An ore is a type of rock that contains minerals with important elements including metals. The ores are extracted through mining; these are then refined to extract the valuable element(s).

Find below a list including a range of ores, by-products, other materials, and classes of minerals.

A. ORES

1. Iron: to be used in the steel production [magnetite (Fe_3O_4), hematite (Fe_2O_3), goethite ($FeO(OH)$), limonite ($FeO(OH).n(H_2O)$) or siderite ($FeCO_3$)].

2. Manganese: to be used in the steel-alloys production [Pyrolusite: MnO2 and other]. Significant quantities of manganese have been used in many stainless steel compositions. Manganese preserves an austenitic structure in the steel as does nickel, but at a lower cost.

3. Chrome: to be used in the stainless steel (inox steel or inox from French "inoxydable") production [Chromite: (Fe, Mg)Cr2O4 for production of chromium]. Chrome plating, often referred to simply as chrome, is a technique of electroplating a thin layer of chromium onto a metal object. The chromed layer can be decorative, provide corrosion resistance, ease cleaning procedures, or increase surface hardness. It possess characteristics including the fact that it only melts at high temperatures "therefore, it is also applied in some refractory materials"; anti-corrosion properties; and it does not allows discoloration to steel. With a minimum of 11% of chromium content by mass it forms an steel alloy, allowing for the creation of the so-called stainless steel. Stainless steel does not stain, corrode, or rust as easily as ordinary steel, but it is not stain-proof. Chrome alum or Chromium potassium sulfate is the potassium double sulfate of chromium. Its chemical formula is $KCr(SO_4)_2$ and it is commonly found in its dodecahydrate form as $KCr(SO_4)_2 \cdot 12(H_2O)$. It was formerly used in leather tanning. Chromium alum is used in the tanning of leather as chromium stabilizes the leather by cross linking the collagen fibers within the leather. However, this application is obsolete because the simpler chromium sulfate is preferred.

4. Nickel: to be used in the alloys and armouring production (Ni). Its most important ore minerals are laterites, including limonite [FeO(OH)·nH2O], garnierite [Ni-Mg-hydrosilicates serpentine, talc, sepiolite, chlorite and smectite], and pentlandite [iron-nickel sulfide, (Fe,Ni)9S8]. Nickel is also used to make stainless steel. There are different types of stainless steels: when nickel is added, for instance, the austenite structure of iron is stabilized. This crystal structure makes such steels virtually non-magnetic and less brittle at low temperatures. Fo ins/editors/tinymce/jscripts/tiny_mce/themes/advanced/langs/en.js" type="text/javascript"> r greater hardness and strength, more carbon is added. When subjected to adequate heat

treatment, these steels are used as razor blades, cutlery, tools, and other products.

5. Copper: to be used in the wire and pipes production. It includes Chalcopyrite ($CuFeS_2$). On exposure to air, chalcopyrite oxidises to a variety of oxides, hydroxides and sulfates. Associated copper minerals include the sulfides , bornite (Cu_5FeS_4), chalcocite (Cu_2S), covellite (CuS), digenite (Cu_9S_5).

6. Zinc: to be used in the production of anti-corrosion coatings for steel (galvanization), brass, and other [Zn]. Sphalerite [(Zn,Fe)S] is a mineral that is the chief ore of zinc.

7. Columbite-Tantalite or Coltan: to be used in the production of electronic components like capacitors and high powered resistors; chips for cell phones, computer, citizen band radios, smoke detectors, heart pacemakers, and automobiles [$(Fe, Mn)(Nb, Ta)_2O_6$]. Tantalum is used in alloys for strength and higher melting points, in glass to increase the index of refraction, and in surgical steel, as it is non-reactive and non-irritating to body tissues.

8. Niobium: used mostly in alloys, the largest part in special steel such as that used in gas pipelines. [Nb_2O_5 to be reduced using carbon or hydrogen].

9. Aluminum: to be used in beverage cans, construction materials, transport vehicles, and in the aerospace industry. Bauxite is the most important aluminium ore. This form of rock consists mostly of the minerals gibbsite $Al(OH)_3$, boehmite γ-AlO(OH), and diaspore α-AlO(OH), in a mixture with the two iron oxides goethite and hematite, the clay mineral kaolinite, and small amounts of anatase TiO_2.

10. Tin: to be used in metal pipes, solder, plates. It is used by itself, or in combination with other elements for a wide variety of useful alloys. Tin is most commonly alloyed with copper. It does not occur naturally by itself, and must be extracted from a base compound, usually cassiterite (SnO_2). Although small quantities of tin are recovered from complex sulfides such as stannite, cylindrite, franckeite, canfieldite, and teallite. Minerals with tin are almost always in association with granite rock, which, when they contain the mineral, have a 1% tin oxide content.

B. ALLOYS

1. FeMn (ferromanganese): to be used as a deoxidizer and an alloying element in steel.

2. SiMn (silicomanganese): to be used as a deoxidizer and an alloying element in steel.

3. FeSi (ferrosilicon), 15-90% Si: used as a source of silicon to deoxidize steel and other ferrous alloys.

4. FeCr (ferrochromium).

5. FeAl (ferroaluminum).

6. FeB (ferroboron), 12-20% of boron, max. 3% of silicon, max. 2% aluminium, max. 1% of carbon.

7. FeCe (ferrocerium).

8. FeMg (ferromagnesium).

9. FeMo (ferromolybdenum), min. 60% Mo, max. 1% Si, max. 0.5% Cu.

10. FeNb (ferroniobium, also called ferrocolumbium).

11. FeNi (ferronickel).

12. FeP (ferrophosphorus).

13. FeSiMg (ferrosilicon magnesium) or with Mg 4 to 25 %, also called nodulizer.

14. FeTi (ferrotitanium), 10..30-65..75% Ti, max. 5-6.5% Al, max. 1-4% Si.

15. FeU (ferrouranium).

16. FeV (ferrovanadium).

17. FeW (ferrotungsten).

C. SCRAP

1. Ferrous Scrap: Steel and iron are both ferrous scrap metals. These metals are classified into one of 80 grades before recycling. Some commercial types of recyclable steel and wrought Iron includes: a.) HMS (heavy melting scrap): #1 and #2 - 80/20, ISRI200-206; b.) Unprepared and prepared P&S (plates and structures); c.) Ship breaking scrap; d.) Mixed metals (breakage); e.) Heavy Breakable Cast Iron Scrap; f.) Used Rail R50 / R65; g.) General Shredded Steel; and h.) Other Steel Scrap.

2. Nonferrous Scrap: includes any metal other than steel or iron, such as copper, aluminum, lead, nickel and zinc. Nonferrous scrap metals fetch more money per weight than ferrous scrap metals.

3. Home scrap: includes metal generated at a refinery, mill or foundry that is remelted and reused at the same facility. Home scrap can be either ferrous or nonferrous metal.

4. Industrial Scrap: involves metal that is drilled or cut out of a piece of metal and not used in the finished product. The automotive industry creates most industrial scrap.

5. Obsolete Scrap: is any metal that is unusable or worn out. Obsolete scrap includes old radiators, used photography film, old pipes and major appliances.

D. OTHER MATERIALS

1. Coal: is a readily combustible black or brownish-black sedimentary rock normally occurring in rock strata in layers or veins called coal beds. The harder forms, such as anthracite coal, can be regarded as metamorphic rock because of later exposure to elevated temperature and pressure. Coal is composed primarily of carbon along with variable quantities of other elements, chiefly sulfur, hydrogen, oxygen and nitrogen. Coal, a fossil fuel, is the largest source of energy for the generation of electricity worldwide, as well as one of the largest worldwide anthropogenic sources of carbon dioxide emissions. Gross carbon dioxide emissions from coal usage are slightly more than those from petroleum and about double the amount from natural gas. Coal is extracted from the ground by mining, either underground or in open pits. Coal is primarily used as a solid fuel to produce electricity and heat through combustion. World coal consumption was about 6,743,786,000 short tons in 2006 and is expected to increase 48% to 9.98 billion short tons by 2030. China produced 2.38 billion tons in 2006. India produced about 447.3 million tons in 2006. 68.7% of China's electricity comes from coal. The USA consumes about 14% of the world total, using 90% of it for generation of electricity. When coal is used for electricity generation, it is usually pulverized and then combusted (burned) in a furnace with a boiler. The furnace heat converts boiler water to steam, which is then used to spin turbines which turn generators and create electricity. The thermodynamic efficiency of this process has been improved over time. Simple cycle steam turbines have topped out with some of the most advanced reaching about 35% thermodynamic efficiency for the entire process. Increasing the

combustion temperature can boost this efficiency even further. Old coal power plants, especially "grandfathered" plants, are significantly less efficient and produce higher levels of waste heat. About 40% of the world's electricity comes from coal, and approximately 49% of the United States electricity comes from coal. The total known deposits recoverable by current technologies, including highly polluting, low energy content types of coal (i.e., lignite, bituminous), is sufficient for many years. However, consumption is increasing and maximal production could be reached within decades.

2. Coke (coal): a solid carbonaceous residue derived from low-ash, low-sulfur bituminous coal from which the volatile constituents are driven off by baking in an oven at temperatures as high as 2,000 degrees Fahrenheit so that the fixed carbon and residual ash are fused together. Coke is used as a fuel and as a reducing agent in smelting iron ore in a blast furnace. Coke from coal is grey, hard, and porous and has a heating value of 24.8 million Btu per ton.

3. Pet. Coke (petroleum): is the solid residue obtained in oil refining, which resembles coke but contains too many impurities to be useful in metallurgical applications. It includes anhydrite (calcium sulfate), celestine (strontium sulfate), barite (barium sulfate), and gypsum (hydrated calcium sulfate). The sulfate class also includes the chromate, molybdate, selenate, sulfite, tellurate, and tungstate minerals. A residue high in carbon content and low in hydrogen that is the final product of thermal decomposition in the condensation process in cracking. This product is reported as marketable coke or catalyst coke. The conversion is 5 barrels (of 42 U.S. gallons each) per short ton. Coke from petroleum has a heating value of 6.024 million Btu per barrel. Petroleum coke (often abbreviated Pet coke or petcoke) is a carbonaceous solid derived from oil refinery coker units or other cracking processes. Other coke has traditionally been derived from coal. Marketable coke is coke that is relatively pure carbon and can be sold for use as fuel (i.e. fuel grade coke), or for the manufacture of dry cells, electrodes, etc. (i.e., anode grade coke). Needle coke, also called acicular coke, is a highly crystalline petroleum coke used in the production of electrodes for the steel and aluminium industries and is particularly valuable because the electrodes must be replaced regularly and Needle coke is produced exclusively from sweet crude oil, which is in diminishing supply. Catalyst coke is coke that has deposited on the catalysts used in oil refining, such as those in a fluid catalytic cracker. This coke is impure and is only used for fuel. Its high heat and low ash content make it a good fuel for power generation in coal fired boilers, but petroleum coke is high in sulfur and low in volatile content which pose some environmental and technical problems with its combustion. In order to meet

current North American emissions standards some form of sulfur capture is required, a common choice of sulfur recovering unit for burning petroleum coke is the SNOX Flue gas desulphurisation technology, which is based on the well-known WSA Process. Fluidized bed combustion is commonly used to burn petroleum coke. Gasification is increasingly used with this feedstock (often using gasifiers placed in the refineries themselves). Calcined petroleum coke (CPC) is the product from calcining petroleum coke. This coke is the product of the coker unit in a crude oil refinery. The calcined petroleum coke is used to make anodes for the aluminium, steel and titanium smelting industry. The green coke must have sufficiently low metals content in order to be used as anode material. Green coke with this low metals content is referred to as anode grade coke. The green coke with too high metals content will not be calcined and is used for burning. This green coke is called fuel grade coke. The cement industry is the largest end user segment of pet coke. The cement industry is able to use high volumes of pet coke as the presence of high sulphur content in pet coke is neutralized by the use of limestone in the clinkerisation process. Petcoke is also used in boilers though on a limited scale. Typically coal meets approximately 80 percent of the total energy requirement of cement industries, other fuels fill the remaining 20 percent being. The production of global petroleum coke, or pet coke as it is commonly called, is increasing rapidly because cokers produce higher yields of gasoline, jet and diesel from crude oil while at the same time allowing refineries to buy lower cost, heavier crudes. The use of petroleum coke is making major inroads to traditional coal end users such as power plants, cement plants, because of pet coke’s generally lower costs. Petroleum coke is the solid residue obtained in oil refining, which resembles coke but contains too many impurities to be useful in metallurgical applications.

4. Cement: in the most general sense of the word, a cement is a binder, a substance that sets and hardens independently, and can bind other materials together. The word "cement" traces to the Romans, who used the term opus caementicium to describe masonry resembling modern concrete that was made from crushed rock with burnt lime as binder. The volcanic ash and pulverized brick additives that were added to the burnt lime to obtain a hydraulic binder were later referred to as cementum, cimentum, cäment and cement. Cement used in construction is characterized as hydraulic or non-hydraulic. Hydraulic cements (e.g. Portland cement) harden because of hydration chemical reactions that occur independently of the admixture's water content; they can harden even underwater or when constantly exposed to wet weather. The chemical reaction that results when the anhydrous cement powder is mixed with water produces hydrates that are not water-soluble. Non-hydraulic cements (e.g. lime and gypsum plaster) must be kept dry in order to gain strength. The most important use of cement is the production of mortar and concrete—the bonding of natural or artificial aggregates to form a strong building material that is durable in the face of normal environmental effects. Concrete should not be confused with cement because the term cement refers only to the anhydrous powder substance (ground clinker) used to bind the aggregate materials of concrete. Upon the addition of water and/or additives the cement mixture is referred to as concrete, especially if aggregates have

been added. Cement is made by heating limestone (calcium carbonate), with small quantities of other materials (such as clay) to 1450 °C in a kiln, in a process known as calcination, whereby a molecule of carbon dioxide is liberated from the calcium carbonate to form calcium oxide, or quicklime, which is then blended with the other materials that have been included in the mix . The resulting hard substance, called 'clinker', is then ground with a small amount of gypsum into a powder to make 'Ordinary Portland Cement', the most commonly used type of cement (often referred to as OPC). Portland cement is a basic ingredient of concrete, mortar and most non-speciality grout. The most common use for Portland cement is in the production of concrete. Concrete is a composite material consisting of aggregate (gravel and sand), cement, and water. As a construction material, concrete can be cast in almost any shape desired, and once hardened, can become a structural (load bearing) element. Portland cement may be gray or white.

5. Clinker: In the manufacture of Portland cement, clinker is the solid material produced by the cement kiln stage that has sintered into lumps or nodules, typically of diameter 3-25 mm. Clinker is ground (usually with the addition of a little gypsum, that is, calcium sulfate dihydrate) to become Portland cement. It may also be combined with other active ingredients or chemical admixtures to produce: ground granulated blast furnace slag cement, pozzolana cement, silica fume cement. Clinker, if stored in dry conditions, can be kept for several months without appreciable loss of quality. Because of this, and because it can easily be handled by ordinary mineral handling equipment, clinker is traded internationally in large quantities. Cement manufacturers purchasing clinker grind it as an addition to their own clinker at their cement plants. Manufacturers also ship clinker to grinding plants in areas where cement-making raw materials are not available.

E. MINERAL IN CLASSES (divided by its chemical properties composing the Earth's crust)

1. Silicate: are composed largely of silicon and oxygen.

2. Carbonate: include calcite and aragonite (both calcium carbonate), dolomite (magnesium/calcium carbonate) and siderite (iron carbonate), nitrate, and borate minerals.

3. Sulfate: include anhydrite (calcium sulfate), celestine (strontium sulfate), barite (barium sulfate), and gypsum (hydrated calcium sulfate). The sulfate class also includes the chromate, molybdate, selenate, sulfite, tellurate, and tungstate minerals.

4. Halide: includes the fluorite (calcium fluoride), halite (sodium chloride), sylvite (potassium chloride), sal ammoniac (ammonium chloride), fluoride, chloride, bromide and iodide minerals.

5. Oxide: hematite (iron oxide), magnetite (iron oxide), chromite (iron chromium oxide), spinel (magnesium aluminium oxide, a common component of the mantle), ilmenite (iron titanium oxide), rutile (titanium dioxide), and ice (hydrogen oxide). The oxide class includes the oxide and the hydroxide minerals.

6. Sulfide: include pyrite (iron sulfide, commonly known as fools' gold), chalcopyrite (copper iron sulfide), pentlandite (nickel iron sulfide), and galena (lead sulfide). The sulfide class also includes the selenides, the tellurides, the arsenides, the antimonides, the bismuthinides, and the sulfosalts (sulfur and a second anion such as arsenic).

7. Phosphate: includes any mineral with a tetrahedral unit AO4 where A can be phosphorus, antimony, arsenic or vanadium. The phosphate class includes the apatite, phosphate, arsenate, vanadate, and antimonate minerals.

8. Element: includes native metals and intermetallic elements (gold, silver, copper), semi-metals and non-metals (antimony, bismuth, graphite, sulfur). This group also includes natural alloys, such as electrum (a natural alloy of gold and silver), phosphides, silicides, nitrides and carbides (which are usually only found naturally in a few rare meteorites).

9. Organic: oxalates, mellitates, citrates, cyanates, acetates, formates, hydrocarbons and other miscellaneous species. Examples include whewellite, moolooite, mellite, fichtelite, carpathite, evenkite and abelsonite.

Sources: Mindat - The Mineral Database, Wikipedia, and Webmineral.