INFORMATION CIRCULAR

A SUMMARY OF THE MINERAL RESOURCES OF WYOMING

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INTRODUCTION

This circular has been prepared for those who may be unfamiliar with the extent and value of the mineral resources of Wyoming. Most of Wyoming's important minerals are listed here, along with the description of their appearance, the location and extent of production and their commercial uses. Some of these minerals are economically very important to the State; others are not presently economically important, but may become so in the future as further uses are found for them, or as supplies elsewhere are depleted.

In order that the reader may orient himself with respect to the geological distribution of the various mineral resources, it is convenient to divide the State into several geological provinces:

1. The Mountain cores of Precambrian crystalline rock.
2. The volcanic area of Yellowstone National Park and the Absaroka Mountains, and other isolated areas of Tertiary intrusive igneous rocks.
3. The basin areas of Paleozoic, Mesozoic, and Tertiary sedimentary rocks.

As a generalization it might be stated that the metallic (copper, gold, lead, zinc, silver, etc.) mineral deposits are almost entirely restricted to the first two areas, while coal, petroleum products, uranium, and the nonmetallic minerals (bentonite, gypsum, phosphate, trona, etc.) are limited to the third-mentioned province.

ALUMINUM

The only potential ore of aluminum in Wyoming is anorthosite which outcrops in a large body thirty-six miles long by ten to eighteen miles wide in the Laramie Range, Albany County. Anorthosite is usually a gray coarse-grained igneous rock which consists almost entirely of plagioclase feldspar and contains from 27% to 30% alumina.

There is no production of alumina at present in the State. However, the U. S. Bureau of Mines and commercial concerns have conducted beneficiation tests relative to the commercial extraction of this ore, and a major aluminum company has acquired large reserves of anorthosite in the Laramie Range.

ASBESTOS

The two sources of asbestos are chrysotile -- a fibrous serpentine -- and various fibrous amphiboles. Chrysotile, the more important of the two, must possess flexibility, long fine fibers, and high tensile strength for commercial use. Asbestos is generally used as an insulating and fireproofing material.

All deposits in Wyoming are in Precambrian metamorphic rocks. The largest deposits are found north of Atlantic City, Fremont County; at Casper Mountain, Natrona County; and along Berry Creek, Teton County. No asbestos is being produced in Wyoming at the present time.

BENTONITE

Bentonite is a sedimentary rock that contains at least 75% of the clay minerals beidellite or montmorillonite. The uses of bentonite depend upon its swelling capacity. A bentonite with a high colloid content may absorb large quantities of water and swell to many times its original volume. The high-swelling types are used as drilling muds in oil wells, in iron ore pellets, as binders for foundry sands, as filler for coffer dams, and in reservoir linings. The non-swelling types may be used for insecticide fillers and industrial filters.

The beds of bentonite in Wyoming are the result of alteration of volcanic ash which was deposited in a sea that covered the State about 100 million years ago.

Wyoming is the leading bentonite-producing state and produces 67% of the nation's output. Most of the bentonite is produced in Big Horn, Crook, Johnson, Natrona, Washakie, and Weston Counties.

CHROMITE

Chromite is a brittle black to brown mineral that commonly occurs in eight-sided crystals, and has a metallic to sub-metallic luster. The mineral is a chemical combination of iron or magnesium, chromium, and oxygen, and is used for preparation of the alloy ferrochrome, chromite fire brick, and in the paint and chemical industries.

Chromite has been found on Casper Mountain, Natrona County. It occurs as disseminated grains and as lenses in Precambrian schist. It was formed by crystallization in an ultra-basic igneous rock that subsequently changed into a schist over one billion years ago.

COAL

Coal is a rock composed of the altered and compressed remains of plants that grew in shallow swamps. Fallen leaves, twigs, branches, and trunks of the swamp vegetation accumulated as peat -- preserved by the stagnant waters

of the swamp. Later, burial by sediments compacted the original peat beds and started the coalifaction process which converts buried peats into coals of various ranks. Dependent on the degree to which coalifaction progresses, peat can change to lignite, subbituminous, bituminous, or anthracite coal.

Wyoming's coal beds are mostly subbituminous in rank although there are some lignites and bituminous coals as well. The swamps that formed these coals grew 38-130 million years ago. Most Wyoming coals are found in the Mesaverde Formation of Upper Cretaceous age, the Fort Union Formation of Paleocene age or the Wasatch Formation of Eocene age. Although Wyoming coal thicknesses range up to 220 feet thick, mined seams average 20-70 feet thick.

The coal-bearing regions of Wyoming occupy 41% of the State's surface area. An estimated 1 trillion tons of coal underlies these coal-bearing regions at depths less than 6000 feet. This is approximately 25% of the national total and ranks Wyoming first among the states in total coal resources. Of this resource, only 14% or 136 billion tons is mapped and explored within 3000 feet of the land surface. Of that amount, one-half or 68 billions tons are considered recoverable by current mining methods. At least 23.7 billion tons of that recoverable resource is strippable coal.

To date, Wyoming has mined over 490 million tons of coal. Although most of this production came from the Hanna and Rock Springs areas, current and future production will be dominated by the Powder River Basin area of northeastern Wyoming. Conservative estimates show State production as high as 96 million tons per year by 1980. This compares with just over 20 million tons mined in 1974.

COPPER

Copper is found in many deposit types: veins, replacement bodies, disseminated deposits in igneous and sedimentary rocks, and cavity fillings and replacements in basaltic lavas. Native copper is often found in many localities, but the principal ore is chalcocite, a blackish-gray mineral containing about 80% copper and 20% sulfur. Chalcopyrite, the other most important ore is a brass-yellow color and contains about 35% copper, 30% iron, and 35% sulfur. Another copper mineral, bornite, is a reddish-brown color and contains about 63% copper, 11% iron, and 26% sulfur.

In addition to these are the oxidized minerals malachite, chrysocolla, and cuprite. These are often found exposed by erosion near the surface of copper deposits. Surface waters oxidize the copper ore minerals and leach out part of the copper down to the groundwater table. Often secondary copper sulphides are precipitated below the groundwater table, producing some of the greatly enriched ore deposits that have made mining history in the Rocky Mountain area.

At the present there are no producing copper mines in Wyoming. However, a major metals company has been evaluating the old Kirwin copper mining district in Park County for possible development of a porphyry copper deposit occurring there.

During the period 1899 - 1908, the State was one of the leading copper producers in the nation. Total production of copper in the State during the years 1867 - 1950 has been reported to be 16,326 short tons. Most of the copper was produced from the Encampment district, Carbon County, but some has come from the Hartville district, Platte County; the Copper Mountain district, Fremont County; and the Douglas Creek district, Albany County.

CORDIERITE

Cordierite, a complex magnesium-iron-aluminum silicate, is found in a wide variety of metamorphic gneisses and schists, granites, volcanics, or in certain sediments that have been subjected to heat. It is used for various industrial items that must withstand high temperatures, such as thermocouple insulators, industrial burner tips, chemical stoneware, and automotive parts.

Although there has been no production in Wyoming, an estimated 500,000 short tons of cordierite is found in two large deposits in the Laramie Range, Albany County. Its use is limited, however, because of high iron content. It is possible that it may be used some time in the future for low thermal expansion bodies where color, dielectric properties, and strength are not critical factors.

FELDSPAR

The feldspar minerals are found in many rocks, but commercial deposits are almost entirely restricted to pegmatites. Orthoclase and microcline are the most widely used of the feldspars. They are used in the ceramic industry, for glass, enamel, and pottery, and in soaps, abrasives, and false teeth. Labradorite, a plagioclase feldspar, often shows a display of colors, and is used for ornamental stone, moonstones or sunstones.

Wyoming has produced an estimated 103,000 tons of feldspar. Fremont County has been the biggest producer in recent years; other producing localities include Casper Mountain, Natrona County; Haystack Range, Goshen County; and the Laramie Range, Albany and Laramie Counties.

FLUORITE

Fluorite, a calcium fluoride, is found in dolomites, limestones, granites, and pegmatites, and in veins associated with lead, silver, zinc and tin minerals. Fluorite is used as an electrolyte and as a flux in metallurgy and the steel industry. Other uses include the manufacture of hydrofluoric acid, opal glass, enamelware, ornamental stones, lenses and other optical equipment. The only known locality in Wyoming where fluorite has any potential economic importance is the Bear Lodge Mountains, Crook County. Nineteen tons of fluorite were shipped from there in 1944.

GOLD

Gold is found in small placer and vein deposits at many places in Wyoming. Since the metal is chemically inert, most is found as native gold or alloyed with silver in veins. Gold in Wyoming is usually found in or near the Precambrian rocks, but some is found associated with the Tertiary igneous rocks in the Wood River and Sunlight Basin areas of Park County, and the Black Hills area of eastern Wyoming.

Most of the gold produced in Wyoming has come from the Atlantic City-South Pass-Sweetwater district where it was discovered in 1840. The total recorded production from this district for the period 1867-1950 has been 80,031 ounces valued at $1,909,413. Production since that time period has been insignificant.

GYPSUM

Gypsum, which is composed of calcium sulphate and water, occurs in several forms; white massive rock gypsum; earthy gypsite; alabaster (fine-grained massive marble-like form); selenite (crystalline gypsum); and satin spar (a fibrous variety and a silky luster). Anhydrite, a calcium sulphate, is similar to gypsum but contains no water.

The commercial gypsum beds in Wyoming lie mainly in the Permian, Triassic, and Jurassic redbeds which were deposited in ancient seas and saline lakes approximately 100 - 200 million years ago. The gypsum in Wyoming is very pure and contains little salt.

Gypsum is used as a fertilizer or soil conditioner, as filler for paper textiles, and as a retarder in the manufacture of Portland Cement. Calcined gypsum is used for molding, casting, pottery, dental plasters, plasterboard, plaster tiles, blocks, etc. Gypsum is mined near Cody and Lovell, and used in the manufacture of plasterboard. Gypsum is mined near Laramie for use in Portland Cement. Other small quarries operating intermittently in Wyoming since 1890 have produced enough gypsum to supply local demand.

IRON

Hematite and magnetite are two major ores of iron that are found in Wyoming. Hematite, an iron oxide, varies in color from dark steel-gray or iron-black to red in the earthy variety. Magnetite, also an iron oxide, commonly occurs in eight-or-ten-sided crystals, has a metallic luster, is black in color, and will attract a magnet. Sometimes magnetite contains titanium, as does that exposed in a large body at Iron Mountain in Albany County.

Some of the iron ore mined in Wyoming is hematite from the Precambrian schists of the Sunrise Mine in Platte County. This mine has operated almost continuously since 1898. Taconite, an iron-bearing siliceous rock, has been mined in the Atlantic City area of Fremont County since August, 1962. This operation, at an elevation of 8,000 feet above sea level, is

the highest large-sclae open pit iron mine in the United States and is now larger than the Sunrise Mine operation. Other iron ore deposits are found near Rawlins and the Shirley and Seminoe Mountains, Carbon County; and the Good Fortune Mine in Platte County.

JADE

There are two mineralogic types of jade: jadeite -- an aluminum-sodium silicate belonging to the pyroxene group of minerals, and nephrite -- a calcium-magnesium silicate belonging to the amphibole group. The jade found in Wyoming is the nephrite variety, and it varies in color from black to apple green. The various shades of green are highly prized for jewelry. Jade has also been used since prehistoric times for weapons, utensils, bells, and ornaments.

Jade occurs in two ways: 1) as lodes or veins in Precambrian rocks, or 2) as boulders in alluvial deposits.

It was initially discovered in Wyoming in 1936. It was found in boulders over a large area southeast of Lander, in Fremont County. The largest specimen found was a boulder weighing 119 pounds. No figures have been kept on the production of Wyoming jade.

LEAD, SILVER, and ZINC

Lead, silver, and zinc often occur together. In addition, many copper deposits contain these three metals. The principal ore of lead is galena, a combination of 87% lead and 13% sulfur. Galena is a metallic gray color, is soft, and often occurs in the shape of cubes. Galena commonly contains silver.

Sphalerite, the primary zinc ore, contains about 67% zinc and 33% sulfur. It is soft and usually resinous-brown in color.

At present there are no producing mines of lead, silver or zinc in Wyoming. In the past, only a total of 32 tons of lead has been mined in the State. No recorded production of zinc is available. Most of the 58,019 troy ounces of silver produced has been a by-product of the copper ores.

There are many small lead, silver, and zinc deposits in the State. The most important ones are in the mountain areas of Albany, Carbon, Crook, and Park Counties.

MANGANESE

There are many known manganese minerals, but pyrolusite and psilomelane are the most important. Both are manganese oxides and are black in color, but psilomelane is very much harder than pyrolusite. In general, they have been concentrated in irregularly bedded deposits by the weathering of other manganese minerals. Manganese has been mined in Garrett and Marshall, Albany County and deposits are also found in Crook, Johnson, Washakie, and Weston Counties.

Manganese is used chiefly to purify steels and to make wearing surfaces of steel more resistant to abrasion. Manganese is also ued for dry batteries, industrial chemicals, insecticides, bricks, plastics and welding rods.

The only recorded manganese production in Wyoming was in Albany County and totaled only 212 tons.

MOLYBDENUM

The mineral molybdenite is the only molybdenum mineral of economic importance. Molybdenite, a combination of molybdenum and sulfur, is a soft lead-gray mineral that occurs as scales of oliated crystals associated with quartz veins of granite. Molybdenum is used in steels where hardness and toughness are necessary.

No molybdenum has been produced in Wyoming, but small deposits are located in the mountain areas of Albany, Laramie, Sublette, and Park Counties. Molybdenum occurs in association with copper minerals in the Kirwin area of the Absaroka Mountains, Park County. Molybdenum also occurs in sandstones associated with some uranium deposits in Wyoming.

PEGMATITE MINERALS

Pegmatites are, in general, very coarse-grained igneous rocks, containing the minerals quartz, feldspar, and muscovite mica. Minor minerals consist of beryl, columbite, tantalite, monazite, lepidolite, spodumene, Topaz, tourmaline, and molybdenite. Of these, beryl, columbite, tantalite, spodumene, and monazite are the most important since they are ores of beryllium, columbium, tantalum, lithium, and thorium respectively.

The only current production of pegmatites in Wyoming is for feldspar at Copper Mountain, Fremont County. Production of other pegmatite minerals has been negligible. Pegmatites have also been found in Albany, Carbon, Goshen, Laramie, and Natrona Counties.

PHOSPHATE

The principal mineral in phosphate rock is collophane, a chemical combination of calcium, phosphorus, fluorine, and carbon dioxide. The phosphate rock in Wyoming is found in the Permian Phosphoria Formation. These rocks were deposited in an ancient sea that covered central and western Wyoming approximately 200 million years ago.

The most important use of phosphate rock is in the manufacture of fertilizer for phsophorus-poor soils. A small amount is used to manufacture elemental phosphorus, which in turn, is used in ceramics, beverages, photography, incendiary and smoke bombs.

At present there is one producing phosphate mine in Wyoming, located 25 miles west of Kemmerer, at Leefe. There are, however, large deposits of phosphate rock in Fremont, Lincoln, Sublette, and Teton Counties, and it is possible that new mines will open up in some of these localities in the future.

During 1974, 852,618 tons of phosphate rock were mined in Wyoming.

SELENIUM

Selenium can be considered either a metal or nonmetal, but the ordinary form is a crystalline, grayish solid with a semi-metallic luster. Commercial selenium is produced at the present time as a by-product from the electrolytic refining of blister copper. The principal use of selenium is in the manufacture of electronics equipment, but it is also used in the glass, ceramic, chemical, pigment, rubber, and stainless steel industries.

The presence of selenium in Wyoming has been recognized since at least 1933. It was discovered by virtue of certain selenium-bearing plants which had a toxic effect on livestock and on persons who ate the meat of the livestock. Paleozoic, Mesozoic, and Cenozoic rocks in various parts of the State are known to support seleniferous vegetation. Important selenium deposits are found in sandstones of the Browns Park Formation near the Baggs-Poison Basin area; in Eocene tuffs near Lysite, Fremont County; and in the Phosphoria Formation cropping out in Lincoln County. In addition, selenium is often found associated with some of the uranium deposits in Wyoming.

There is no production of selenium in Wyoming at the present time.

SULFUR

Sulfur is obtained from naturally occurring elemental sulfur, pyrite (fool's gold), and in natural gas bearing hydrogen sulphide. Elemental sulfur is a soft resinous yellow mineral, while pyrite, an iron sulphide, is a hard, brittle brassy colored mineral. Sulfur is common in volcanic areas and hot springs, such as those in Yellowstone National Park. Pyrite is found in many of the mineral veins in the mountain areas of the State.

For many years Wyoming has been an important sulfur producer by virtue of the "sour gas" (hydrogen sulphide-bearing) wells in the Big Horn Basin.

Wyoming's production of sulfur comes from Big Horn, Fremont, Park and Washakie Counties, ranking the State eighth in the nation in sulfur production. Some of Wyoming's sulfur is used in the manufacture of sulfuric acid in plants at Riverton and Jeffrey City.

STONE

Of all the many types of stone found in Wyoming, probably granite, limestone, and sandstone are the most important from an economic standpoint.

Granite is a coarse-grained igneous rock that is found in the cores of many of the mountain ranges of Wyoming. Limestone is a sedimentary rock composed predominantly of the mineral calcite, but impurities are often present. Sandstone is a sedimentary rock composed of quartz grains bound together with silica, calcium carbonate, or iron oxide cement.

Chief uses for these different types of stones include sugar refining (for which pure limestone is required), cement products, railroad ballast, road metal, rip-rap, and concrete blocks.

The supply of most types of stone in Wyoming is unlimited, and the different types can be found in almost every county.

TITANIUM

In addition to the titaniferous magnetite deposits of Iron Mountain, Albany County, there are a number of titanium-bearing black sand deposits in the State. All of these occur in rocks of Cretaceous age. Three minerals in the deposits contain titanium: ilmenite, anatase, and rutile. Ilmenite is a submetallic black mineral roughly similar to magnetite, but is not as highly magnetic. Anatase, the alteration product of ilmenite, is a brown brittle mineral. Rutile is a hard reddish brown prismatic mineral.

The black sand deposits in the State often contain radioactive zircon crystals, which fluoresce under an ultraviolet lamp. Such titanium deposits have been reported on Sheep Mountain, west of Laramie; west of Casper, Natrona County; at Grass Creek, Hot Springs County; south of Rock Springs, Sweetwater County; and at Cumberland Gap, south of Kemmerer, Lincoln County. At the present time, there is no production of titanium from these deposits.

TRONA

Wyoming's third most valuable mineral resource is trona, exceeded only by petroleum and natural gas in dollar value of annual production.

A naturally occuring sodium sesquicarbonate, trona is a brown to gray, soft, translucent mineral with a glassy or vitreous appearance. The mineral, whose composition is similar to a mixture of washing soda and baking soda, occurs with other sodium minerals in approximately twenty-five different trona-bearing beds 440 to 3,500 feet below the present surface of the Green River Basin, Sweetwater County. These beds of saline minerals were deposited during evaporation of Lake Gosiute, an enormous lake which existed in Southwestern Wyoming some 50 million years ago.

The trona-soda ash industry of Sweetwater County began to boom in the early sixties. This was due to the increasing use of the industrial chemical called soda ash and to the phasing out of obsolete soda ash manufacturing facilities in the East. Today the four active trona mining companies in the County produce over 50% of the nation's soda ash. Most soda ash is used in the manufacture of glass, chemicals, paper and soap. There is also a plant west of Green River which produces baking soda.

TUNGSTEN

The most important tungsten minerals are wolframite, scheelite, ferberite, and huebnerite. Scheelite, a chemical combination of calcium tungsten and oxygen, is the major ore of tungsten in Wyoming. This mineral, which fluoresces a light blue under ultraviolet light is usually found in quartz veins or pegmatites in the Precambrian rocks of Wyoming.

Some scheelite has been shipped from Wyoming in the past, but there are no active producing mines at present. The most important known scheelite deposits are found at Copper Mountain in Fremont County. In addition, small deposits have been found in Albany, Converse, Fremont and Washakie Counties.

URANIUM

There are many uranium minerals, but carnotite, schroeckingerite, uranophane, and uraninite are among the most important varieties detected with a geiger or scintillation counter. These minerals emit alpha, beta, and gamma particles, which, in turn, produce pulses of current in the tube of the geiger counter. These are recorded as "clicks" in the earphones or as readings on a meter, or both.

Carnotite is a yellow, earthy, powdery mineral. Schroeckingerite, a hydrous uranium carbonate and silicate, is a mineral that fluoresces a vivid yellow-green. Uranophane, a calcium-uranium silicate, is soft and bright yellow in color. Uraninite, or pitchblende as it is often called, is a uranium oxide that is fairly hard and dark brownish-black in color.

Uranium has been found in Wyoming in rocks ranging from Precambrian to Tertiary in age. Practically all of the uranium production, however, has come from Lower Cretaceous or Tertiary sandstone.

Producing uranium mines are located in the southern Powder River Basin, Converse County; Shirley Basin area, Carbon County; and Gas Hills, Crooks Gap-Green Mountain area, Fremont County. Additional uranium prospects or inactive mines are located in the "Red Desert" and Lost Creek areas of Sweetwater County; Baggs-Poison Basin, Carbon County; Black Hills area, Crook County; Miller Hill, Pedro Mountains, Shirley Mountains-Freezeout Hills areas, Carbon County; Esterbrook area, Albany County; Lance Creek and Lusk areas, Niobrara County; and the Little Mountain area, Big Horn County.

Radioactive dinosaur bones are not uncommon and have been found in Albany, Big Horn, Carbon and Teton Counties. There are many other uranium prospects in the State, and with increased exploration it is not unlikely that additional deposits will be found.

Among states possessing commercial uranium deposits, Wyoming holds the second largest reserves in the nation. Seven uranium mills, located in Carbon, Converse, Fremont, and Natrona Counties, operate in Wyoming. During 1974 the State ranked second in the nation according to uranium concentrates produced.

Most of the uranium mined today is used in the production of atomic energy materials and in nuclear power plants for the generation of electricity, atomic powered ships and submarines and medicines.

VANADIUM

The vanadium-bearing phosphate rocks are the best potential sources of vanadium in Wyoming. The principal reserves are in the Park City formation which crops out in Lincoln County. The Bureau of Mines has estimated that ver 20,000 tons of rock averaging 0.9% to 1.0% vanadium pentoxide are present in this locality. It occurs elsewhere in western Wyoming in the equivalent Phosphoria formation.

Most of the vanadium produced is used in vanadium steel alloys. Vanadium is produced as a by-product of uranium ores mined in the Powder River Basin, Wyoming.

VERMICULITE

Vermiculite, a magnesium-aluminum-iron silicate, is a soft, pliable, and micaceous mineral that varies greatly in color, composition and general appearance. Since the mineral is fireproof and lightweight, it is well suited for insulating purposes. It is also used for concrete and plaster aggregate, in horticultural work, for insulation materials, refractory bricks, and as lubricants and fillers. When heated the volume of this mineral will expand as much as twenty times.

Production of vermiculite in Wyoming between 1935-1948 amounted to 13,017 tons. The Wyoming vermiculite deposits are found in the Precambrian rocks in parts of Albany, Carbon, Converse, Fremont, Natrona, Platte, and Sheridan Counties.

ZEOLITES

Zeolites are hydrous silicate minerals of white color, vitreous to pearly luster, and prismatic crystal form. Many of the zeolites of Wyoming are found in beds of volcanic ash and in sedimentary rocks which contain a high percentage of volcanic ash. The principal zeolite minerals found in the State are clinoptilolite, heulandite, erionite, and thomsonite. They occur in the Beaver Rim southeast of Lander, Fremont County and in the Sunlight Creek area of the Absaroka Mountains, Park County.

The zeolites have the unique ability to act as molecular filters to remove undesirable chemical substances from waters. Because of this property, zeolites are now used in water softeners and may in the future be increasingly used in the treatment of industrial waste waters for pollution control. Commercial development could occur within a few years.

GLOSSARY OF GEOLOGICAL TERMS

alluvium -- sediments deposited by a stream

amphibole -- a mineral composed largely of silica, calcium, and magnesia; its varieties include tremolite asbestos and hornblende

basaltic rocks -- fine-grained, compact, dark-colored, usually extrusive, igneous rocks

beneficiation -- upgrading of ore material by mechnical or chemical processing

calcine -- to change to powder and remove volatiles such as water and carbon dioxide by heating

Cenozoic -- see Geologic Time Table following this glossary

fluoresce -- to produce light when acted upon by radiant energy from sources such as ultraviolet lamps

foliated -- divided into thin layers

formation -- a set of sedimentary rocks that is used as a geological mapping unit and named after a geographic locality, i.e., Tensleep Sandstone, Thermopolis Shale, etc.

gneiss -- a coarse-grained, metamorphic rock resembling granite and having a banded appearance, consisting of alternating layers of different minerals such as feldspar, quartz, mica, and hornblende

hornblende -- a black, brown, or green complex silicate mineral containing iron, magnesium, and calcium, found in igneous and metamorphic rocks

igneous -- a type of rock produced from molten mineral matter which originated within the earth

Jurassic -- see Geologic Time Table following this glossary

Mesozoic -- see Geologic Time Table following this glossary

metamorphic -- a type of rock produced by the application of heat and pressure to pre-existing sedimentary or igneous rocks, i.e., limestone into marble, granite into gneiss

mineral -- a naturally-occurring homogeneous substance of definite chemical composition and possessing a definite internal crystal form

Paleozoic -- see Geologic Time Table following this glossary

Permian -- see Geologic Time Table following this glossary

Precambrian -- see Geologic Time Table following this glossary

placer -- a water-borne or glacial deposit of gravel and sand containing heavy ore minerals, such as gold or platinum, which have been eroded from their original bedrock

plagioclase -- calcium and sodium-bearing members of the feldspar family

pyroxene -- a group of complex silicate minerals usually containing iron, magnesium, and clacium, found in igneous and metamorphic rocks

schist -- a strongly foliated crystalline rock, formed by dynamic metamorphism, which can be readily split into thin flakes or slabs due to the well developed parallelism of the minerals present

seleniferous vegetation -- plants that absorb and retain large quantities of selenium from the soil

serpentine -- a magnesium-iron silicate usually derived from alteration of an ultra-basic igneous rock

siliceous -- having high content of silica (SiO_2)

Tertiary -- see Geologic Time Table following this glossary

Triassic -- see Geologic Time Table following this glossary

tuff -- consolidated volcanic ash

ultra-basic igneous rock -- a dark colored igneous rock that contains a very high percentage of iron and magnesium-bearing minerals

vitreous -- having a glassy luster

GEOLOGIC TIME TABLE

ERA	PERIOD	EPOCH	MILLIONS OF YEARS BEFORE PRESENT
Cenozoic	Quaternary	Recent *(Age of Man)* Pleistocene *(Ice Age)*	Present to 2
	Tertiary	Pliocene	2-10
		Miocene	10-25
		Oligocene	25-40
		Eocene	40-60
		Paleocene	60-70
Mesozoic	Cretaceous *(Extinction of Dinosaurs)*		70-130
	Jurassic *(First Birds)*		130-180
	Triassic *(Advent of Dinosaurs)*		180-230
Paleozoic	Permian *(Rise of Reptiles)*		230-270
	Pennsylvanian		270-310
	Mississippian *(Rise of Land Plants)*		310-350
	Devonian *(Age of Fishes)*		350-400
	Silurian *(Age of Invertebrates)*		400-440
	Ordovician		440-500
	Cambrian		500-600
Proterozoic*			
Archeozoic*			

*Both part of the **Precambrian**

Present geologic knowledge indicates that the age of the earth is approximately five billion years.