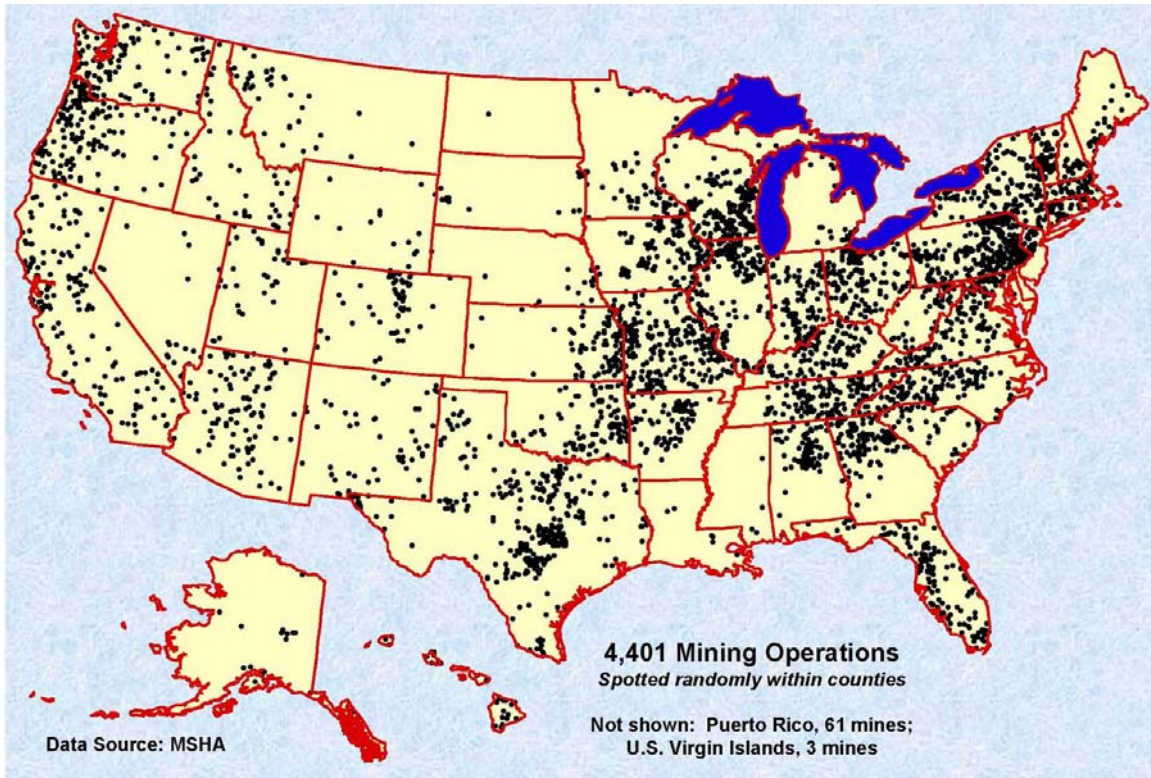


Figure 4. - US stone mining operations (includes limestone, granite, traprock, sandstone, stone, dimension, lime, slate, marble).

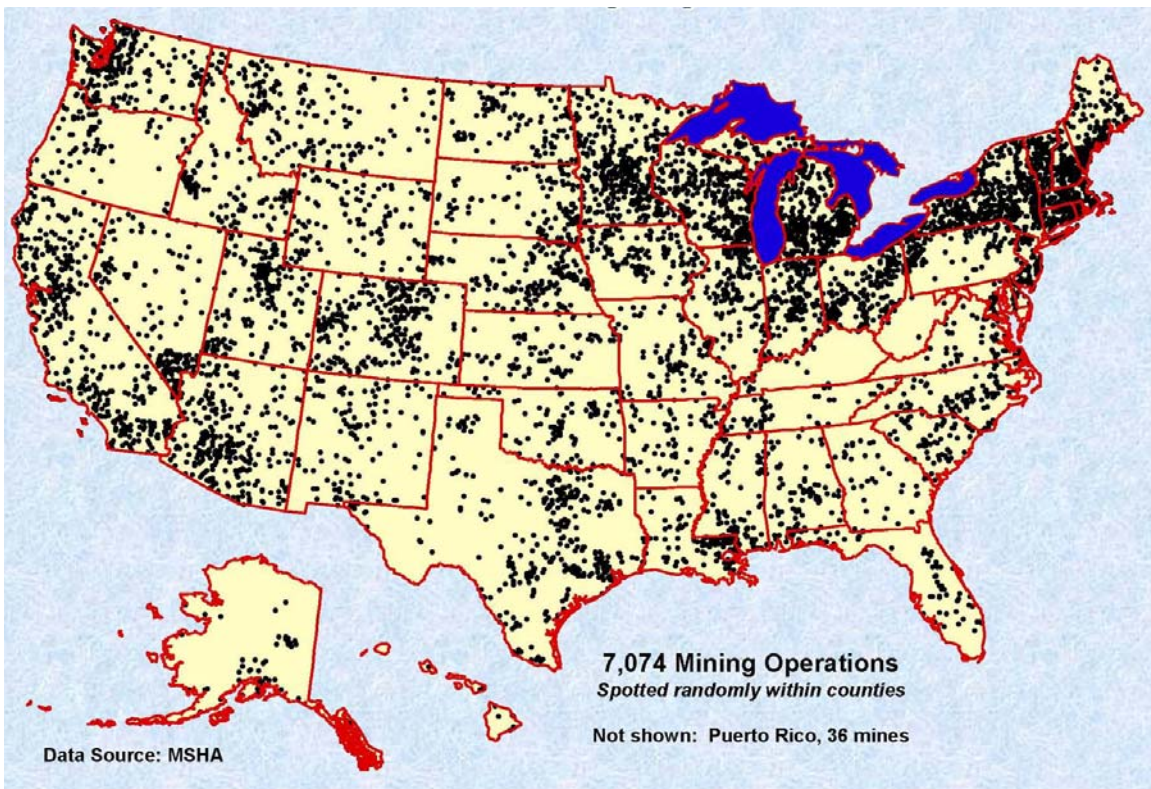


Figure 5. - U.S. sand and gravel operations.

Most building materials, unlike metals, have little intrinsic value; they are not scarce commodities, but when removed and processed to a useful form, they increase in value enormously. Building materials are the largest crop that we reap from the earth. Furthermore, building materials are second, after fossil fuels, as the most valuable mineral commodity.

Some of the building rocks such as limestone are abundant throughout the earth's crust. When attractive building stone deposits are discovered, the main concern is how to extract the rock without destroying it. Most mining methods use aggressive methods, like blasting to obtain the mineral or rock, which usually shatters the mineral or rock. However, with building stones selecting where natural joints and cracks are in the deposit aid in the removal in their natural state.

Gypsum

GENERAL: Gypsum is found as an extensive sedimentary deposit. It is normally the first salt dropped in the evaporation of seawater. Gypsum is extensively mined in many parts of the world and consists of 79% calcium sulfate and 21% water. Gypsum is the raw material for making plaster of paris. Plaster of paris got its name from the gypsum deposit in the Paris Basin in France.

SAMPLE LOCATION: American No. 2 Mine, Celotex Corp., Port Clinton, OH

PHYSICAL PROPERTIES*:

Luster - Vitreous, pearly, silky

Hardness - 2.0

Color(s) - Colorless to transparent, white, gray, yellowish or brown

Streak - White

Cleavage - Perfect to very good

Fracture - None

Specific Gravity - 2.3

Other Properties - Soluble in hydrochloric acid and water. Can be fluorescent in ultraviolet light.

ORIGIN: Gypsum forms as an evaporite mineral from saline water (sea water). It is found in extensive sedimentary deposits interbedded with limestone, red shales, sandstones, clays, and rock salt.

USAGE:

- Plaster, wall board
- Some cements
- Fertilizer
- Paint filler
- Ornamental stone
- Brewing industry
- Flux in pottery making

[Physical properties presented above are based on averages and/or purer minerals than in your kit.]*

Limestone

GENERAL: Limestone consists mainly or entirely of calcite and calcium carbonate. Limestone usage is so diversified that we use it everyday and we may not even be aware of it. For example, limestone has made a major impact on almost everyone's education: blackboard chalk is limestone. When that fine white powder is viewed under a microscope you can see the remains of a single-celled animals called foraminifera.

SAMPLE LOCATION: Springfield Pike Mine, Hanson Aggregates, Connellsville, PA

PHYSICAL PROPERTIES*:

Mineral content - Calcite; small percentage of other varying dark minerals.

Texture, Color, Density, and Other Properties - Calcite is about the only thing common to all limestones. Limestones differ widely in texture, color, content, structure, and origin. Most of their diversity is the result of the physical and chemical properties of calcite. The mineral calcite is much more susceptible to solution, recrystallization, and replacement than any other common rock-forming mineral. The distinguishing characteristics of limestone deposits in southwestern Pennsylvania are more generally gray-white and they fizz under acid.

ORIGIN: Limestone is a sedimentary rock. Nearly all limestone deposits are related to marine environments. Sea water is slightly alkaline, while fresh water bodies (lakes and rivers) are more acidic and dissolve calcium which prevents limestone accumulation. Limestone can be formed through a wide range of organisms that live in the marine environment. They include one-cell plants such as algae to specialized animals, such as corals. The plants and animals extract calcium carbonate from the sea water and use it to build skeletons and shells. The accumulation of these dead plants and animals make a large contribution to limestone deposits. In general, limestone is a consolidation of limy mud, calcareous sand or shell fragment that may go through a physical and/or chemical change as it turns into rock.

USAGE:

- Portland cement and aggregate
- Crushed stone for roads
- Soil stabilizer
- Neutralizing agent in manufacturing processes
- Paper, glass, fiberglass, porcelain, petrochemicals, insecticides
- Chewing gum, Toothpaste
- Antacids
- Food products - cereals and bakery items
- Source of calcium essential to healthy bone and muscle development.

[Physical properties presented above are based on averages and/or purer minerals than in your kit.]*

Marble

GENERAL: Marble is a metamorphic rock. Most marble deposits result when the rocks, limestone or dolomite, are subjected to increases in temperature and pressure. As mentioned previously, limestone consists of calcium carbonate, while dolomite consists of calcium-magnesium carbonate. Marble, granite, limestone, sandstone, and slate are called dimension stone by the construction industry because of its use in construction. Marble is the least common of the dimension stone to be produced because it is the least abundant. Overall, the demand for dimension stone in the United States has decreased due to the increasing use of stronger, less dense, less costly alternative materials like reinforced concrete, steel, glass, plastics, aluminum etc. Of all dimension stones, marble is most notable for its beautiful appearance.

SAMPLE LOCATION: Mine No. 2, ECC International, Sylacauga, AL

PHYSICAL PROPERTIES*:

Mineral content - Calcite and a small percentage of other varying dark minerals.

Texture, Color, Density, and Other properties - The process that recrystallized the parent rock (limestone and dolomite) to marble caused the grains in the limestone and dolomite to grow and become visibly crystalline and give the surface a livelier sparkle. White marble is the result of almost pure calcite. The impurities that were either present in the parent rock or introduced during the recrystallization tend to segregate into knots or spread out in wavy streaks, produce the varicolored “marbling” that is so attractive in the ornamental marble.

ORIGIN: Marble is a metamorphic rock. Marble formed as the result of deep burial, increase in temperature and pressure, such as tectonic activity (mountain building), or hydrothermal activity.

USAGE:

- Dignified buildings where its architectural adaptability, permanence, and prestige are of prime importance
- Monuments (Tomb of the Unknown Soldier)
- Curbing
- Decorative (Clocks, pen holders, etc.)

[Physical properties presented above are based on averages and/or purer minerals than in your kit.]*

Salt

GENERAL: Common salt is the mineral halite. The production of salt started with the beginning of man. Each year, each person consumes approximately 12 pounds of salt. Salt is an essential nutrient for the existence of life. Salt has had a profound impact on the history of man. It has promoted exploration, warfare, conquest, and barter. Salt has been used as basis for government taxation and payment for services. The earliest record of using salt in an economic situation was traced to about 2000 B.C. in China. Salt was also recorded as being used to pay Roman soldiers. This payment of salt rations was called "Salarium argementum". The English word "salary" is derived from this Latin term.

SAMPLE LOCATION: Cargill Salt Co., Newark, CA

PHYSICAL PROPERTIES*:

Luster - Nonmetallic

Hardness - 2.5

Color(s) - Colorless, white to blue

Streak - White

Cleavage - Good cleavage

Fracture - None

Specific Gravity - 2.1

Other Properties - Dissolves easily in water, and taste salty

ORIGIN: Salt deposits are basically derived from evaporation of saline water and can be obtained from solid deposits or brine solutions. The most common solid deposits are sedimentary beds, salt domes, or playa deposits. The more common brine solutions include ocean water, salt lake water, and subsurface brine. The salt in your kit is called "extra course solar salt", which means it was obtained by evaporation of a brine solution. Impurities can be controlled better when the evaporation is controlled.

USAGE:

- | | |
|---|-------------------------|
| -Plastic products for building and construction | -Soaps and detergents |
| -Home furnishings | -Deicing on highways |
| -Packaging | - Alkaline and chlorine |
| -Paper industry | -Canning |
| -Water and sewage treatment | -Table salt |
| -Tanning | -Casing Manufacturing |

[Physical properties presented above are based on averages and/or purer minerals than in your kit.]*

Zeolite

GENERAL: The name zeolite comes two Greek words meaning “to boil” and “stone”. It refers to the swelling-up and apparent boiling that occurs when this mineral is heated and water is driven off. Zeolites have the unique ability to not only lose water, but absorb water and other compounds such as methane and carbon dioxide. Zeolite is actually referred to as a family of minerals that are aluminum silicates. Some of the more common zeolite minerals include: Chabazite, Clinoptilolite, Erionite, and Mordenite. The sample in your kit is one of the aforementioned minerals. Zeolites were first identified in 1756. They were considered geologic oddities and were collectable items. Interest in the industry for zeolites has skyrocketed recently because of the potential uses of their chemical properties. Zeolite deposits are abundant and have a low cost to mine.

SAMPLE LOCATION: Steel Head Specialty Minerals, Spokane, WA

PHYSICAL PROPERTIES*:

Luster - Vitreous to pearly

Hardness - 4.0 - 5.0

Color(s) - Colorless, white, sometimes red stains

Streak - White

Cleavage - Perfect

Fracture - None

Specific Gravity - 2.2

Other Properties - Gives off water when heated. Very light and fragile.

ORIGIN: Zeolite deposits are associated with magmatic solutions and hydrothermal activity or diagenesis. For the most part zeolites are a secondary mineral, occurring in cavities and veins. They are often a product of alteration of feldspars, or volcanic glass. They are found in igneous and sedimentary deposits.

USAGE:

- Ionic exchanger in environmental clean up and water purification.
- Dimension stone
- Insulation
- Food supplement
- Soil conditioner
- Detergent
- Medical
- Filler in paper

[Physical properties presented are based on averages and/or purer minerals than in your kit.]*