Minerals and Mineral Related Resources and their uses

Every segment of society uses minerals and mineral resources everyday. The roads we ride or drive on and the buildings we live learn and work in all contain minerals. Below is a selected list of commonly used metallic and non-metallic minerals, ore minerals, mineral byproducts, aggregates, and rock types that are used to make products we use in our daily life (see Frank, Weathers, and Galloway, 2001; Weathers, Galloway, and Frank, 2001).

Aggregates Natural aggregates include sand, gravel, and crushed stone. Aggregates are composed of rock fragments that may be used in their natural state or after mechanical processing, such as crushing, washing, or sizing. Recycled aggregates consist mainly of crushed concrete and crushed asphalt pavement (Goonan, 1999). For additional information on aggregates see Tepordei (1997).

Aluminum Aluminum is the most abundant metallic element in the Earth's crust. Bauxite ore is the main source of aluminum. Aluminum is used in automobiles and airplanes (36%), bottling and canning industries (25%), building and electrical (14%) and in other applications (25%).

Asbestos Asbestos is a class of minerals that can be readily separated into thin, strong fibers that are flexible, heat resistant, and chemically inert. Asbestos minerals are used in fireproof fabrics, yarn, cloth, and paper and paint filler. Asbestos is used to make friction products, asbestos cement pipes and sheets, coatings and compounds, packing and gaskets, roofing and flooring products, paints and caulking, and chemical filters. Fibers are dangerous when breathed, so uses must protect against fibers becoming airborne.

Basalt Basalt is an extrusive igneous rock. Crushed basalt is used for railroad ballast, aggregate in highway construction, and is a major component of asphalt.

Barium Barium is an element, derived primarily from the mineral barite, and used as a heavy additive in oil-well-drilling mud, paints, rubber, plastic and paper; production of barium chemicals; and glass manufacturing.

Beryllium Beryllium, an element commonly associated with igneous rocks, has industrial and nuclear defense applications and is used in light, very strong alloys for the aircraft industry. Beryllium salts are used in x-ray tubes and as a deoxidizer in bronze metallurgy. The gemstones of beryl, a beryllium mineral, are emerald and aquamarine.

Bromine Bromine, recovered commercially through the treatment of seawater brines, is used in leaded gasoline, fire extinguishers and retardants, well-completion fluids, and sanitary preparations. Bromine is the only liquid nonmetallic element.

Cadmium Cadmium is used in plating and alloying, pigments, plastics, and batteries. Cadmium is obtained from the ore minerals Sphalerite (Zn,Cd)S and Greenockite (CdS)

Cement Cement is used for building materials, stucco, and mortar. Cement is "a mixture of powdered lime, clay, and other minerals that crystallize to form a hard solid when water is added (hydraulic cement) or as a binding material in concrete" (Kesler, 1994). An excellent overview of cement, its chemistry, and properties can be found in MacLaren and White (2003).

Chromium Chromium is used in the production of stainless and heat-resistant steel, full-alloy steel, super alloys and other alloys. Chromium is obtained from the ore mineral Chromite $(Mg,Fe)(Cr,Al,Fe)_2O_4$

Clays There are many different clay minerals that are used for industrial applications. Clays are used in the manufacturing of paper, refractories, rubber, ball clay, dinnerware and pottery, floor and wall tile, sanitary wear, fire clay, firebricks, foundry sands, drilling mud, iron-ore pelletizing, absorbent and filtering materials, construction materials, and cosmetics.

Cobalt Half of the consumption of cobalt is used in corrosion- and abrasion-resistant alloys with steel, nickel, and other metals for the production of industrial engines. Other uses of cobalt metal include magnets and cutting tools. Cobalt salts are used to produce a blue color in paint pigments, porcelain, glass, and pottery. Cobalt is obtained from the ore minerals Linneaite (Co_3S_4), Cobaltite $(Mg,Fe)(Cr,Al,Fe)_2O_4$, and $(Fe,Ni,Co)_{1-x}S_x$.

Copper Copper is used in electric cables and wires, switches, plumbing; heating, electrical, and roofing materials; electronic components; industrial machinery and equipment; transportation; consumer and general products; coins; and jewelry.

Diatomite Diatomite is a rock composed of the skeletons of diatoms, single-celled organisms with skeletons made of silica, which are found in fresh and salt water. Diatomite is primarily used for filtration of drinks, such as juices and wines, but it is also being used as filler in paints and pharmaceuticals and environmental cleanup technologies.

Dolomite Dolomite is the near twin-sister rock to limestone. Like limestone, it typically forms in a marine environment but also as has a primary magnesium component. Dolomite is used in agriculture, chemical and industrial applications, cement construction, refractories, and environmental industries.

Feldspar Feldspar is a rock-forming mineral. It is used in glass and ceramic industries; pottery, porcelain and enamelware; soaps; bond for abrasive wheels; cement; glues; fertilizer; and tarred roofing materials and as a sizing, or filler, in textiles and paper applications.

Fluorite Fluorite is used in production of hydrofluoric acid, which is used in the pottery, ceramics, optical, electroplating, and plastics industries. It is also used in the metallurgical treatment of bauxite, as a flux in open-hearth steel furnaces, and in metal smelting, as well as in carbon electrodes, emery wheels, electric arc welders, and toothpaste as a source of fluorine.

Garnet Garnet is used in water filtration, electronic components, ceramics, glass, jewelry, and abrasives used in wood furniture and transport manufacturing. "Garnet is a common metamorphic mineral that becomes abundant enough to mine in a few rocks" (Kesler, 1994).

Germanium "Most germanium is recovered as a byproduct of zinc smelting. It is also found in some copper ores" (Kesler, 1994). Applications include use in fiber-optic components, which are replacing copper in long-distance telecommunication lines, as well as in camera lenses and other glasses and infrared lenses.

Gold Gold is used in dentistry and medicine, jewelry and arts, medallions and coins, and in ingots. It is also used for scientific and electronic instruments, computer circuitry, as an electrolyte in the electroplating industry, and in many applications for the aerospace industry.

Granite Granite can be cut into large blocks and used as a building stone. When polished, it is used for monuments, headstones, countertops, statues, and facing on buildings. It is also suitable for railroad ballast and for road aggregate in highway construction.

Graphite Graphite is the crystal form of carbon. Graphite is used as a dry lubricant and steel hardener and for brake linings and the production of "lead" in pencils. Most graphite production comes from Korea, India, and Mexico.

Gypsum Processed gypsum is used in industrial or building plaster, prefabricated wallboard, cement manufacture, and for agriculture.

Halite Halite (salt) is used in the human and animal diet, primarily as food seasoning and as a food preservation. It is also used to prepare sodium hydroxide, soda ash, caustic soda, hydrochloric acid, chlorine, and metallic sodium, and it is used in ceramic glazes, metallurgy, curing of hides, mineral waters, soap manufacture, home water softeners, highway deicing, photography, and scientific equipment for optical parts. An excellent review of the salt industry can be found at http://www.saltinstitute.org/15.html.

Industrial Diamond Industrial diamonds are those that can not be used as gems. Large diamonds are used in tools and drilling bits to cut rock and small stone. Small diamonds, also known as dust or grit, are used for cutting and polishing stone and ceramic products.

Iron Ore Iron ore is used to manufacture steels of various types and other metallurgical products, such as magnets, auto parts, and catalysts. Most U.S. production is from Minnesota and Michigan. The Earth's crust contains about 5% iron, the fourth most abundant element in the crust.

Lead Lead is used in batteries, construction, ammunition, television tubes, nuclear shielding, ceramics, weights, and tubes or containers. The United States is largest producer (mainly from Missouri), consumer, and recycler of lead metal.

Limestone "A sedimentary rock consisting largely of the minerals calcite and aragonite, which have the same composition $CaCO_3$" (Kesler, 1994). Limestone, along with dolomite, is one of the basic building blocks of the construction industry. Limestone is used as aggregate, building stone, cement, and lime and in fluxes, glass, refractories, fillers, abrasives, soil conditioners, and a host of chemical processes.

Magnesium Magnesium (see dolomite) is used in cement, rubber, paper, insulation, chemicals and fertilizers, animal feed, and pharmaceuticals. Magnesium is obtained from the ore minerals Olivine $(Fe,Mg)_2SiO_4$, Magnesite $MgCO_3$, and Dolomite $CaMg(CO_3)_2$.

Manganese Manganese is essential to iron and steel production. Manganese is obtained from the ore minerals Braunite $(Mn,Si)_2O_3$, Pyrolusite MnO_2, and Psilomelane $BaMn_9O_{18}•2H_2O$.

Mercury Mercury is extracted from the mineral cinnabar and is used in electrical products, electrolytic production of chlorine and caustic soda, paint, and industrial and control instruments (thermometers and thermostats).

Mica Mica minerals commonly occur as flakes, scales, or shreds. Sheet muscovite (white) mica is used in electronic insulators, paints, as joint cement, as a dusting agent, in well-drilling mud and lubricants, and in plastics, roofing, rubber, and welding rods.

Molybdenum Molybdenum is used in stainless steels (21%), tool steels (9%), cast irons (7%), and chemical lubricants (8%), and in other applications (55%). It is commonly used to make automotive parts, construction equipment, gas transmission pipes, and as a pure metal molybdenum is used as filament supports in light bulbs, metalworking dies, and furnace parts because of its high melting temperature (2,623°C).

Nickel Nickel is vital as an alloy to stainless steel, and it plays a key roll in the chemical and aerospace industries. Leading producers are Canada, Norway, and Russia.

Phosphate rock Primarily a sedimentary rock used to produce phosphoric acid and ammoniated phosphate fertilizers, feed additives for livestock, elemental phosphorus, and a variety of phosphate chemicals for industrial and home consumers. The majority of U.S. production comes from Florida, North Carolina, Idaho, and Utah.

Platinum Group Metals (PGMs) PGM's include platinum, palladium, rhodium, iridium, osmium, and ruthenium. These elements commonly occur together in nature and are among the scarcest of the metallic elements. Platinum is used principally in catalytic converters for the control of automobile and industrial plant emissions; in jewelry; in catalysts to produce acids, organic chemicals, and pharmaceuticals; and in dental alloys used for making crowns and bridges.

Potash Potash is an industry term that refers to a group of water-soluble salts containing the element potassium, as well as to ores containing these salts (Kesler, 1994). Potash is used in fertilizer, medicine, the chemical industry, and to produce decorative color effects on brass, bronze, and nickel.

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

Quartz Quartz crystals are popular as a semiprecious gemstone; crystalline varieties include amethyst, citrine, rose quartz, and smoky quartz. Because of its piezoelectric properties (the ability to generate electricity under mechanical stress), quartz is used for pressure gauges, oscillators, resonators, and wave stabilizers. Quartz is also used in the manufacture of glass, paints, abrasives, refractories, and precision instruments.

Sandstone Sandstone is used as a building stone, road bases and coverings, construction fill, concrete, railroad ballast, and snow and ice control.

Silica Silica is used in the manufacture of computer chips, glass and refractory materials, ceramics, abrasives, and water filtration; and is a component of hydraulic cements, a filler in cosmetics, pharmaceuticals, paper, and insecticides; as an anti-caking agent in foods; a flatting agent in paint, and as a thermal insulator.

Silicon Silicon is used in iron, steel, and aluminum, as well as in the chemical and electronic industries.

Silver Silver is used in photography, chemistry, electrical and electronic products (because of its very high conductivity), fine silverware, electroplated wire, jewelry, coins, and brazing alloys and solders.

Sulfur Sulfur is widely used in manufacturing processes, drugs, and fertilizers.

Talc The primary use for talc is in the production of paper. Ground talc is used as filler in ceramics, paint, paper, roofing, plastics, cosmetics, and in agriculture. Talc is found in many common household products, such as baby (talcum) powder, deodorant, and makeup. Very pure talc is used in fine arts and is called soapstone. It is often used to carve figurines.

Tin Tin is used in the manufacture of cans and containers, electrical equipment, and chemicals.

Titanium Titanium is a metal used mostly in jet engines, airframes, and space and missile applications. In powdered form, titanium is used as a white pigment for paints, paper, plastics, rubber, and other materials.

Trona Trona is used in glass container manufacture, fiberglass, specialty glass, flat glass, liquid detergents, medicine, food additives, photography, cleaning and boiler compounds, and control of water pH. Trona is mined mainly in Wyoming.

Tungsten Tungsten is used in steel production, metalworking, cutting applications, construction electrical machinery and equipment, transportation equipment, light bulbs, carbide drilling equipment, heat and radiation shielding, textile dyes, enamels, paints, and for coloring glass.

Uranium Uranium is a radioactive material used in nuclear defense systems and for nuclear generation of electricity. It is also used in nuclear-medicine x-ray machines, atomic dating, and electronic instruments.

Zeolites Some of the uses of zeolite minerals include aquaculture (for removing ammonia from the water in fish hatcheries), water softener, catalysts, cat litter, odor control, and removing radioactive ions from nuclear-plant effluent.

Zinc Zinc is 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 paint. Additional uses include galvanizing iron, electroplating, metal spraying, automotive parts, electrical fuses, anodes, dry-cell batteries, nutrition, chemicals, roof gutters, cable wrapping, and pennies. Zinc oxide is used in medicine, paints, vulcanizing rubber, and sun-block lotions.

Zirconium Zirconium is a metal recovered from zircon. "Zircon is used in mineral form in refractory products, where it is valued for its high melting temperature of 2,550°C. Some zircon is processed by chemical leaching to yield elemental zirconium. The best known use for zirconium metal is in nuclear reactors, where zirconium contains the fuel" (Kesler, 1994).