

Crystallography

The Chemical Composition of Rocks and Minerals

Atoms and Elements - the building blocks

All natural organic matter is made from atoms. An atom consists of three components, a proton, a neutron and an electron. The proton and electron are attracted to each other, one being positive and the other negatively charged. The proton is fairly still and lazy whilst the electron whizzes around the proton dynamically. The neutron is neutral and stays fairly close to the proton. Every atom contains the same amount of protons and electrons as they work in pairs. The atom nucleus is formed consisting of protons and neutrons which are orbited by electrons. All natural elements, of which there are 83, consist of different atoms. The differences between the elements lie in the amounts of protons, neutrons and electrons within each atom. For example, hydrogen (H) has only 1 proton, Iron (Fe) has 26 and lead (pb) has 82. Other elements do not form minerals in nature because they are either gases which do not form bonds (noble gases such as neon, argon, krypton) or they are man made, such as plutonium.

Some minerals are made up of a single element or one type of atom, eg. Gold, silver, copper, sulphur. Others are compounds made up of more than one type of atom. Eg quartz is made of the elements silicon and oxygen which form the molecule silicon dioxide. Calcium is made up of the elements calcium, carbon and oxygen forming the molecule calcium carbonate.

Some rocks are made of one mineral. Eg. Limestone is made of calcium carbonate. Some rocks for instance, granite is made from more than one mineral - quartz, feldspar and mica.

In summary:

The surface of the earth is made of rocks.

Rocks are made up from minerals.

Minerals are made from elements such as oxygen, iron, silicon, calcium, sodium (there are 83 natural elements).

Elements are made from atoms

Atoms consist of protons, electrons and neutrons.

What makes the difference between types of elements is dependent on the amount of protons, electrons and neutrons present in the atom.

Metals, Non-Metals and Metalloids

99% of the Earth's crust consists of eight elements which are oxygen, silicon, aluminium, iron, calcium, sodium, potassium and magnesium. The other elements combine to make up the remaining 1%.

Most minerals are made up of a metal and a non-metal

Metals are: aluminium, iron, calcium, sodium, potassium and magnesium as well as antimony, beryllium, lead, chromium, gold, cobalt, copper, lithium, manganese, nickel, platinum,, silver, titanium, vanadium, bismuth, zinc, tin, zirconium.

Non-metals are: oxygen as well as boron, bromine, chlorine, fluorine, carbon, iodine, phosphorus, sulphur

Metalloids: silicon as well as boron, germanium, arsenic, selenium, tellurium.

Native elements: - examples of which are found among - copper, gold, platinum and silver. Non metals are carbon (which diamond consists of) and sulphur.

Oxides - usually formed from a metal plus oxygen

Eg. Hematite is formed from iron plus oxygen - iron oxide (Fe_2O_2)

Quartz is an oxide of silicon (metalloid) plus oxygen to make silicon dioxide (SiO_2) - all members of the quartz family macro and microcrystalline.

Ruby is a member of the corundum family and is an oxide made from aluminium plus oxygen (Al_2O_3)

Sulphides - formed from metals plus sulphur

Pyrite is a sulphide of Iron (iron plus sulphur) (FeS_2)

Halides - formed from a metal plus a halide (fluorine, chlorine, bromine, iodine)

Fluorite is a halide formed from calcium and fluorine (CaF_2)

Silicates - formed from a metal plus silicon plus oxygen

Beryl is a silicate of beryllium and aluminium plus silicon plus oxygen ($Be_3Al_2(Si_6O_{18})$)

Kyanite is a silicate of aluminium, silicon and oxygen

Topaz is a hydrous or hydrated silicate of aluminium - aluminium, silicon, oxygen plus hydrogen ($Al_2(F_2/SiO_4)$ plus OH).

Many of the crystals we study are in fact silicates including apophyllite, charoite, chrysocola, diopase, garnet, kunzite, lazurite, larimar, lepidolite, moonstone, peridot, prehnite, rhodonite, sugilite and tourmalines.

Metals etc continued . . .

Carbonates - formed from a metal plus carbon plus oxygen. **Calcite/aragonite** is a carbonate of calcium plus carbon plus oxygen. **Rhodocrosite** is a carbonate of manganese plus carbon plus oxygen ($MnCO_3$)

Azurite and **Malachite** are hydrous or hydrated carbonates of copper made from copper plus carbon plus oxygen plus hydrogen.

Sulphates - formed from a metal plus sulphur plus oxygen

Celestite is a sulphate of strontium plus sulphur plus oxygen

Selenite is a hydrous or hydrated sulphate of calcium plus sulphur plus oxygen plus hydrogen

Phosphates - formed from a metal plus phosphorus plus oxygen.

Turquoise is a hydrous or hydrated phosphate of copper and aluminium and phosphorus and oxygen.

Some crystal healers believe that the chemicals composition of minerals is an important factor in determining the energetic healing properties of crystals. As you become more familiar with the energies of crystals and their chemical make up you may form your own opinions on this.

Crystals and Colour

The colour of a crystal is often the first thing that we notice. In fact many crystals are named as a result of their colour, for example rose quartz (pink quartz). **Rhodonite** (Rhoda being the name for rose in greek) **Ruby** named after the latin rubius meaning red.

White light from the sun and stars, if passed through a prism contains all the colours of the rainbow. When white light falls on an object, some or all of the frequencies will be absorbed, reflected or refracted. This transmission of light and how this information is translated by our eyes and brain determines the apparent colour of the object. In an opaque stone, if all frequencies are absorbed, it appears black. If all are reflected it appears white. A red stone will absorb all but the red frequencies, a green stone all but the green frequencies.

Some minerals are coloured due to the presence of a particular element. For example chromium, cobalt, copper, iron, manganese, nickel, titanium, vanadium. Some minerals are always the same colour eg. **Malachite** is always green, **rhodocrosite** and **rhodonite** are pink - these minerals are called **ideochromatic** - their colour is determined by an element which is part of their atomic structure.

Crystal colour continued

Other minerals such as quartz when pure are colourless - and their colour changes due to the influence and presence of just a few atoms of another element.

Clear quartz becomes amethyst due to the presence of a few atoms of iron. If the presence of iron is subjected to immense heat, citrine will form.

Corundum is aluminium oxide - traces of chromium produce the red of ruby, whereas traces of iron and titanium create the blue of sapphire since both these are members of the Corundum family. These minerals are called allochromatic as they may occur in many different colours.

Colour can also be created by exposure to radiation such as in smoky quartz, or by damage to the internal structure as in the rainbows seen within many clear crystals. Light may be reflected from the particular internal structure eg moonstone and labradorite. Light may also be affected by the inclusion of tiny particles of water, gases, organic substances or other minerals. An example of the latter is the 'star' effect in star rubies, sapphires or occasionally rose quartz these are called 'asterized' crystals.

Many crystal healers consider that the colour of a crystal is a big factor determining its healing property. Again bear this in mind as you learn more and you will form your own opinion on this theory.