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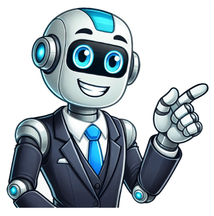

Home » Minerals » What is a Mineral? Mineral Crystals: The beautiful purple crystals in the photo above are examples of amethyst, a purple color variety of quartz. These amethyst crystals grew in a cavity below the earth and because they grew in an open space they were able to form into six-sided prisms with pointed terminations. The prismatic habit is characteristic of amethyst. Image copyright iStockphoto / MvH. Every person uses products made from minerals every day. The salt that we add to our food is the mineral halite. Antacid tablets are made from the mineral calcite. Rubies and sapphires are colored varieties of a mineral named corundum. It takes many minerals to make something as simple as a wooden pencil. The "lead" is made from graphite and clay minerals, the brass band is made of copper and zinc, and the paint that colors it contains pigments and fillers made from a variety of minerals. A cell phone is made using dozens of different minerals that are sourced from mines throughout the world. The cars that we drive, the roads that we travel, the buildings that we live in, and the fertilizers used to produce our food are all made using minerals.In the United States, about three billion tons of mineral commodities are consumed each year to support the standard of living of 300 million citizens. That is about ten tons of mineral materials consumed for every person, every year. Common items made from minerals: Most of the things that we use in our daily life are either made from minerals or produced using mineral products. Antacid tablets are made from calcite, table salt is crushed halite, several minerals are used to make a wood pencil, and dozens of minerals from many different countries are used to make a cell phone. Did You Know? The white "m" on a piece of M&M's candy is a titanium oxide pigment, most likely produced from the mineral rutile. Structure of the mineral halite: The mineral "halite" has a chemical composition of NaCl. That means it contains equal numbers of sodium and chloride atoms. In this case they are electrically charged atoms, known as ions. Those ions are arranged in a cubic pattern that repeats in all directions. The small sodium ions are positioned between the larger chloride ions. To meet the definition of "mineral" used by most geologists, a substance must meet five requirements: naturally occurring inorganic solid definite chemical composition ordered internal structure "Naturally occurring" means that people did not make it. Steel is not a mineral because it is an alloy produced by people. "Inorganic" means that the substance is not made by an organism. Wood and pearls are made by organisms and thus are not minerals. "Solid" means that it is not a liquid or a gas at standard temperature and pressure. Water is not a mineral because it is a liquid. "Definite chemical composition" means that all occurrences of that mineral have a chemical composition that varies within a specific limited range. For example: the mineral halite (known as "rock salt" when it is mined) has a chemical composition of NaCl. It is made up of an equal number of atoms of sodium and chlorine. "Ordered internal structure" means that the atoms in a mineral are arranged in a systematic and repeating pattern. The structure of the mineral halite is shown in the illustration on this page. Halite is composed of an equal ratio of sodium and chlorine atoms arranged in a cubic pattern. Did You Know? Although liquid water is not a mineral, it is a mineral when it freezes. Ice is a naturally occurring, inorganic solid with a definite chemical composition and an ordered internal structure. Learn more. The word "mineral" is used in many different ways. Here are some examples: Geologist's Definition A formal definition of a mineral, as used by geologists would be: A naturally occurring inorganic solid that has a definite chemical composition, and an ordered internal structure. Geologists are able to identify minerals because they have characteristic physical properties. Nutritionist's Definition The word "mineral" also has a nutritional meaning, which is different from the meaning used by geologists. A nutritionist uses the word mineral when referring to the many inorganic substances that organisms need to grow, repair tissue, metabolize, and carry out other body processes. Mineral nutrients for the human body include: iron, calcium, copper, sulfur, phosphorus, magnesium and many others. Rhodochrosite: Specimen of rhodochrosite from the Sunnyside Mine, San Juan County, Colorado. Rhodochrosite is a manganese carbonate mineral (MnCO3) that is used as an ore of manganese and is also cut as a gemstone. USGS image. An archaic use of the word "mineral" comes from the Linnaean taxonomy in which all things can be assigned to the animal, vegetable, and mineral kingdoms. Minerals in rocks: Most rocks are aggregates of minerals. This rock, a granite pegmatite, is a mixture of mineral grains. It contains pink orthoclase, milky quartz, black hornblende and black biotite. The word "mineral" is also used inconsistently. In mining, anything obtained from the ground and used by man is considered to be a "mineral commodity" or a "mineral material." These include: crushed stone, which is a manufactured product made from crushed rocks; lime, which is a manufactured product made from limestone or marble (both composed of the mineral calcite); coal which is organic; oil and gas which are organic fluids; rocks such as granite that are mixtures of minerals; and, rocks such as obsidian which are mineraloids and do not have a definite composition and ordered internal structure. 2019 United States Mineral Commodity Consumption Mineral Commodity Million Metric Tons Crushed Stone1,600 Sand and Gravel980 Cement102 Salt57.0 Gypsum42.0 Iron Ore41.0 Phosphate Rock25.0 Clays22.0 Lime18.0 Sulfur9.4 Potash5.4 Soda Ash5.2 Barite3.0 Copper1.8 Lead1.6 Values above are estimates of apparent mineral commodity consumption from the United States Geological Survey. Many other commodities could be added to this table. The construction industry is the largest consumer of mineral commodities. Crushed stone is used for foundations, road base, concrete, and drainage. Sand and gravel are used in concrete and foundations. Clays are used to make cement, bricks, and tile. Iron ore is used to make reinforcing rods, steel beams, nails, and wire. Gypsum is used to make drywall. Dimension stone is used for facing, curbing, flooring, stair treads, and other architectural work. These are just a few of the many uses for these commodities in construction. In agriculture, phosphate rock and potash are used to make fertilizer. Lime is used as an acid-neutralizing soil treatment. Mineral nutrients are added to animal feed. The chemical industry uses large amounts of salt, lime, and soda ash. Large amounts of metals, clay, and mineral fillers/extenders are used in manufacturing. Mohs Hardness Scale is a set of reference minerals used for classroom hardness testing. Determining the hardness of a mineral is one of the most important tests used in mineral identification. The best way to learn about minerals is to study with a collection of small specimens that you can handle, examine, and observe their properties. Inexpensive mineral collections are available in the Geology.com Store. Image copyright iStockphoto / Anna Usova. The Acid Test: Geologists use dilute hydrochloric acid to identify carbonate minerals. Carbonate minerals will effervesce with various levels of vigor in contact with the acid. There are approximately 4000 different minerals, and each of those minerals has a unique set of physical properties. These include: color, streak, hardness, luster, diaphaneity, specific gravity, cleavage, fracture, magnetism, solubility, and many more. These physical properties are useful for identifying minerals. However, they are much more important in determining the potential industrial uses of the mineral. Let's consider a few examples. The mineral talc, when ground into a powder, is perfectly suited for use as a foot powder. It is a soft, slippery powder so it will not cause abrasion. It has the ability to absorb moisture, oils, and odor. It adheres to the skin and produces an astringent effect - yet it washes off easily. No other mineral has a set of physical properties that are as suitable for this purpose. The mineral halite, when crushed into small grains, is perfectly suited for flavoring food. It has a salty taste that most people find pleasing. It dissolves quickly and easily, allowing its flavor to spread through the food. It is soft, so if some does not dissolve it will not damage your teeth. No other mineral has physical properties that are better suited for this use. The mineral gold is perfectly suited for use in jewelry. It can be easily shaped into a custom item of jewelry by a craftsperson. It has a pleasing yellow color that most people enjoy. It has a bright luster that does not tarnish. Its high specific gravity gives it a nice "heft" that is preferred by most people over lighter metals. Other metals can be used to make jewelry, but these properties make gold an overwhelming favorite. (Some people might add that gold's rarity and value are two additional properties that make it desirable for jewelry. However, rarity is not a property, and its value is determined by supply and demand.) Star sapphire: A deep blue star sapphire 8 mm x 6 mm cabochon from Thailand. Inclusions of rutile within the stone align with the crystallographic axis of the corundum to produce the star - which is only clearly visible and centered when the back of the stone is cut at 90 degrees to the C-axis of the crystal. This stone has been heat treated to darken the stone and enhance visibility of the star. The primary characteristics of a mineral that determine its physical properties are its composition and the strength of the bonds in its ordered internal structure. Here are some examples: Galena, a lead sulfide, has a much higher specific gravity than bauxite, an aluminum hydroxide. This difference is because of their composition. Lead is much heavier than aluminum. Diamond and graphite both consist of pure carbon. Diamond is the hardest natural mineral, and graphite is one of the softest. This difference occurs because of the types of bonds connecting the carbon atoms in their mineral structures. Each carbon atom in diamond is bonded to four other carbon atoms with strong covalent bonds. Graphite has a sheet structure in which atoms within the sheets are bonded to one another with strong covalent bonds, but the bonds between the sheets are weak electrical bonds. When graphite is scratched the weak bonds fail easily, making it a soft mineral. The gemstones ruby and sapphire are color variations of the mineral corundum. These color differences are caused by composition. When corundum contains trace amounts of chromium, it exhibits the red color of a ruby. However, when it contains trace amounts of iron or titanium, it exhibits the blue color of sapphire. If, at the time of crystallization, enough titanium is present to form tiny crystals of the mineral rutile, a star sapphire may form. This occurs when tiny crystals of rutile align systematically within the crystalline structure of the corundum to give it a silky luster that might produce a "star" that aligns with the primary crystallographic axis (see photo). Find Other Topics on Geology.com: Rocks: Galleries of igneous, sedimentary and metamorphic rock photos with descriptions. Minerals: Information about ore minerals, gem materials and rock-forming minerals. Volcanoes: Articles about volcanoes, volcanic hazards and eruptions past and present. Gemstones: Colorful images and articles about diamonds and colored stones. General Geology: Articles about geysers, maars, deltas, rifts, salt domes, water, and much more! Geology Store: Hammers, field bags, hand lenses, maps, books, hardness picks, gold pans. Diamonds: Learn about the properties of diamond, its many uses, and diamond discoveries. © 2005-2025 Geology.com. All Rights Reserved. Images, code, and content on this website are property of Geology.com and are protected by copyright law. Geology.com does not grant permission for any use, republication, or redistribution. Science Earth Science, Geologic Time & Fossils Earth Sciences mineral, naturally occurring homogeneous solid with a definite chemical composition and a highly ordered atomic arrangement; it is usually formed by inorganic processes. There are several thousand known mineral species, about 100 of which constitute the major mineral components of rocks; these are the so-called rock-forming minerals. A mineral, which by definition must be formed through natural processes, is distinct from the synthetic equivalents produced in the laboratory. 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Any new mineral name must be approved by this committee, and the type material is usually stored in a museum or university collection. The chemical properties of minerals mainly reflect the chemical properties of the atoms present in each. However, even here these properties depend on the way the atoms are bound in the mineral's crystal structure. Let us examine the property known as solubility — the ability of a mineral to dissolve in a liquid, like salt and water.Nearly all minerals are soluble in water. But most dissolve to such a limited extent as to go almost unnoticed. A liquid is called a solvent when it's action on a solid substance is to break apart the atoms of the crystal structure, thus dissolving it.With some minerals, not all the atoms in the crystal structure are taken into solution. The two specimens at the lower left illustrate this phenomenon for the mineral muscovite. Fresh crystals in one specimen contrast with the other, to its right, which look somewhat faded. If the fresh looking sample were subjected to running water, potassium atoms originally present in the layered structure would dissolve, and the muscovite would gradually change from a mica to a clay minerals. Such is the mineral illite, the faded-looking sample.In the series of mineral groups displayed on the right side of this case, different specimens show variations in chemical properties. The top group represents the range of temperatures at which the minerals will melt or change to a liquid. The melting point is also known as the fusing temperature.Minerals composed of atoms that are not tightly bonded within the crystal structure will melt at relatively low temperatures. However, much heat may be needed to break the chemical bonds of other minerals.The mineral quartz, for example, will only melt above 1,610 degrees Celsius, or 2,930 degrees Fahrenheit. The next group of minerals are not found in areas of high rainfall or high humidity because these minerals dissolve easily in water. Thus, a desert region, such as Death Valley, would be an ideal place for these minerals to form.Water is not the only liquid which will dissolve minerals. Several minerals, especially some of the carbonates, will dissolve readily in dilute hydrochloric acid. When that happens, a chemical reaction releases carbon dioxide gas.The resulting bubbling, or effervescence, is a useful aid in identifying some of the more readily soluble carbonates, such as calcite, calcium carbonate, specimen number 12, which is found in limestones, and of which seashells are made.The next group of minerals show another kind of solution quite common among minerals. This is called solid solution, in which two or more chemical compounds share the same crystal structure, forming a homogeneous crystalline substance. A mineral which belongs to such a solid solution has no single fixed chemical composition.Rather, its composition is a proportion of the two or more limiting compositions called end members. Such minerals are commonly named for the end members they most nearly resemble in composition.However, intermediate members have sometimes been used for naming, as with the plagioclase feldspars. The plagioclases are a solid solution series with the end members, albite, sodium bearing, and anorthite, calcium bearing, but also with intermediate members, such as labradorite and oligoclase, number 27. Science Earth Science, Geologic Time & Fossils Earth Sciences mineral, naturally occurring homogeneous solid with a definite chemical composition and a highly ordered atomic arrangement; it is usually formed by inorganic processes. There are several thousand known mineral species, about 100 of which constitute the major mineral components of rocks; these are the so-called rock-forming minerals. 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Siderite, for example, does not always occur as pure iron carbonate (FeCO3); magnesium (Mg), manganese (Mn), and, to a limited extent, calcium (Ca) may sometimes substitute for the iron. Since the amount of the replacement may vary, the composition of siderite is not fixed and ranges between certain limits, although the ratio of the metal cation to the anionic group remains fixed at 1:1. Its chemical makeup may be expressed by the general formula (Fe, Mn, Mg, Ca)CO3, which reflects the variability of the metal content. pyriteSchematic representation of the structure of pyrite (FeS2) as based on a cubic array of ferrous iron cations (Fe2+) and sulfur anions (S−).Minerals display a highly ordered internal atomic structure that has a regular geometric form. Because of this feature, minerals are classified as crystalline solids. Under favourable conditions, crystalline materials may express their ordered internal framework by a well-developed external form, often referred to as crystal form or morphology. Solids that exhibit no such ordered internal arrangement are termed amorphous. Many amorphous natural solids, such as glass, are categorized as mineraloids. Rocks, Minerals, and More Quiz Traditionally, minerals have been described as resulting exclusively from inorganic processes; however, current mineralogic practice often includes as minerals those compounds that are organically produced but satisfy all other mineral requirements. Aragonite (CaCO3) is an example of an inorganically formed mineral that also has an organically produced, yet otherwise identical, counterpart; the shell (and the pearl, if it is present) of an oyster is composed to a large extent of organically formed aragonite. Minerals also are produced by the human body: hydroxylapatite [Ca5(PO4)3(OH)] is the chief component of bones and teeth, and calculi are concretions of mineral substances found in the urinary system. franklinite, willemite, and calciteSpecimen showing bright fluorescent colour resulting from ultraviolet irradiation of calcite (calcium carbonate; red fluorescence) with grains of franklinite (a zinc, manganese, and iron oxide; black coloration), which is nonfluorescent. Veins and grains of willemite (a zinc silicate; green fluorescence) also appear.While minerals are classified in a logical manner according to their major anionic (negatively charged) chemical constituents into groups such as oxides, silicates, and nitrates, they are named in a far less scientific or consistent way. Names may be assigned to reflect a physical or chemical property, such as colour, or they may be derived from various subjects deemed appropriate, such as, for example, a locality, public figure, or mineralogist. Some examples of mineral names and their derivations follow: albite (NaAlSi3O8) is from the Latin word (albus) for “white” in reference to its colour; goethite (FeO • OH) is in honour of Johann Wolfgang von Goethe, the German poet; manganite (MnO • OH) reflects the mineral’s composition; franklinite (ZnFe2O4) is named after Franklin, New Jersey, U.S., the site of its occurrence as the dominant ore mineral for zinc (Zn); and sillimanite (Al2SiO4) is in honour of the American chemist Benjamin Silliman. Since 1960 the Commission on New Minerals and Mineral Names of the International Mineralogical Association has reviewed descriptions of new minerals and proposals for new mineral names and has attempted to remove inconsistencies. Any new mineral name must be approved by this committee, and the type material is usually stored in a museum or university collection. Everything around you is formed from chemical elements, or substances made up of only one kind of atom. There are 118 identified elements, of which 94 are natural and the rest are human-made. Most of these elements are found combined with other elements as chemical compounds.Minerals are naturally occurring elements or compounds. Most are inorganic solids (apart from liquid mercury and a few organic minerals) and defined by their chemical composition and crystal structure.By weight, 99.5 per cent of minerals are formed from only 12 of the natural elements. Clearly, some elements are far more common than others. The same goes for minerals. Of the 5800 or so known minerals, only 10 make up 95 per cent of the Earth’s crust. Some minerals are only made up of one element – we call these minerals ‘native elements’. They include metals, gemstones, simple ores and the only liquid metal mineral, mercury. Some, like gold, only combine with a small number of other elements.Others, like sulphur, can combine readily with other elements, but also form alone under special chemical conditions. Some metallic elements mix easily with each other and are called alloys. An example of a natural alloy is osmiridium, which is made of two rare elements osmium and iridium. There are over 5800 different minerals. Each mineral is classified by both its chemical composition (the elements from which it is formed) and crystal structure (the pattern the atoms form when they lock together). Graphite and diamond are made of the same element, carbon, but have different crystal shapes so are different minerals.The unique chemical composition and crystal structure affect a mineral’s physical properties such as colour, hardness, density, or how it breaks or reflects light. Testing for these properties helps identify an unknown mineral. Sometimes, complex tests are needed such as magnetism, radioactivity, acidic reaction or x-rays. Minerals of the same species, such as quartz, all have the same x-ray pattern, although they may look quite different. We can identify some minerals using our senses. For instance, talc feels soapy, some clays have distinctive smells and salt has certain taste. Talc is the softest of the minerals, measuring 1 on Mohs Hardness Scale. Hardness is measured by scratching a mineral against ten standard minerals and other common objects. The table below indicates the accepted standard of the comparative hardness of minerals, ranging from the softest (talc) to the hardest (diamond). Mohs Hardness Scale Hardness Mineral 1 Talc 2 Gypsum 3 Calcite 4 Fluorite 5 Apatite 6 Orthoclase 7 Quartz 8 Topaz 9 Corundum 10 Diamond Different minerals with the same volume can have different weights. This is because their weight depends on that of their elements and their density (how closely they are packed together).Density is measured by the relative weight of the item to water and is referred to as its specific gravity (SG). Specific gravity is one of the most important, constant and quantifiable properties of a mineral. Magnetism occurs in iron-rich minerals. Magnetite is one of the most magnetic minerals. You can see for yourself how it is attracted to a magnet, but it can also be a magnet itself. Graphite and diamond are both made of carbon but have different crystal structures. This makes them different minerals. The bonds between each layer of graphite’s carbon atoms are weak, giving it a soft character and allowing us to write with it.The bonds holding diamond’s carbon atoms together are interlocking giving it great strength and making it the hardest natural substance known. Some minerals are always the same colour; malachite is green because copper is its main element. Other minerals can have many colours because of impurities or faults in their structure. Ruby and sapphire are both the same mineral, corundum, which is colourless when pure. The red in ruby comes from traces of chromium. The blue in sapphire comes from traces of iron and titanium.Though a mineral may appear in several colours its powdered form is always the same and is a useful identity test. Rubbing a mineral across an unglazed ceramic plate creates a powdered streak. Lustre describes how light reflects off the surface of a mineral. There are special terms to describe the lustre of a mineral, starting with metallic and non-metallic. Tenacity is the mineral’s reaction to pressure. Most minerals are brittle and shatter when hit. Others may be easy to cut, flatten, bend or can spring back. The way a mineral breaks is due to its molecular structure. Cleavage refers to a break that is along flat planes, with smooth, even splits. Fracture refers to breaks that are not flat or even. Most minerals exhibit fracture, but not all exhibit cleavage. You have reached the end of the page. Thank you for reading. A mineral is a naturally occurring, inorganic solid substance that has a specific chemical composition and a crystalline structure. Minerals are the building blocks of rocks, which are made up of one or more minerals. They are typically formed through various geological processes, such as crystallization from a melt (igneous), precipitation from a solution (sedimentary), or metamorphism (metamorphic). Minerals can have a wide range of physical properties, including color, luster, hardness, cleavage, fracture, streak, specific gravity, crystal habit, and solubility, among others. These properties can be used for mineral identification and characterization. Minerals have a defined chemical composition, consisting of specific elements in fixed proportions. The chemical composition of a mineral determines its characteristic properties and behavior. Minerals can be composed of a single element, such as native copper, which is composed solely of copper atoms, or they can be composed of multiple elements arranged in a specific crystal lattice structure, such as quartz, which is composed of silicon and oxygen atoms arranged in a repeating pattern. Minerals are important for many aspects of human society and the environment. They are used as raw materials in various industries, such as mining, construction, energy, electronics, agriculture, and manufacturing. Minerals are also used in the production of metals, ceramics, glass, fertilizers, chemicals, and other products. Some minerals, known as gemstones, are highly prized for their beauty and rarity, and are used in jewelry and decorative objects. Minerals also play a crucial role in Earth’s geology, as they provide clues about the planet’s history, the processes that have shaped its surface and interior, and the evolution of life on Earth. They are also important for understanding natural resources, environmental issues, and sustainable resource management. Overall, minerals are fundamental components of the Earth’s geology, human society, and natural environment, with diverse applications and significance in various fields. Gemstones are precious or semi-precious minerals or rocks that are prized for their beauty, rarity, and durability. They are used in jewelry, decorative items, and sometimes in industrial applications. Gemstones are typically minerals that are found in nature, but some gemstones can also be rocks composed of several minerals. Some common examples of gemstones include diamonds, emeralds, rubies, sapphires, amethyst, topaz, and garnet, among many others. Gemstones are formed through various geological processes, such as crystallization from magma, precipitation from hydrothermal fluids, and metamorphism. The unique combination of chemical composition, crystal structure, and color or optical properties of each gemstone gives them their distinctive appearance and value. Gemstones are often cut and polished to enhance their beauty and make them suitable for use in jewelry or other decorative items. Gemstones have been prized by humans for thousands of years for their aesthetic appeal, cultural significance, and perceived metaphysical properties. They are often used as symbols of wealth, power, and status, and are associated with special occasions such as engagements, weddings, and anniversaries. Gemstones are also used in various healing and metaphysical practices, believed to have different properties and energies that can affect the well-being and spirituality of individuals. The study of gemstones, known as gemology, involves the identification, classification, and evaluation of gemstones based on their physical and optical properties, as well as their rarity and value in the market. Gemstones are traded globally in a multi-billion dollar industry, and their value can vary greatly depending on factors such as rarity, size, color, clarity, and cut. Proper identification and evaluation of gemstones require specialized knowledge and expertise in gemology, and professional gemologists use various tools and techniques to accurately identify and appraise gemstones. Minerals can be classified in various ways based on different criteria, such as their chemical composition, crystal structure, physical properties, and mode of formation. Here are some common classifications of minerals: Chemical composition: Minerals can be classified based on their chemical composition, which refers to the elements and their proportions present in the mineral. For example, minerals can be classified as silicates (containing silicon and oxygen), carbonates (containing carbon and oxygen), sulfides (containing sulfur), oxides (containing oxygen), halides (containing halogens such as chlorine or fluorine), and many others. Crystal structure: Minerals can also be classified based on their crystal structure, which refers to the arrangement of atoms or ions in the mineral’s internal structure. Some common crystal structures include cubic, tetragonal, orthorhombic, hexagonal, and rhombohedral, among others. Crystal structure plays a significant role in determining the physical properties of minerals, such as their hardness, cleavage, and optical properties. Physical properties: Minerals can be classified based on their physical properties, such as hardness, cleavage, color, streak, luster, specific gravity, and others. For example, minerals can be classified as metallic minerals (containing metal elements), non-metallic minerals (not containing metal elements), and gemstones (precious or semi-precious minerals used in jewelry). Mode of formation: Minerals can also be classified based on their mode of formation, which refers to the geological processes that led to their formation. Some common types of minerals based on their mode of formation include igneous minerals (formed from solidification of molten magma or lava), sedimentary minerals (formed from the accumulation and consolidation of sediment), and metamorphic minerals (formed from the alteration of pre-existing minerals through heat, pressure, or chemical reactions). Economic value: Minerals can be classified based on their economic value, particularly when it comes to minerals that are extracted for their metal content and used in various industrial processes. For example, minerals can be classified as ore minerals (minerals containing valuable elements or minerals that can be economically extracted), gangue minerals (minerals without economic value that are associated with ore minerals), and accessory minerals (minor minerals that occur in small quantities but do not have economic significance). These are some of the common ways minerals can be classified. It’s important to note that minerals can belong to multiple classifications, as they can have different chemical compositions, crystal structures, physical properties, and modes of formation. The classification of minerals is a complex and multidisciplinary field that involves the study of various aspects of mineralogy, geology, chemistry, and materials science. Silicates are the most important organization of minerals. Silicates are crafted from metals blended with silicon and oxygen. There are greater silicates than all other minerals put together.The mica at the left is a member of this group. Nesosilicates or orthosilicates, have the orthosilicate ion, which represent isolated (insular) [SiO4]four− tetrahedra which might be related best via interstitial cations. Nickel–Strunz classification.The mantle is a thick shell among the core and the crust. Sorosilicates, They have isolated double tetrahedra groups with (Si2O7)6− or a ratio of 2:7. Nickel–Strunz classification: 09.B Cyclosilicates: Cyclosilicates or ring silicates, have linked tetrahedra with (TxO3x)2x− or a ratio of 1:3. These exist as 3-member (T3O9)6− and 6-member (T6O18)12− rings, where T stands for a tetrahedrally coordinated cation. Nickel–Strunz classification: 09.C Inosilicates: They are two types of inosilicates mineral. Single chain inosilicates: Pyroxene group ,Pyroxenoid group Double chain inosilicates: Amphibole group Inosilicates or chain silicates, have interlocking chains of silicate tetrahedra with either SiO3, 1:3 ratio, for single chains or Si4O11, 4:11 ratio, for double chains. Nickel–Strunz classification: 09.D Phyllosilicates: Phyllosilicates or sheet silicates, form parallel sheets of silicate tetrahedra with Si2O5 or a 2:5 ratio. Nickel–Strunz classification: 09.E. All phyllosilicate minerals are hydrated, with either water or hydroxyl groups attached. Tectosilicates: Tectosilicates, or “framework silicates,” have a three-dimensional framework of silicate tetrahedra with SiO2 or a 1:2 ratio. This group comprises nearly 75% of the crust of the Earth. Tectosilicates, with the exception of the quartz group, are aluminosilicates. Nickel–Strunz classification: 09.F and 09.G, 04.DA (Quartz/ silica family) Minerals are valuable natural resources, they constitute the important raw material for many basic industries and are major resources for development. A Mineral has a definite chemical composition, atomic structure and is formed by inorganic processes. Mineral generally occur in the earth’s crust in the form of ore, Inida has a large number of resources of metallic and non metallic minerals. A Total of 95 minerals are produced within a country, of which 10 are metallic minerals, 3 atomic minerals and 55 are other minerals. This topic is essential for UPSC aspirants, as questions related to mineral resources frequently appear in both Preliminary and Main exams. This article provides a detailed overview of minerals, their classification, and their significance in various sectors. Definition of Minerals Minerals are naturally occurring inorganic substances with a defined chemical composition and a crystalline structure. They are solid at room temperature and can be composed of one or more elements. The study of minerals encompasses their physical properties, classification, and economic importance. Characteristics of Minerals Chemical Composition: Minerals have a specific chemical formula. For instance, quartz is composed of silicon dioxide (SiO_2). Crystal Structure: The internal arrangement of atoms in minerals forms a crystal lattice, which determines the mineral’s physical properties. Physical Properties: Hardness: Measured by the Mohs scale, it indicates a mineral’s resistance to scratching. For example, diamond (10 on the Mohs scale) is the hardest mineral. Luster: Refers to the way light reflects off the mineral’s surface. It can be metallic, glassy, or dull. Cleavage: The tendency of a mineral to break along flat planes. Mica, for instance, has perfect cleavage in one direction. Fracture: How a mineral breaks when it does not have cleavage planes. Examples include conchoidal fracture in quartz. Color and Streak: The color of a mineral and its powdered form, respectively. Streak can sometimes differ from the mineral’s color. Specific Gravity: The density of a mineral relative to water, indicating how heavy a mineral is for its size. Types of Minerals Metallic Minerals: Ferrous Minerals: Contain iron. Key examples include: Iron Ore: Found primarily as hematite and magnetite. Major deposits are in Odisha, Jharkhand, Karnataka, and Goa. Manganese: India has the 6th largest reserve of manganese in the world. It is found in the sedimentary rocks in the Dharawar system. Essential for steel production, mainly extracted from Odisha and Madhya Pradesh. Non-Ferrous Minerals: Do not contain iron. Important types include: Bauxite: The primary ore of aluminum, found in Odisha, Jharkhand, and Chhattisgarh. Copper: Used in electrical wiring, with deposits in Jharkhand, Madhya Pradesh, and Rajasthan. Non-Metallic Minerals: Industrial Minerals: Used in manufacturing and construction. Limestone: Used in cement production and building materials. Gypsum: Used in plaster and drywall. Gemstones: Valued for their beauty. Notable examples are diamonds, sapphires, and rubies. Energy Minerals: Important for energy production. Coal: A primary source of energy, with major fields in Jharkhand, Chhattisgarh, and West Bengal. Petroleum: Found in Gujarat, Assam, and offshore Mumbai High. Natural Gas: Extracted from fields in Gujarat, Mumbai High, and the Krishna-Godavari basin. Atomic Mineral: Uranium and Thorium are the major minerals for the production of atomic energy, Uranium is mined directly whereas thorium is obtained from Monatize sand found in Kerala Classification of Minerals By Chemical Composition: Silicates: Minerals containing silicon and oxygen, such as quartz and feldspar. Carbonates: Contain carbon and oxygen, such as calcite and dolomite. Oxides: Contain oxygen and another element, such as hematite (Fe_2O_3). Sulfides: Contain sulfur and another element, such as pyrite (FeS_2). Halides: Contain halogen elements, such as halite (NaCl). By Physical Properties: Hardness: Ranges from talc (1) to diamond (10). Cleavage and Fracture: Essential for mineral identification. Luster: Includes metallic, vitreous, and pearly. By Origin: Primary Minerals: Formed directly from magma or crystallization, such as quartz. Secondary Minerals: Result from the alteration of primary minerals, such as clay minerals. Economic Importance of Minerals Minerals are vital for economic development and industrial growth. They are essential in sectors such as construction, manufacturing, energy production, and technology. The extraction and processing of minerals contribute significantly to national economies, providing raw materials for various industries and creating employment opportunities. Construction: Minerals like limestone and gypsum are used in cement and plaster production. Manufacturing: Metals like iron, aluminum, and copper are crucial for building machinery, vehicles, and infrastructure. Energy Production: Coal, petroleum, and natural gas are primary sources of energy. Technology: Silicon and rare earth elements are vital for electronics and high-tech applications. Mineral Belts in India India is rich in mineral resources, distributed across various regions: North-Eastern Peninsular Belt: Includes the Chhota Nagpur Plateau, rich in iron, coal, manganese, bauxite, and mica. Central Belt: Features manganese, bauxite, limestone, and coal. Prominent states are Chhattisgarh, Madhya Pradesh, and Maharashtra. Southern Belt: Known for its ferrous minerals and lignite, located in Karnataka and Tamil Nadu. South-Western Belt: Contains iron ore and garnet, found in Karnataka and Goa. North-Western Belt: Rich in non-ferrous metals like copper, lead, and zinc, located in Rajasthan and Gujarat. Indian Ocean Belt: The continental shelf(it is a bed sloping gradually and bordering the continent) of the Arabian sea and the Bay of Bengal are rich in mineral oil and natural gas Top Mineral Producing states Mineral Mines Top producing states Top reserves in Iron Ore Metallic (Ferrous) Barabil – Koira Valley(Orissa) Bailadila Mine (Chhattisgarh) Dalli-Rajhara(CH) – the largest mine in India 1. Orissa 2. Chhattisgarh 3. Karnataka 1. Orissa 2. Jharkhand 3. Chhattisgarh Manganese Metallic (Ferrous) Nagpur– Bhandara Region (Maharashtra) Gondite Mines (Orissa) Khondolite deposits (Orissa) 1. MP 2. Maharashtra 1. Orissa 2. Karnataka 3. Madhya Pradesh Chromite Metallic (Ferrous) Sukinda Valley (Orissa) Hasan Region (Karnataka) 1. Orissa 2. Karnataka 3. Andhra Pradesh 1. Sukinda Valley (OR) 2. Guntur Region (AP) Nickel Metallic (Ferrous) Sukinda Valley (Orissa) Singhbhum Region (Jharkhand) 1. Orissa 2. Jharkhand 1. Orissa 2. Jharkhand 3. Karnataka Cobalt Metallic (Ferrous) Singhbhum Region (Jharkhand) Kendujhar (Orissa) Tuensang (Nagaland) 1. Jharkhand 2. Orissa 3. Nagaland Bauxite Metallic (Non-Ferrous) Balangir(Orissa) Koraput (Orissa) Gumla(Jharkhand) Shahdol (Madhya Pradesh) 1. Orissa 2. Gujarat 1. Junagarh (GJ) 2. Durg (CH) Copper Metallic (Non-Ferrous) Malanjkhand Belt (Madhya Pradesh) Khetri Belt (Rajasthan) Kho-Dariba (Rajasthan) 1. Madhya Pradesh 2. Rajasthan 3. Jharkhand 1. Rajasthan 2. Madhya Pradesh 3. Jharkhand Gold Metallic (Non-Ferrous) Kolar Gold Field (Karnataka) Hutti Gold Field (Karnataka) Ramagiri Mines (Andhra Pradesh) Sunarnarekha Sands (Jharkhand) 1. Karnataka 2. Andhra Pradesh 1. Bihar 2. Rajasthan 3. Karnataka Silver Metallic (Non-Ferrous) Zawar Mines (Rajasthan) Tundoo Mines (Jharkhand) Kolar Gold Fields (Karnataka) 1. Rajasthan 2. Karnataka 1. Rajasthan 2. Jharkhand Lead Metallic (Non-Ferrous) Rampura Aghucha (Rajasthan) Sindesar Mines (Rajasthan) 1. Rajasthan 2. Andhra Pradesh 3. Madhya Pradesh 1. Rajasthan 2. Madhya Pradesh Tin Metallic (Non-Ferrous) Chhattisgarh (the only state in India) Chhattisgarh Magnesium Metallic (Non-Ferrous) Chalk Hills (Tamil Nadu) Almora (Uttarakhand) 1. Tamil Nadu 2. Uttarakhand 3. Karnataka 1. Tamil Nadu 2. Karnataka Limestone Non-Metallic Jabalpur (Madhya Pradesh) Satna (Madhya Pradesh) Cuddapah (AP) 1. Rajasthan 2. Madhya Pradesh 1. Andhra Pradesh 2. Rajasthan 3. Gujarat Mica Non-Metallic Gudur Mines (Andhra Pradesh) Aravalis (Rajasthan) Koderma (Jharkhand) 1. Andhra Pradesh 2. Rajasthan 3. Orissa Dolomite Non-Metallic Bastar, Raigarh (Chhattisgarh) Birmitrapur (Orissa) Khammam Region (Andhra Pradesh) 1. Chhattisgarh 2. Andhra Pradesh 1. Chhattisgarh 2. Orissa Asbestos Non-Metallic Pali (Rajasthan) – largest mine Cuddapah (Andhra Pradesh) 1. Rajasthan 2. Andhra Pradesh 3. Karnataka 1. Rajasthan 2. Andhra Pradesh Kyanite Non-Metallic Pavri Mines (Maharashtra) – Oldest kyanite mine in India Nawargaon Mines (Maharashtra) 1. Jharkhand 2. Maharashtra 3. Karnataka 1. Maharashtra 2. Jharkhand Gypsum Non-Metallic Jodhpur, Bikaner, Jaisalmer, (Rajasthan) 1. Rajasthan 2. Tamil Nadu 3. Gujarat 1. Rajasthan 2. Tamil Nadu 3. J & K Diamond Non-Metallic Majhgawan Panna Mines (Madhya Pradesh) is – the only active diamond mine in India 1. Madhya Pradesh – only diamond-producing state Coal Non-Metallic (Energy) Korba Coalfield, Birampur –(Chhattisgarh) Jharia Coalfield, Bokaro Coalfield, Giridh –(Jharkhand) Talcher field – (Orissa) Singaruli coalfields (Chhattisgarh) – Largest 1. Chhattisgarh 2. Jharkhand 3. Orissa 1. Jharkhand 2. Orissa 3. Chhattisgarh Petroleum Non-Metallic (Energy) Lunej, Ankleshwar, Kalol–Gujarat Mumbai high–(Maharashtra) – largest oil field Digboi (Assam)–Oldest oil filed in India 1. Maharashtra 2. Gujarat 1. Gujarat 2. Maharashtra Uranium Atomic Jaduguda mine (Jharkhand) Tummalapalle mine (Andhra Pradesh) –largest mine Domiasiat Mine (Meghalaya) 1. Andhra Pradesh 2. Jharkhand 3. Karnataka 1. Jharkhand 2. Andhra Pradesh 3. Karnataka Thorium Atomic 1. Kerala 2. Jharkhand 3. Bihar 1. Andhra Pradesh 2. Tamil Nadu 3. Kerala Minerals UPSC Knowing about minerals, their types, features, and importance is very important for UPSC preparation. This knowledge helps in answering questions and understanding how minerals are important to national development. Students should pay attention to how minerals are classified, where they are found, and how they are used. This will improve their exam performance and help them understand their significance for India’s economy and industry.