Journal Homepage: -www.journalijar.com

INTERNATIONAL JOURNAL OF ADVANCED RESEARCH (IJAR)

Article DOI: 10.21474/IJAR01/22337
DOI URL: http://dx.doi.org/10.21474/IJAR01/22337

ISSN (O): 2320-5407
ISSN (P): 3107-4928

*RESEARCH ARTICLE*

# IDENTIFICATION AND MINERALOGICAL QUANTIFICATION OF DIATOMITES FROM FAYA–CHAD USING X-RAY DIFFRACTION

**Annouar Djidda Mahamat[1], Idriss Mahamat Yaya[2], Mahamat Bichara Abderaman[2], Yacoub Abdallah Nassour[3] and Mahamat Adoum Abdraman[1]**

1. Department of Technology – University of N'Djamena – Chad.
2. Department of Chemistry – University of N'Djamena – Chad.
3. Department of Geology – University of N'Djamena – Chad.

## Manuscript Info

*Manuscript History*
Received: 4 October 2025
Final Accepted: 6 November 2025
Published: December 2025

*Key words:-*
Diatomite, Diffraction, Mineralogy, Amorphous silica.

## Abstract

This study focuses on identifying and quantifying the mineralogical composition of two diatomite samples collected in the Faya-Largeau region (Borkou, northern Chad) in order to assess their mechanical suitability and potential use as local construction materials. The research is set within the Saharan context, where imported materials remain expensive and difficult to transport, making the development of local geological resources essential. Diatomite, a lightweight sedimenta ry rock rich in silica originating from fossilized diatoms, is a key material for sustainable construction thanks to its porosity, thermal insulation capacity, and ease of shaping. Two samples from the Tchang-Sousse and Dozanga districts were analyzed using X-ray diffraction (XRD) to identify their mineral phases and determine their behavior during firing and their suitability for local brick production.



**The results show that:**

- Both samples are dominated by quartz, confirming a highly siliceous nature.
- Clays (kaolinite and montmorillonite) are present in varying proportions, providing plasticity and shaping ability.
- Small amounts of carbonates (calcite) and feldspars (albite, sanidine) were detected, reflecting minor detrital inputs or slight geochemical alteration.

The "Faya-Tchad" sample (Tchang-Sousse) contains a high proportion of quartz with small amounts of calcite and feldspars, characteristic of a high-quality siliceous-clayey diatomite. The second sample (Dozanga) also shows quartz dominance and contains well-identified clays (kaolinite, montmorillonite-15A) as well as traces of feldspars, suggesting a sedimentary origin with moderate amorphous phase content.

## Introduction:-

Northern Chad, including the Borkou, Ennedi, and Tibesti regions, is characterized by an arid Saharan climate, scarce natural resources, and a strong dependence on imported construction materials (fired bricks, cement, tiles, etc.). This dependence increases costs and limits housing development, especially in remote areas such as Faya-Largeau.

In this region, traditional materials such as cement blocks or industrial bricks are expensive to produce or transport over long distances. This highlights the need to capitalize on local geological resourcesclays, sands, silts, diatomitesto develop construction materials that are adapted, affordable, and sustainable.

**Sustainable construction in Saharan environments is based on three pillars:**
- Local economy: using locally available raw materials to reduce costs.
- Ecology: minimizing emissions from transport and industrial manufacturing.
- Climate adaptation: producing lightweight, insulating bricks capable of resisting large daily thermal variations.

**Diatomite-based materials meet these criteria thanks to:**
- their low density and high porosity, which enhance thermal insulation,
- their high amorphous silica ($SiO_2$) content, favourable for cohesion after firing,
- and their natural abundance in the sedimentary formations of Faya-Bodélé.

The Borkou province is located within the (Charlie S. Bristow, Nick Drake, Simon Armitage, 2009), (Servant, M. ; Servant, S., 1970) (Servant, 1983)Bodélé Depression, at the southern margin of the Sahara Desert, in north-central Africa. It is the lowest point in Chad. The depression is 500 km long, 150 km wide, and about 160 m deep, with its floor lying approximately 155 m above sea level.

Diatomite is a sedimentary rock rich in amorphous silica, composed of fossil remains of diatoms (microscopic algae). This provides useful properties such as filtration capacity and moisture absorption. The presence of a high-quality deposit in Chad indicates promising potential for exploitation or local utilisation.

**Figure 2: Eroded surface of diatomite sediments in the Bodélé Depression**

**In this context, studying diatomite from the Faya province aims to:**
- identify its mineral constituents via X-ray diffraction (XRD),
- quantify dominant phases to assess their behavior during firing,
- and evaluate its potential for producing local bricks that meet durability and thermal-performance requirements.

**Two samples were collected from the Tchang-Sousse and Dozanga districts.**

**Sample 1 from Tchang-Sousse district (Faya-Tchad)**

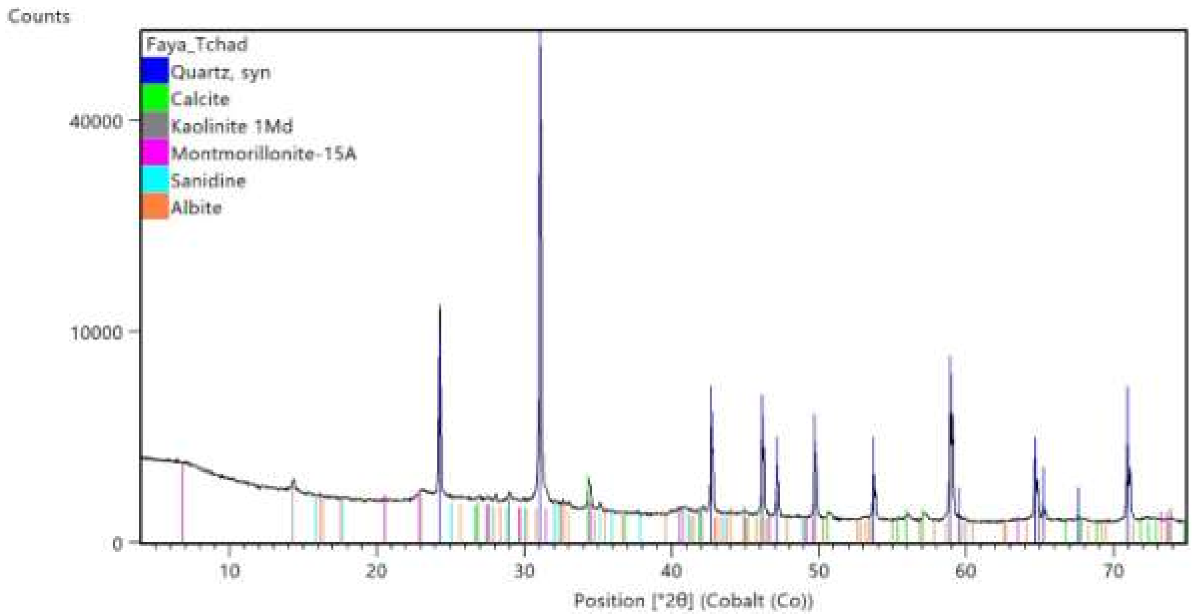


**Figure 3: Diatomite soil sample from Tchang-Sousse district.**

Figure 2 shows the X-ray diffractogram of sample "Faya_Tchad," used to identify mineral phases in diatomite or clay. A detailed analysis is as follows:

**General Reading**

- **X-axis:** 2θ position (Cobalt Co) indicating diffraction peak positions.
- **Y-axis:** Counts (intensity of diffracted rays), proportional to the relative abundance of each phase.
- The **black profile** represents the measured signal, while the **colored markers** indicate characteristic peaks of identified minerals.

**Table 1: Minerals Identified in Sample 1**

| Color | Mineral | Chemical Formula | Type / Family | Interpretation |
|---|---|---|---|---|
| Blue | Quartz | $SiO_2$ | Silicate | Dominant mineral; strong peak at ~31°–32° (Co Kα); main siliceous source of diatoms. |
| Green | Calcite | $CaCO_3$ | Carbonate | Present in low proportion; secondary peak at ~36°–38°; indicates secondary carbonate sedimentation. |
| Grey | Kaolinite 1Md | $Al_2Si_2O_5(OH)_4$ | Clay | Typical alteration clay provides plasticity. |
| Cyan | Sanidine | $K(AlSi_3O_8)$ | Alkali feldspar | Indicates volcanic input; often residual. |
| Orange | Albite | $Na(AlSi_3O_8)$ | Plagioclase feldspar | Silicate; minor presence. |

**Mineralogical Interpretation:**

- Quartz dominance indicates a very siliceous material consistent with siliceous diatomite.
- Presence of clays (kaolinite, montmorillonite) indicates moderate hydrolytic alteration and good plasticity/adsorption.

- Calcite presence indicates light carbonate contamination.
- Feldspars (sanidine, albite) reflect minor detrital contributions, likely volcanic or ancient alluvial.
-

**Table 2: Implications for Use**

| Domain | Interpretation |
|---|---|
| Filtration/absorbent | Good siliceous base; high expected porosity (to be confirmed by BET); swelling clays enhance liquid retention. |
| Construction materials (bricks, coatings) | Natural silica + clay mixture provides good aptitude for lightweight insulating brick production. |
| Mineral filler / thermal insulation | High $SiO_2$ content → low density and reduced thermal conductivity. |
| Chemical purity | Calcite likely <10%; must be monitored for industrial uses (food-grade filtration). |

**Sample 2 from Dozanga district (Faya)**

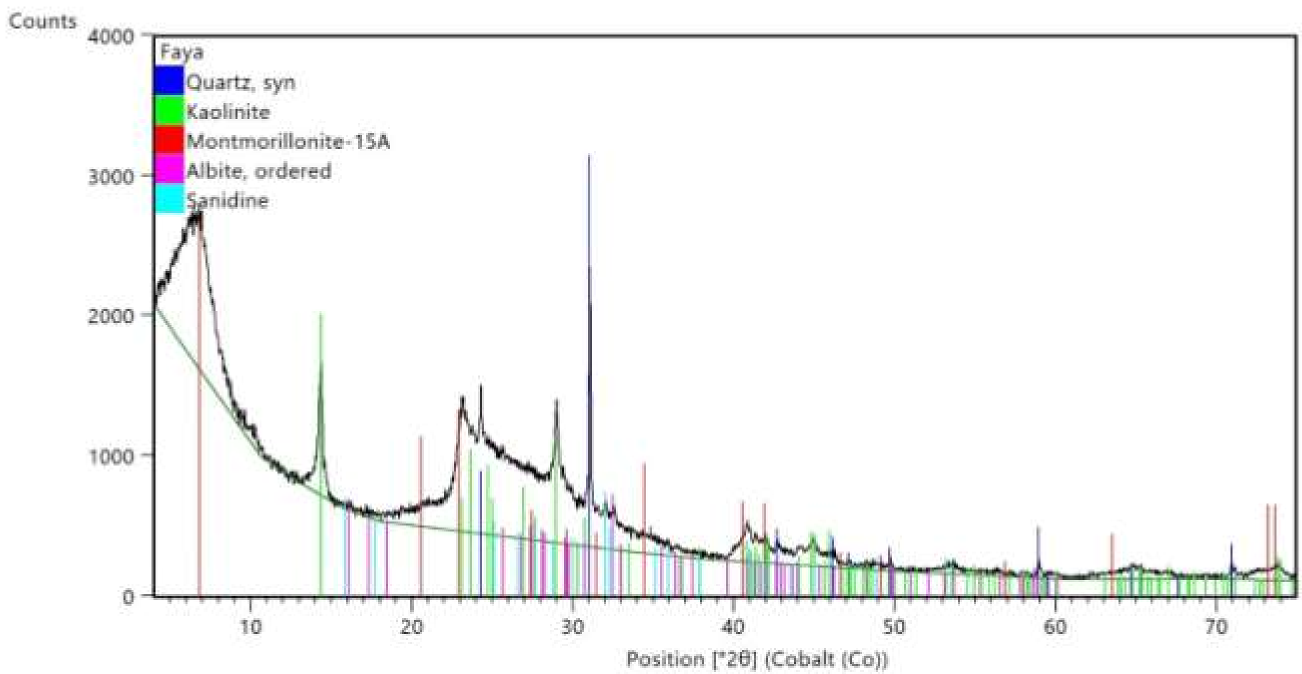


**Figure 4 : Diatomite soil sample from Dozanga district.**

**General Reading**

- X-axis: 2θ position (degrees) measured using a cobalt tube (Co).
- Y-axis: Peak intensity (counts per second) proportional to diffracted radiation.
- Black curve: experimental spectrum.
- Colored vertical bars: theoretical diffraction peaks of identified minerals.

**Table 3: Minerals Identified in Sample 2**

| Color | Mineral | Interpretation |
|---|---|---|
| Blue | Quartz (syn) | Dominant mineral – intense peaks at 26–31° 2θ |
| Green | Kaolinite | Alumino-silicate clay – peaks around 12° and 24° 2θ |
| Red | Montmorillonite-15A | Swelling clay – main peak at 6–8° 2θ |
| Magenta | Albite (ordered) | Sodium feldspar – moderate peaks at 22–28° 2θ |
| Cyan | Sanidine | Potassium feldspar – secondary peaks at 27–30° 2θ |

**Qualitative Interpretation**

- Strong quartz peaks confirm it as the major mineral.
- Clay peaks (kaolinite, montmorillonite) are visible but less intense, indicating moderate to low proportions.
- Feldspar peaks (albite, sanidine) are discreet, confirming minor quantities.
- Elevated background between 5° and 15° 2θ suggests an amorphous or poorly crystallized phase (often associated with clays).

**Table 4: Semi-Quantitative Estimation of Mineral Proportions**

| Mineral | Estimated Percentage (%) | Role |
|---|---|---|
| Quartz | **45 – 50 %** | Main mineral |
| Kaolinite | **20 – 25 %** | Major clay |
| Montmorillonite-15A | **10 – 15 %** | Secondary swelling clay |
| Albite (ordered) | **8 – 10 %** | Accessory sodium feldspar |
| Sanidine | **5 – 7 %** | Accessory potassium feldspar |

## Conclusion:-

X-ray diffraction analysis of the Faya-Largeaudiatomites enabled precise characterization of mineral phases in samples from Tchang-Sousse and Dozanga. The materials are largely dominated by quartz, confirming their high silica content typical of Saharan diatomitic formations. Clays (kaolinite and montmorillonite), present in variable proportions, provide the necessary plasticity for shaping, while feldspars and calcite appear only in minor amounts without significantly affecting material quality.

This mineralogical composition provides good firing suitability and makes the diatomites appropriate for producing lightweight, insulating construction materials adapted to Saharan climatic conditions. The local abundance of these resources represents a strategic advantage for reducing dependence on imported materials and promoting economical, durable, and climate-adapted building solutions for northern Chad.

The study reveals a real potential for developing a local diatomite-based materials industry in Faya. It opens the path to further work on physical properties (density, porosity, mechanical strength), thermal performance, and optimized formulations of clay–diatomite bricks. Such investigations would help establish a sustainable construction sector based on local geological resources.

## References:-

1. Charlie S. Bristow, Nick Drake, Simon Armitage, «Deflation in the dustiest place on Earth: The Bodélé Depression, Chad,» Geomorphology, pp. 50-58, 2009.
2. M. Servant, «Sequencescontinentals et variations climatiques:evolution du Bassin du Tchad au CenozoiqueSuperieur.,» Travaux et Documents de L'O.R.S.T.O.M. Paris, p. 515, 1983.
3. Servant, M. ; Servant, S., «Les formations lacustres et les diatomees du Quaternaire Recent du fond de la cuvette Tchadienne,» Revue de Géographie Physique et de Géologie Dynamique, vol. XII, n° 11, pp. 63-76, 1970.