Clay

Clay minerals are the hydrous aluminium phyllosilicates of chemical formula $Al_2O_3.\ 2SiO_2.\ 2H_2O$ that are available at times with varying amounts of iron, alkali, metals, magnesium, alkaline earth, and such other cations. There are several different clay minerals; for example: Kaolinite - a clay mineral with the chemical composition $Al_2Si_2O_5(OH)_4$. They are generally found on or near some planetary surfaces. Clay minerals are formed mainly in the presence of water. They are proved to be very important to our life.

Types of Clays:

The main four types of clay are as follow:

1. Earthenware clay
2. Stoneware clay
3. Ball clay
4. Porcelain.

All of these clays are used to make pottery. These seem all same but the texture, colour, and flexibilities differ a great deal.

Some important Clays and their Constituents:

Kaolinite Clay or China Clay:

The clay mineral is termed Kaolinite which has $Al_2Si_2O_5(OH)_4$ as its chemical composition. Kaolinite Clay is very much important as an industrial mineral. Kaolinite is a layered mineral of silicate coupled with silica which is SiO_4, this is further linked through the oxygen atoms to an octahedral sheet of the alumina (AlO_6) octahedra. Rocks that are rich in kaolinite are called the kaolin or also known as China Clay.

Bentonite:

Bentonite is a type of absorbent swelling clay which majorly consists of montmorillonite. This type of clay usually is formed from the weathering of the volcanic ash in the presence of seawater, after which it converts into volcanic gases that are present in the ash and clayey minerals. The Bentonite beds are white or pale blue or green in colour when exposed to fresh exposures, they can also turn to a cream colour and after which they can turn into yellow, red, or brown as the exposure is more.

Montmorillonite:

Montmorillonite is a very soft mineral that comes under the group of phyllosilicate minerals. These mineral forms when they precipitate from the water solution in the form of microscopic crystals. This clay is named after Montmorillon in the country France. The clay is in the ratio of 2:1, which means that it has two tetrahedral sheets of silica and a single octahedral sheet of the alumina. The particles are featured as plate-shaped with an average diameter of around 1 micrometer (1 μm) and have a thickness of about 0.96 nm.

Powdered Bentonite:

Bentonite clay is used by human beings to remove impurities on their skin, like oils, and other toxins from the body. This practice is done for thousands of years. Bentonite clay is also present in many skincare products. While some people also add this to foods or drinks with the aim to improve digestive issues or to remove toxins from the body.

Smectite:

Smectite is also a clay mineral (like bentonite) that undergoes reversible expansion while absorbing the water.

Sepiolite:

Sepiolite is the English name, while in German it is known as meerschaum which means 'sea foam'. This is soft textured while clayey mineral which is often used in making tobacco pipes also called the meerschaum pipes. This is a complex magnesium silicate which is a specific chemical formula $Mg_4Si_6O_{15}(OH)_2 \cdot 6H_2O$, this can be present in the fibrous, fine-particulate, and solid forms.

Pyrophyllite:

Pyrophyllite is a type of mineral which is phyllosilicate and this is composed of aluminium silicate hydroxide, the chemical formula which is $Al_2Si_4O_{10}(OH)_2$. This occurs in two forms crystalline folia and the form of compact masses, while there are distinct crystals as well which are well known. Pyrophyllite which occurs in the phyllite and schistose rocks is generally associated with kyanite used as an altered product.

Ball Clay:

Ball clays are made up of kaolinitic sedimentary clays which are commonly constituted with 20–80% of kaolinite, 10 to 25% mica 6 to 5% of quartz. The localized seams in the same deposit have variations in their composition, this includes the quantity of these major minerals, which are accessorized minerals and carbonaceous materials like lignite. They form fine-grained and quite is quite plastic in nature, and this is unlike the earthenware clay. They produce fine quality pottery with white colour body.

Feldspar:

Feldspar refers to a group of minerals that contain alumina and silica (SiO_2) in their chemical makeup, and are natural minerals. Feldspar can be described as a large group of rock-forming silicate minerals. Aluminum silicates of soda, potassium, or lime belong to this group of natural minerals. This is a common mineral group and makes up about 60% of the exposed rocks, as well as sand, clay, and other unconsolidated sediments, and are important parts of rock classification schemes. Included in this group are orthoclase, microcline, and plagioclase feldspars.

Chemical Formula of Feldspar:

Potassium feldspar chemical formula or (K-spar) formula- $KAlSi_3O_8$

Sodium feldspar chemical formula or albite formula- $NaAlSi_3O_8$

Calcium feldspar chemical formula- $CaAl_2Si_2O_8$.

Properties of Feldspar:

Feldspar has different chemical formulas each depending on its composition. The specific chemical formula is $KAlSi_3O_8$ – $NaAlSi_3O_8$ – $CaAl_2Si_2O_8$.

1. The minerals are chemically alert and have a stable pH value.

2. In the Physical properties of Feldspar, we can say that the Feldspars have a monoclinic or a triclinic crystal system

3. The refractive index of this mineral is 1.518 – 1.526. The cleavage of feldspar is two and it consists of two planes that intersect each other at an angle of 90º.

4. On the Mohs hardness scale, the hardness of this mineral is 6 – 6.5.

5. The density of Feldspar is 2.56 g/cm^3 and the double refraction is of the first order.

Feldspar Composition:

Tectosilicates, or silicate minerals, are a type of natural mineral. Silicon ions are connected by shared oxygen ions to form a three-dimensional network in this type of mineral. Three end members may be used to express the compositions of major elements in common feldspar. Let's look at the chemical formulas for various forms of feldspar.

Feldspar Structure:

Aluminosilicate tetrahedra make up the backbone of feldspar crystals. An aluminum or silicon ion is surrounded by four oxygen ions in each tetrahedron. A three-dimensional network is formed when each oxygen ion is shared by a neighboring tetrahedron. Long chains of aluminosilicate tetrahedra can be seen, which are often referred to as crankshaft chains due to their kinked form. Each crankshaft chain forms a three-dimensional network of fused four-member rings by connecting to neighboring crankshaft chains.

The structure is open enough for cations (usually sodium, potassium, or calcium) to fit inside and balance the charge.

Types of Feldspar:

Alkali feldspars are grouped into two types:

Containing potassium in combination with sodium, aluminium, or silicon.

Containing barium (barium replaced potassium).

The first of these include:

Orthoclase (monoclinic) $KAlSi_3O_8$

Sanidine (monoclinic) (K, Na) $AlSi_3O_8$

Microcline (triclinic) $KAlSi_3O_8$

Anorthoclase (triclinic) (Na, K) $AlSi_3O_8$

Potassium and Sodium Feldspars:

Since these aren't perfectly miscible in the melt at low temperatures, intermediate alkali feldspar compositions can only be found in higher-temperature settings. Sanidine is stable at high temperatures and microcline is stable at low temperatures. Perthite is a common texture in alkali feldspar, resulting from the exsolution of different alkali feldspar compositions during the cooling of intermediate composition. Many granites have perthitic textures in their alkali feldspars that can be seen with the naked eye. With a light microscope, one can see micro perthitic textures in crystals, but only an electron microscope can see crypto perthitic textures.

Barium Feldspars:

Alkali feldspars are also known as barium feldspars. Barium feldspars are formed when barium is substituted for potassium in the mineral structure. The monoclinic barium feldspars contain the following:

a. Celsian $BaAl_2Si_2O_8$
b. Hyalophane (K, Ba) $(Al, Si)_4O_8$

The triclinic plagioclase feldspars are a type of plagioclase feldspar. The following is the plagioclase series (with percent anorthite in parentheses):

1. Albite (0 to 10) $NaAlSi_3O_8$
2. Oligoclase (10 to 30) (Na, Ca) (Al, Si) $AlSi_2O_8$
3. Andesine (30 to 50) NaAlSi3O8-$CaAl_2Si_2O_8$
4. Labradorite (50 to 70) (Ca, Na) Al (Al, Si) Si_2O_8
5. Bytownite (70 to 90) (Na Si, Ca, Al) $AlSi_2O_8$
6. anorthite (90 to 100) $CaAl_2Si_2O_8$

Plagioclase feldspar with intermediate compositions can also exsolve to two feldspars with contrasting compositions during cooling, but diffusion is much slower than in alkali feldspar, and the resulting two-feldspar intergrowths are usually too fine-grained to be visible with optical microscopes. In comparison to the difference in alkali feldspars, the immiscibility differences in plagioclase solid solutions are more complicated. The colour play apparent in some feldspar of labradorite composition is due to Boggild intergrowth, which is a very fine-grained exsolution lamellae. From albite (2.62) to anorthite (2.72–2.75), the specific gravity of the plagioclase sequence increases.

Uses of Feldspar:

1. Dinnerware, bathroom and construction tiles are all made of feldspar.
2. In the manufacture of ceramics and glass.
3. As a flux, feldspar is used. A flux is a substance that decreases the melting temperature of another substance, such as glass in this case.