Name: Boumann Khashmn Sule

Department: Civil Engineering

Matric number: 18/ENG03/022

Course: Engineering Geology

Course code: CVE 313

<u>Question:</u>

Read and write extensively on clay minerals and their distinct properties

Write comprehensively on geology of Nigeria

What are clay Minerals?

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

Clays and clay minerals occur under a fairly limited range of geologic conditions. The environments of formation include soil horizons, continental and marine sediments, geothermal fields, volcanic deposits, and weathering rock formations. Most clay minerals form where rocks are in contact with water, air, or steam. 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.

Classification

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 serpentine. 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:

i. Kaolin group
ii. Smectite group
iii. Illite group
iv. Chlorite group
v. Other 2:1 clay types exist such as palygorskite (also known as attapulgite) and sepiolite, clays with long water channels internal to their structure.

Structure of clay minerals

Clay minerals are composed essentially of silica, alumina or magnesia or both, and water, but iron substitutes for aluminum and magnesium in varying degrees, and appreciable quantities of potassium, sodium, and calcium are frequently present as well.

The atomic structure of the clay minerals consists of two basic units, an octahedral sheet and a tetrahedral sheet. The octahedral sheet is comprised of closely packed oxygen's and hydroxyls in which aluminum, iron, and magnesium atoms are arranged in octahedral coordination.

While tetrahedral clay minerals are characterized by two-dimensional sheets of corner-sharing SiO 4 tetrahedral and/or AlO 4 octahedral. The sheet units have the chemical composition (Al, Si) 3O

Each silica tetrahedron shares 3 of its vertex oxygen atoms with other tetrahedral forming a hexagonal array in two-dimensions. The fourth vertex is not shared with another tetrahedron and all of the tetrahedral "point" in the same direction; i.e. all of the unshared vertices are on the same side of the sheet.

In clays, the tetrahedral sheets are always bonded to octahedral sheets formed from small cations, such as aluminum or magnesium, and coordinated by six oxygen atoms. The unshared vertex from the tetrahedral sheet also forms part of one side of the octahedral sheet, but an additional oxygen atom is located above the gap in the tetrahedral sheet at the center of the six tetrahedral. This oxygen atom is bonded to a hydrogen atom forming an OH group in the clay structure. Clays can be categorized depending on the way that tetrahedral and octahedral sheets are packaged into layers.

If there is only one tetrahedral and one octahedral group in each layer the clay is known as a 1:1 clay. The alternative, known as a 2:1 clay, has two tetrahedral sheets with the unshared vertex of each sheet pointing towards each other and forming each side of the octahedral sheet.

Bonding between the tetrahedral and octahedral sheets requires that the tetrahedral sheet becomes corrugated or twisted, causing tetragonal distortion to the hexagonal array, and the octahedral sheet is flattened. This minimizes the overall bond-valence distortions of the crystallite.

Properties

- 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.

Geology of Nigeria

The geology of Nigeria is made up of three major litho-petrological components, namely,

i. Basement Complex
ii. Younger Granites
iii. Sedimentary Basins

The Basement Complex, which is Precambrian in age, is made up of the Migmatite-Gneiss Complex, the Schist Belts and the Older Granites.

Basement complex

The basement complex is one of the three major litho-petrological components that make up the geology of Nigeria. The Nigerian basement complex forms a part of the Pan-African mobile belt and lies between the West African and Congo Cratons and south of the Tuareg Shield. It is intruded by the

Mesozoic calc-alkaline ring complexes (Younger Granites) of the Jos Plateau and is unconformably overlain by Cretaceous and younger sediments. The Nigerian basement was affected by the 600 Ma Pan-African orogeny and it occupies the reactivated region which resulted from plate collision between the passive continental margin of the West African craton and the active Pharusian continental margin. The basement rocks are believed to be the results of at least four major orogenic cycles of deformation, metamorphism and remobilization corresponding to the Liberian (2,700 Ma), the Eburnean (2,000 Ma), the Kibaran (1,100 Ma), and the Pan-African cycles (600 Ma).

Younger Granites

The Younger Granites of Nigeria in particular 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 col- jumbite as an accessory. Most of the workable deposits of cassiterite and columbite are in alluvial concentrations. The per alkaline granites also contain accessory uranium-bearing minerals, which probably provided the primary source for the sedimentary uranium deposits of Niger.

sediments cover the parts of Nigeria that are located in a number of sedimentary basins, comprising;

i. Benue (central) Basin

   The Benue Basin is a large elongate rifted basin running along the approximate line of the Benue River. The basin is in-filled with about 5000 m of Cretaceous sediment overlying crystalline basement rocks.

ii. Sokoto (north-west border) Basin

   The Sokoto Basin in the north-west is dominated by Tertiary marine clays.

iii. Chad (north-east) Basin

   In the Chad Basin three main aquifers consisting of an upper aquifer at 30 to 100 m depth, a middle aquifer (eastern part of the basin) some 40 to 100 m thick occurring from 230 m depth near Maiduguri and a lower aquifer consisting of 100 m of medium to coarse sands and clays occurs at a depth of 425 to 530 m

iv. Bida (central, along the Niger valley) Basin

   The Bida Basin, aligned north-west to south-east passing through Bida to Auna, is a shallow un-faulted extension of the Benue Basin. Conglomerates and pebbly sandstones with clay lenses are predominant in the Cretaceous sequence of the Bida Basin.

v. Dahomey (south-west) Basin

   Most of the wells that penetrated the basement are in the Eastern Dahomey embayment of western Nigeria.

vi. Anambra (south-east) Basin

In the Anambra Basin, coarse Cretaceous sandstones form good aquifers. These aquifers are largely unconfined in the northern part but become artesian further south with groundwater levels typically about 60 to 150 m deep.

vii. Niger delta (south coastal)
The Niger delta in south has been prograding outwards to the Atlantic Ocean since late Cretaceous times and is in-filled with Tertiary and Quaternary sediments which decreases in age progressively southwards

References

https://link.springer.com

https://en.wikipedia.org/

https://www.researchgate.net