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CLAY MINERALS

Clay minerals are hydrous aluminium phyllosilicates, sometimes with variable amounts of iron, magnesium, alkali metals, alkaline earths, and other cations found on or near some planetary surfaces.

Clay minerals form in the presence of water and have been important to life, and many theories of abiogenesis involve them. They are important constituents of soils, and have been useful to humans since ancient times in agriculture and manufacturing. Given the requirement of water, clay minerals are relatively rare in the Solar System, though they occur extensively on Earth where water has interacted with other minerals and organic matter. Clay minerals have been detected at several locations on Mars.

Clay minerals can be classified as 1:1 or 2:1, this originates because they are fundamentally built of tetrahedral silicate sheets and octahedral hydroxide sheets, as described in the structure section below. A 1:1 clay would consist of one tetrahedral sheet and one octahedral sheet, and examples would be kaolinite and serpentinite. A 2:1 clay consists of an octahedral sheet sandwiched between two tetrahedral sheets, and examples are talc, vermiculite, and montmorillonite.

Clay minerals include the following groups:

- Kaolin group which includes the minerals kaolinite, dickite, halloysite, and nacrite (polymorphs of $Al_2Si_2O_5(OH)_4$
- Some sources include the kaolinite-serpentine group due to structural similarities.
- Smectite group which includes dioctahedral smectites, such as montmorillonite, nontronite and beidellite, and trioctahedral smectites, such as saponite. In 2013, analytical tests by the Curiosity rover found results consistent with the presence of *smectite clay materials* on the planet Mars.
- Illite group which includes the clay-micas. Illite is the only common mineral.
- Chlorite group includes a wide variety of similar minerals with considerable chemical variation.
- Other 2:1 clay types exist such as palygorskite (also known as attapulgite) and sepiolite, clays with long water channels internal to their structure.

Mixed blue layer clay variations exist for most of the above groups. Ordering is described as a random or regular order and is further described by the term reichweite, which is German for range or reach. Literature articles will refer to an R1 ordered illite-smectite, for example. This type would be ordered in an ISIS fashion. R0 on the other hand describes random ordering, and other advanced ordering types are also found (R3, etc.). Mixed layer clay minerals which are perfect R1 types often get their own names. R1 ordered chlorite-smectite is known as corrensite, R1 illite-smectite is rectorite.

DINSTINCT PEOPERTIES

1. cation exchange capabilities:
   When erosion, transport, and deposition take place, clay minerals react to change in the environment. Ion exchange, reconstruction of degraded mineral, and formation of one type clay-based mineral from another or simpler substance appear as a result of those processes. Exchange reactions are dominated by physicochemical laws and depend upon the clay mineral, the nature, and ion population of the exchange sites and on the concentration and the composition of the solution in which the clay mineral is found

2. swelling behaviour:
   Clay mineral swelling is dependent on clay mineral type, the electrolyte concentration, and the nature of the cations in the solution. The swelling mechanism can be divided into mechanical and physicochemical processes. Through burial diagenesis, expandable layers are removed in the clay mineral structure such that inter and intralayer swelling of expandable clay mineral types can be expected to be at a minimum in older rocks than in younger rocks. Mechanical swelling occurs in response to elastic and time-dependent stress unloading, which can be brought by man in digging excavations or by nature in tectonic uplift and erosion because the clay is free to expand in the vertical direction but not in the horizontal direction.

3. low permeability:
   Permeability properties of clay minerals can be explained by the type and distribution of the clay minerals within the pore system. Generally, in rocks which are predominantly argillaceous, permeability is low. The mineralogy of different types of rocks semi-permeable in nature gives a noticeably different set of chemical parameters, whereas low to medium permeability can be assimilated to a closed system where rocks and fluid are effectively part of the same physicochemical unit.

GEOLOGY OF NIGERIA

The **geology of Nigeria** formed beginning in the Archean and Proterozoic eons of the Precambrian. The country forms the Nigerian Province and more than half of its surface is igneous and metamorphic crystalline basement rock from the Precambrian. Between 2.9 billion and 500 million years ago, Nigeria was affected by three major orogeny mountain-building events and related igneous intrusions. Following the Pan-African orogeny, in the Cambrian at the time that multi-cellular life proliferated, Nigeria began to experience regional sedimentation and witnessed new igneous intrusions. By the Cretaceous period of the late Mesozoic, massive sedimentation was underway in different basins, due to a large marine transgression. By the Eocene, in the Cenozoic, the region returned to terrestrial conditions.

Nigeria has tremendous oil and natural gas resources housed in its thick sedimentary basins, as well as reserves of gold, lead, zinc, tantalite, columbite, coal and tin. Nigeria has extensive natural resources and is the largest crude oil producer in Africa and 20 billion barrels of reserves. As such, petroleum is central to economy of Nigeria, producing 80 percent of government revenues and 95 percent of export earnings. Additionally, Nigeria has 2.6 trillion cubic meters of natural gas and a high overall gas to oil ratio. Seventy percent of both oil and gas resources are onshore.

The country also has extensive mineral deposits, although most are under-exploited. According to the Geological Survey of Nigeria Agency, Nigeria has some 34 known major mineral deposits across the country. Exploration of solid minerals like tin, niobium, lead, zinc and gold, goes back for more than 90 years, but there has been a world-wide scale production of tin and niobium only.

Gold mines were active before World War II, extracting from crystalline basement rock in the northwest, but a combination of low gold prices and legal turmoil ended the industry, recently the demand for gold has gone up due its high prices and Gold can be found in commercial quantity in states like Osun, Zamfara and Cross River states in Nigeria. The Younger Granites of the Jos Plateau contain significant tin deposits, mined since before European colonization. However, in recent years, tin mining has been significantly curtailed by flooding in the mines and low tin prices, as well as water pollution from the mines. Tantalite and columbite are both associated with the tin ore in the plateau.

The states of Anambra, Benue, Plateau and Taraba have small-scale lead and zinc mining, from deposits that also have large quantities of cadmium, arsenic and antimony. Barite veins commonly contain lead and zinc in Plateau State and other parts of eastern Nigeria. Kwara State has iron ore in Agbaja Plateau and Itakpe Hills.

Nigeria also has other resources useful for energy and construction, including a poorly understood lignite belt in the south, kaolin, gypsum and feldspar. Coal mining provided much of the country's energy between 1915 and 1960, although the industry has been in a long-running decline, now providing energy only for small-scale kilns and smelter.

Paleozoic (541-251 million years ago)

In the Cambrian, at the beginning of the Paleozoic, volcanic debris filled molasse grabens, forming dacite and shoshonite, as the Older Granites continued to emplace. In some cases, granite intrusions formed large batholiths and charnockite. The end of the Pan-African orogeny was also accompanied by the intrusion of basalt and dolerite dikes.

Mesozoic (251-66 million years ago)

In the Mesozoic, during the Jurassic, ring complexes known as the Younger Granites intruded Neoproterozoic and Paleozoic basement rocks in the Jos Plateau, as well as in the Air region in Niger. The Younger Granites are primarily alkali-feldspar granites, although the ring complexes also include rhyolite, gabbro and syenite. The ring dikes tend to be highly mineralized and enriched in niobium and tin.

Cenozoic (66 million years ago-present)

High sea levels continued into the early Cenozoic. In the west, the Akinbo Formation and Ewekoro Formation both deposited in the Paleocene, while the Ino Formation took shape atop the Nsukka in the east, with layers of thick, clay shale. The Sokoto Group in the Iullemeden Basin contains marine sediments. However, by the Eocene, sea levels retreated and afterward Nigeria mainly experienced terrestrial sedimentation.