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COURSE:CVE 313

MATRIC N:18/ENG03/050

ENGINEERING GEOLOGY

**Clay Minerals and Their Distinct Properties**

Clay minerals are a diverse group of hydrous layer of aluminosilicates  that constitute the greater part of phyllosilicate  family of minerals.

Clay minerals are hydrous aluminum particles that consist of various metals found on or near planetary surfaces. These clay minerals form in the presence of water and go into a plastic state with the absence of water, they are essential to soils and have also been useful to humans since ancient times. Generally, soils are the product of rock weathering and it is here that most soil minerals are common rock-forming materials. The most common of these materials are sheet and framework silicate minerals. The weight of soil in the world is mostly composed of silicate minerals.

They are three(3) major groups of clay minerals which are divided into :

1)Kaolinite 2) Illite 3)Montmorillonite.

They are other common groups of clay minerals which are

1. Chlorite 2)Halloysite 3)Vermiculite

Physical and Chemical Properties of Clays

Looking at the physical properties of clay: Specific gravity of most clay minerals are within the range from 2 to 3.3. Their hardness generally falls below 2.5 Refractive indices of clay minerals generally fall within a relatively narrow range from 1.47 to 1.68. Generally the size and shape, the two properties, are determined by electron micrographs.

CHEMICAL PROPERTIES:

Chemical properties of clays are very important to the understanding of their behaviour. The electrical charge and colloidal size of clay mineral particles make them hydrate and interact so that their hydraulic conductivity and stress/ strain properties are quite different from those of sandy soil.

Generally :

The properties common to all clay minerals derive from their chemical composition, layered structure, and size. Clay minerals all have a great affinity for water. Some swell easily and may double in thickness when wet. Most have the ability to soak up ions (electrically charged atoms and molecules) from a solution and release the ions later when conditions change.

Water molecules are strongly attracted to clay mineral surfaces. When a little clay is added to water, a slurry forms because the clay distributes itself evenly throughout the water. This property of clay is used by the paint industry to disperse pigment (color) evenly throughout a paint. Without clay to act as a carrier, it would be difficult to evenly mix the paint base and color pigment. A mixture of a lot of clay and a little water results in a mud that can be shaped and dried to form a relatively rigid solid. This property is exploited by potters and the ceramics industry to produce plates, cups, bowls, pipes, and so on. Environmental industries use both these properties to produce homogeneous liners for containment of waste.

The process by which some clay minerals swell when they take up water is reversible. Swelling clay expands or contracts in response to changes in environmental factors (wet and dry conditions, temperature). Hydration and dehydration can vary the thickness of a single clay particle by almost 100 percent. Infrastructures built on soils containing swelling clays may be subject to structural damage caused by seasonal swelling of the clay portion of the soil.

Another important property of clay minerals, the ability to exchange ions, relates to the charged surface of clay minerals. Ions can be attracted to the surface of a clay particle or taken up within the structure of these minerals. The property of clay minerals that causes ions in solution to be fixed on clay surfaces or within internal sites applies to all types of ions, including organic molecules like pesticides.

GEOLOGY OF NIGERIA

  The geology of Nigeria is composed of three litho-petrological components which are;

• Basement complex • Sedimentary Basins • Younger Granites

Basement Complex : The Nigerian basement complex covers about 50% of the entire country,

underlying mainly the Southeast, Northwest, Central and Northeastern parts of the country and these comprises a wide range of rock types. The other 50% of the country’s land surface is covered by Cretaceous and younger sediments overlying the basement complex. Towards the central part of the country high level intrusive granites of Jurassic age intrudes into the basement complex referred to as the younger granite suite or ring complexes. The Nigeria basement complex rocks is a group of crystalline igneous and metamorphic rock of Precambrian to lower Proterozoic in age. The rocks are generally grouped into three lithological units.

1. The migration-gneiss-quartzite complex 2. The schist belt 3. The older granites 4. Undeformed acid and basic cycles

Sedimentary Basins ;The sedimentary basins in Nigeria are regions where long-term subsidence creates accommodation space for accumulation of sediments. As the sediments are buried, they are subject to increasing pressure and begin the processes of compaction and lithification that transform them into sedimentary rock. Sedimentary basins occur in diverse geological settings usually associated with plate tectonic activity. Tectonic processes that lead to subsidence include the thinning of underlying crust; sedimentary, volcanic, or tectonic loading; or changes in the thickness or density of adjacent lithosphere.

A culmination of these depositional events resulted in the formation of about seven sedimentary basins in Nigeria where active petroleum exploration activities can be carried out. These basins include the following:

• Anambra Basin • Benue Trough • Borno Basin • Sokoto Basin• Dahomey Basin• Bida Basin

• Niger Delta Basin

Younger Granites: The Younger Granites are a group of granitic massfs which are discordantly intrusive into the Pre- Cambrian Basement Complex in Northern Nigeria. They are high-level, magmatic granites with sharply defined, cross-cutting contacts against the older rocks. The Younger Granitescannot be related to any cycle of orogeny.

The Younger Granites of Nigeria are famous for their tin (cassiterite) mineralisation, which is mainly associated with the biotite granites. These rocks also contain significant quantities of the niobium-rich mineral as an accessory. Most of the workable deposits of cassiterite and columbiteare in alluvial concentrations. The peralkaline granites also contain accessory uranium-bearing minerals, which probably provided the primary source for the sedimentary uranium deposits of Niger.