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RESEARCH ARTICLE

PETROGRAPHIC, MINERALOGICAL AND GEOMECHANICAL CHARACTERIZATION OF SANDSTONES EXPLOITED IN QUARRIES IN KINSHASA

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ABSTRACT

The sandstone of Inkisi, serving as support for infrastructure and construction materials in the city province of Kinshasa, is of interest for geomechanical studies in particular and geological studies in general. Given its outcrop almost everywhere in Kinshasa and its high consumption in the field of buildings and public works, we have set ourselves the main goal of its macroscopic petrographic characterization and on thin sections using a polarizing microscope, mineralogical by X-ray diffraction and geomechanical by Simple and Los Angeles compression tests using quarry samples from the Kimwenza and Kinsuka sandstones. Petrographically, they are essentially arkosic sandstones. X-ray diffraction reveals the abundance of quartz in our sandstones. It also allowed the detection of minerals containing titanium in addition to feldspars. The simple compression test showed that these sandstones follow mode A from the point of view of rupture and that these sandstones belong to the class of medium strength from the point of view of the classification of resistance to simple compression. The Los Angeles test suggests that these sandstones have a coefficient in the good to average range. And therefore, on a geomechanical level, the sandstones studied in the two quarries of Kimwenza and Kinsuka are suitable for various construction works.

KEYWORDS

Geomaterials, petrography, mineralogy, geomechanics, X-ray diffraction

1. INTRODUCTION

The power of a nation is measured by its diversity as well as its immensity, particularly by its civil engineering works. Given the evolution of science and technology, man, in order to obtain a decent and good quality habitat, has adopted new methods of constructing infrastructures and superstructures. In Kinshasa, the capital of the Democratic Republic of Congo, various types of rocks are used as construction materials, depending on their local availability, characteristics and the specific needs of construction projects (Beeckmans, 2018; Mufungizi et al., 2023).

An igneous rock that is highly valued for its strength and durability is granite. It is frequently utilized for flooring and masonry construction in the Kinshasa region because of its pleasing looks and capacity to handle large weights. It is seldom imported or taken from certain quarries, and its presence in the area is restricted (Guilherme et al., 2017). Another type of rock used in building is sandstone. Its natural look and simplicity of the work are especially praised. Sandstone is frequently utilized in Kinshasa for retaining walls, paving stones, and ornamental stone applications. Typically, local quarries are used to extract it (Sharma et al., 2023). In Kinshasa, limestone a sedimentary rock is frequently utilized in building, especially in the manufacturing of cement and lime. It is a common building material for simple buildings like walls and foundations because of its accessibility and affordability. Building blocks are also made from limestone. Similar to basalt, volcanic rock is utilized for its robust mechanical qualities. Due of its resilience to wear, it is frequently employed in the construction of roads and other infrastructure. Typically found in modest amounts, basalt can be imported or extracted from certain quarries (Iştoan et al., 2020).
There are plenty of alluvial rocks, such pebbles and gravel, in the riverine regions surrounding Kinshasa. They are mostly utilized for drainage, backfilling, and as aggregates in concrete. Their low price and wide availability make them especially well-liked. Although less common due to its high cost, marble is sometimes used in high-end construction projects and for decorative applications. It is imported mainly because of its local rarity. The kind of rocks used in building in Kinshasa is determined by a number of criteria, including cost, availability in the area, and the particular qualities needed for each project. While more specialist materials like marble are still less prevalent but are employed in certain contexts, rocks like granite, sandstone, limestone, and alluvial materials are essential in the building industry. Because of their durability and hardness, high-quality materials are needed to complete these tasks. Only behavioral research has made this feasible. As the basis of the Kinshasa region and its near environs, the Inkisi sandstone deposit is now under debate and serves as a building material reserve.

The main objective of this research is to carry out a geological survey for a petrographic and geomechanical characterization of Inkisi sandstone in

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the Kinshasa quarries of Kimwenza and Kinsuka. The specific objectives pursued in this work are as follows: macroscopically describe the sandstone lithofacies present in the Inkisi sandstone formation exploited in these quarries, determine the petrographic and mineralogical composition of the different arkosic sandstone lithofacies present in the formation exploited by these careers; and determine the geo-mechanical characteristics of these rocks. This study, which is based on the formation of Inkisi sandstone, led us to the geological and mechanical characterization of the latter with a view to determining its petrographic nature, its mineralogical composition and its geomechanical behavior for its exploitation as well as its use in civil engineering

2. REGIONAL GEOLOGY

The Kinshasa city-province's geological structure evolved in a transitional zone between two geologically distinct regions: The Congo River experiences its first cataracts or rapids as sedimentary rocks of the Inkisi Group known as Kinsuka, start to appear to the west of Mount Ngaliema's drop and farther downstream of the pool, subhorizontal, slightly northeast red silico-clastic bed facies (Frimmel et al., 2006). From this point on, the river runs southwest through a canyon that is 500 meters wide and carved into the Inkisi red beds. The conjugate joints of the rocks are oriented north-east and north-west, and they are visible as notable subvertical outcrops. They are often unconformably covered by the weakly consolidated system, while the Upper Cretaceous sandstone, Kwango series, is occasionally cemented, forming a range of flat hills (≈500 m), with interstratified traces and large inactive valley (Linol et al., 2015; De Ploey et al., 1968). To the east, near the locality of Maluku and upstream of the pool, the exposed section consists (from bottom to top) of Cretaceous white sands (Kwango series), commonly consolidated and forming the northernmost part- East of the pool, the so-called Cliff of Dover (Readman, 2018). These sandstones are overlain by Cenozoic Kalahari sequences, including Paleogene sands, locally strongly silicified into orthoquartzite plates (Polymorphic Sandstones), covered by loose Neogene sands (Ochre Sands) (Mufungizi et al., 2023).

Inkisi formation is located to the east of the West-Congo chain. This formation, which constitutes a wine-colored sandstone sedimentary body, with a thickness of 600 to 700 m, was formerly interpreted as being a late Pan-African molasse (Miyouna et al., 2024). In reality, the discordant Inkisi deposits on the Mpioka formation appear to clearly postdate the Pan-African orogeny. They correspond to a fluvio -deltaic edifice set up in an expanding basin linked to the Karoo episode.

As for the age of the Inkisi basin, a study in 1997 states that it belongs to the Paleozoic (Kaseba, 1997). The age of the Inkisi basin is between the post-Cambrian and the pre-Permian (Figure 1) (Lateef et al., 2010)

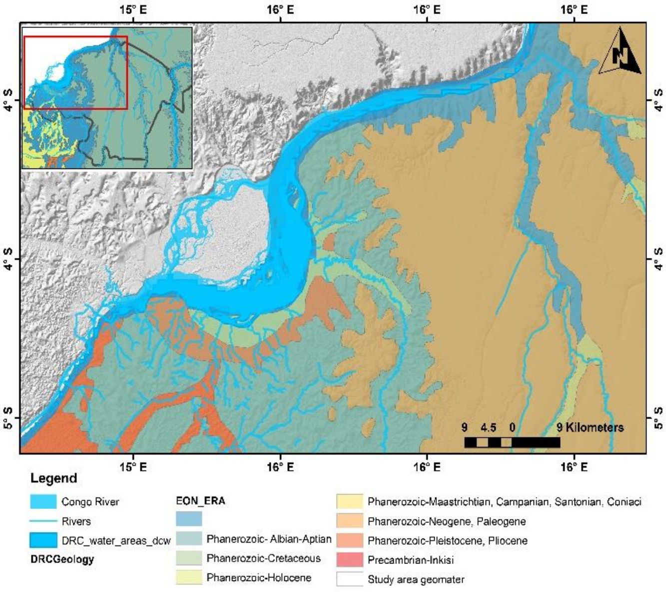

Figure 1: Geological map of the study area.

The stratigraphy of the Kinshasa region was developed more than 50 years ago (Cahen, 1978; Cahen, 1966; Lateef et al., 2010; Mfumu et al., 2017).

All deposits are continental river, fluviodeltaic, fluviolacustrine, lacustrine and aeolian genesis. The documented stratigraphy of Kinshasa extends from the Paleozoic to the Holocene with numerous unconformities of various magnitudes. The Lithostratigraphy of Kinshasa constitutes part of the stratigraphy of the large province of Kinshasa. Except for the marly sandstone unit that overlies the Inkisi silico-clastics, the continental deposit pile lacks independent dating. The spatial and temporal stratigraphy, relationship of Neogene units is generally unclear.

This basin was superimposed on a zone of weakness of the Congo craton corresponding to the Bas-Congo and Comba trenches belonging to the Upper Proterozoic. The Inkisi of the Brazzaville-Kinshasa region appears as a transition zone between a presumably lacustrine delta and the first accumulations of an alluvial plain (Nkodia et al., 2020; Alsdorf et al., 2016).

3. MATERIALS AND METHODS

3.1 Geological survey

During the field stage, we carried out a macroscopic description of the rocks while taking samples (Figure 2) for the laboratory. For this purpose, we used the following field tools: the geologist's compass, the geologist's hammer, a sledgehammer and chisels, a GPS, a double tape measure, a monocular magnifying glass, bags, markers and knives for sampling, a field notebook, a digital camera, pens and pencils and several other accessories. Figure 1 shows the sampling map.

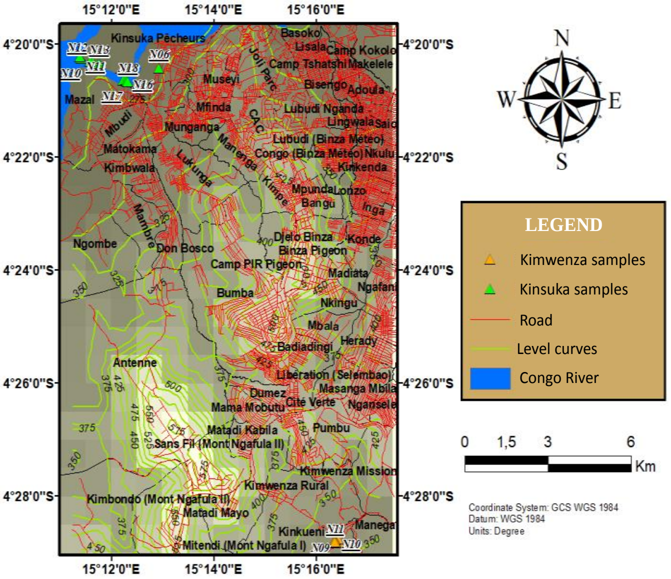

Figure 2: Map showing sampling

3.2 Laboratory analyzes and studies

3.2.1 Petrographic analysis

The facies selected for the petrographic analyzes are: the stratified massive sandstone facies (fine and coarse grained), the conglomeratic sandstone facies. After making thin sections in the petrographic laboratory of the geosciences department of the University of Kinshasa, polarizing microscopes were used to carry out the petrographic study. The samples concerned by these two observation methods are listed in Table 1 below, with their respective locations.

The samples brought back from the Kimwenza field bear identification numbers preceded by the letters BB. This numbering is not done by order of sampling but rather by difference in facies identified macroscopically in the field, such as the case of Kinsuka (KT). The facies selected for the petrographic analyzes are: the stratified massive sandstone facies (fine and coarse grained).

Table 1: Presentation of the samples concerned by the petrographic analyzes

Numbers	Location	Samples
1	Kinsuka	KT1
2	Kinsuka	KT2
3	Kinsuka	KT3
4	Kinsuka	KT4
5	Kimwenza	BB1
6	Kimwenza	BB2

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3.2.2 Mineralogical analysis by X-ray diffraction

The X-ray diffraction spectra of the samples taken were obtained using the XR 4.0 EXPERT UNI brand x-ray diffractometer (Figure 3) having Cu as an anode. The analysis of X-ray diffraction spectra makes it possible to identify the constituent minerals of the rock very precisely.

Figure 3: Presentation of the XR 4.0 EXPERT UNIT diffractometer.

The x-ray diffraction operation consists of applying radiation of the wavelength λ (0.01 < λ< 10nm) to a sample. The radiation penetrates the crystal, there is absorption of part of the energy and excitation of the atoms with radiation emissions in all directions. The radiation emitted by atomic planes which are in phases will generate a coherent beam which can be detected. However, for the radiations to be in phase, they must respect Bragg's law (Kacher et al., 2009).

Indeed, by calculating the directions in which we have the signal, we see that we obtain a very simple law: if we trace parallel imaginary planes passing through the atoms, and if we call d the distance between these planes (inter-reticular distance), then the interferences are constructive according to the relationship below:

$$2.d.sin(\Theta) \ = n.\lambda \qquad (1)$$

where: θ is half the deviation; n an integer called "diffraction order", generally small (1, 2, 3 for example); λ the wavelength of the X-rays; d the distance between two neighboring reticular planes. There can only be reflection of X-rays on a given family of reticular planes if the angle θ has a very particular value, calculated by Bragg's law. We use X-ray diffraction by the powder method (Gravereau et al., 2011)

The procedure was followed in 3 phases including the preparation of the samples : after obtaining the small fragments of the rocks by several hammer blows, we then proceeded with the following operations in order to obtain a fine and homogeneous powder of the rock for this diffraction analysis; grinding: after crushing, we crushed the small fragments of rocks resulting from crushing using a mortar and pestle; labeling: this operation consists of placing the powdered rock samples in plastic packaging (bottles) and adding a label corresponding to the rock number.

We varied $2\theta$from 20° to 90°. We used the "Panalytical Xpert Highscore plus (PXHP)" software to interpret the results obtained using PHywe's Measure software in the form of spectra. The PXHP software holds an "International Center of Diffraction Data" (ICDD) database, more precisely the PDF-2 database dealing with inorganic and natural minerals. The PXHP was used to carry out a qualitative and semi-quantitative study of minerals, the results of which are presented in table form.

3.2.3 Simple compression test

Using a core drill and a compressor, we were able to carry out this test. It consists of applying a compressive force to a cylindrical rock sample (Figure 4). This stress causes the specimen to be crushed. The purpose of this test is to determine the nominal resistance in simple compression of a rock. The sample should preferably have an elongation (height to diameter ratio) of 2 to 2.5.

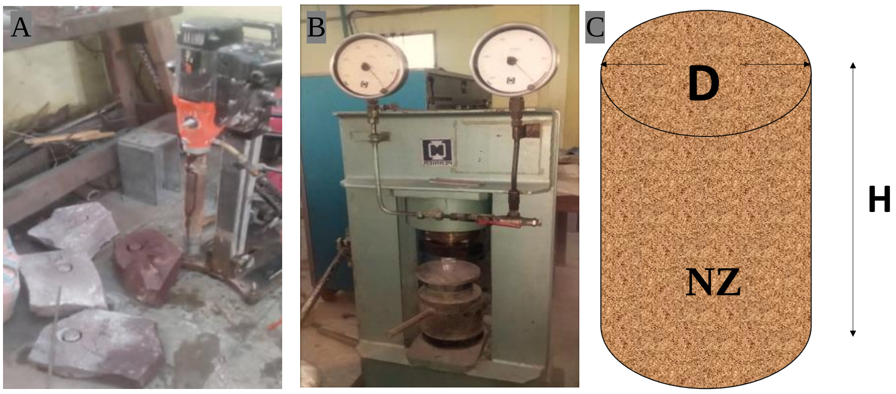

Figure 4: Equipment overview. A: Core drill and cores, B: Compressor and C: illustration of volume.

The test calculations are as follows:

$$\mathbf{V} = \pi \ \frac{D^2}{4} \ h \qquad (2)$$

Where: **π**: 3.14, **V**: volume in (Cm3), **D**: diameter in (cm), **h:** height in (cm)

Density = $\frac{P}{V}$Where P: weight in (g);

Elevation: 2 for the cylinder and 1 for the cube;

$$\delta_{\text{rupture}} = \frac{charge\ rupture}{surface\ comprimée} \ ; \qquad (3)$$

Or:

δ_{rupture} : Breaking stress in Kg/Cm^2;

Breaking load = in kg;

Comptot surface: total compressed surface Cm^2;

Total compressed surface Cm^2: r^2 **π**;

$$\delta_{\text{rupture}} \text{ in N/mm}^2 = \frac{\text{Contrainte de } rupture \text{ en (Kg/Cm}^2\text{)}}{10}$$

Or:

δ_{rupture} : Breaking stress in N/mm^2

1N/mm^2 = 1Mpa

3.2.4 Los Angeles trial

Resistance to shock and wear depends on the nature of the grains and that of the cement. It is measured in the laboratory by the Los Angeles test. The hardness of rocks is generally defined by the resistance that their polished surfaces present to wear. This property is determined by different units. The material evolves during the test, on the one hand as a result of the impact of the balls on the aggregate (brittle rupture of the elements), on the other hand by friction of the elements against each other, on the cylinder of the machine and on the balls.

The standards NF EN 1097-2, AASHTO T 96, ASTM C 131 define the Los Angeles coefficient as the percentage of the initial sample passing through a 1.6 mm sieve. after fragmentation in a cylinder in the presence of steel balls (Figure 5). Indeed, the fracturability of a rock is the way in which it behaves against fragmentation and wear. The Los Angeles test makes it possible to measure the combined resistance between impact fragmentation and wear by mutual friction of the elements of an aggregate.

The Los Angeles (LA) trial is defined as:

$$LA = 100\frac{(\mathrm{M0} - \mathrm{M1})}{\mathrm{M0}} = 100\frac{\mathrm{m}}{\mathrm{M0}} \quad (4)$$

With: LA: Los Angeles coefficient, M0: starting mass before the test, M1: mass after the test, and m: the difference between the mass before the test (starting) and after the test.

Figure 5: Conduct of the test. A: Sieve; B: Libra; C: Los Angeles camera.

A classification of rocks based on the Los Angeles test is proposed by the Polytechnique faculty of Mons to assess the results (**Table 2**)

Table 2: Classification of rocks based on the Los Angeles coefficient

Coefficient of Los Angeles LA	Appreciation
<15	Very good
13 to 25	Good to average
25 to 40	Medium to low
>40	Poor

4. RESULTS

4.1 Petrographic study

4.1.1 Kinsuka craft quarry

The lithostratigraphy is presented from bottom to top as follows: medium-grained sandstone approximately 17m thick intercalated with a thin layer of more or less 10cm of clay. Subsequently a massive bench of fine-grained sandstone with a thickness of around 10m of very fine-grained sandstone at the top of which is soft sandstone with pebbles with an average thickness of 4m.

Sample KT1: Sandstone with a purplish to pinkish color, fine-grained and rich in phylliths (Figure 6A). This rock is mineralogically composed of abundant quartz, feldspars with some micas and other accessory minerals. Under a polarizing microscope, the rock presents (Figure 6A, B) a joined texture highlighted by fine to medium grains of white or gray (LPA) and colorless (LPNA) quartz. These subrounded, subangular, angular and elongated grains have borders that are sometimes smooth, sometimes indented. The rock also presents granules and small elongated clusters of opaque minerals. According to the classification of Dott (2003), It is a quartz arenite.

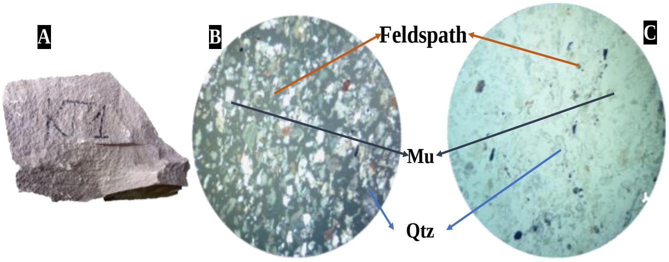

Figure 6: Macroscopic view of KT1 (A), Microscopic view of KT1. B: LPA and C: LPNA

Sample KT2: We have a purplish to pinkish sandstone. It has a medium to coarse grain size, mineralogically composed of abundant quartz and feldspars with also large, more or less rounded quartz pebbles. We can deduce that it is a conglomeratic sandstone (Figure 7A).

Under the microscope, the rock (**Figure 7A, B**) has a joined texture highlighted by fine, medium and coarse grains of white or gray (LPA) and colorless (LPNA) quartz. Fine grains are interspersed with medium grains. Coarse grains are weakly cracked and generally have a sub-rounded shape. Fine grains are rounded and medium grains are subrounded and subangular. Locally, the rock presents rare and small cavities. According to Dott 's classification in 2003, it is a quartz arenite.

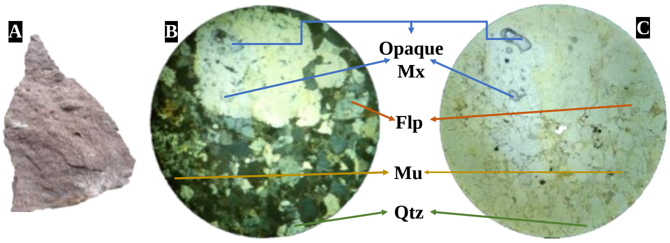

Figure 7: Macroscopic view of KT2 (A). Microscopic view of KT2. B: LPA and C: LPNA

Sample KT3: Brownish to purplish in color with coarse to medium grains (Figure 8A). The rock is essentially composed of quartz, feldspars and fine particles of mica.

Under the microscope, the rock presents a jointed texture (Figure 8B, C). It is highlighted by medium to coarse grains of white or gray (LPA) and colorless (LPNA) quartz between which flakes of brown (LPA) and colorless (LPNA) biotite are interspersed. The coarse grains of quartz are elongated; medium grains are subangular, angular and elongated. According to the classification of Dott (2003), it is a quartz arenite.

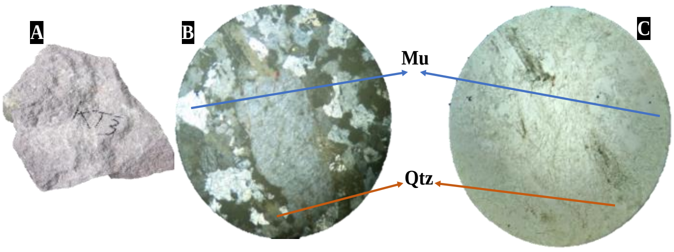

Figure 8: Macroscopic view of KT3 (A). Microscopic view of KT3. B: LPA and C: LPNA

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Sample KT4: Arkosic sandstone with purplish to pinkish coloring, fine to medium grained and composed of abundant quartz, feldspar with some micas and other accessory minerals (Figure 9A).

Under the microscope, the rock presents (Figure 9B, C) a joined texture highlighted by white or gray (LPA) and colorless (LPNA) quartz grains. These fine to medium grains are subangular and elongated. They have generally indented borders. According to the classification in a study, it is a quartz arenite (Dott, 2003).

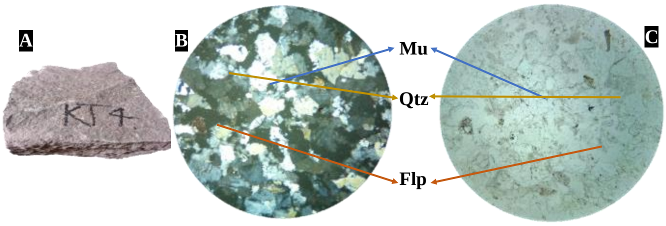

Figure 9: Macroscopic view of KT4 (A). Microscopic view of KT4. B: LPA and C: LPNA

4.1.2 Kimwenza Sandstone quarry

The lithostratigraphy of the said quarry presents itself with a bench of medium-grained feldspar sandstone having a thickness of approximately 4m located below the level of fine-grained sandstone with an average thickness of 8m. At the top of this quarry there is a bench of approximately 1.7m of massive, very fine-grained sandstone. Note an intercalation of a surrounding 1.5m bench of micaceous sandstone between the fine-grained and very fine-grained sandstone.

Sample BB1: The rock is massive, made up of fine, mauve-colored grains (Figure 10A). Under the microscope, the rock presents a non-jointed texture (Figure 10B, C). It is highlighted by a dark gray (LPA) and light gray (LPNA) clay matrix encompassing white or gray (LPA) and colorless (LPNA) quartz grains. These grains are fine and medium; the majority of fine grains are rounded; the middle grains are subrounded, subangular and elongated; some have a smooth border; others have an indented border. According to the classification of Dott (2003), it is a greywacke.

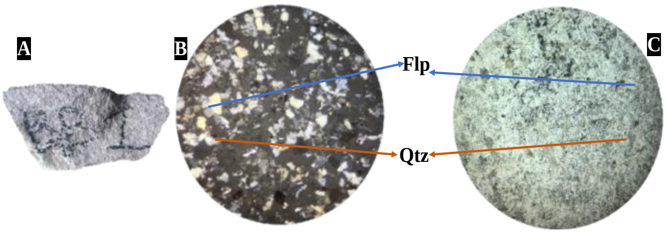

Figure 10: Macroscopic view of sample BB1 (A). Microscopic view of sample BB1. B: LPA and C: LPNA

Sample BB2: The rock is massive, made up of fine, mauve-colored grains (Figure 11A). Under the microscope, the rock presents (Figure 1AB, C) a non-jointed texture highlighted by the dark gray (LPA) and light gray (LPNA) clay matrix impregnating white or gray (LPA) and colorless quartz grains (LPNA). These grains are fine and medium; They are rounded, subrounded, subangular, and elongated and generally have a smooth border. According to the classification of Dott (2003), it is a greywacke.

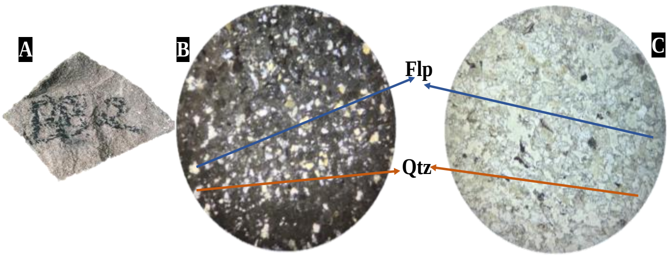

Figure 11: Macroscopic view of sample BB2 (A). Microscopic view of sample BB2. B: LPA and C: LPNA

4.2 Mineralogical study by X Diffraction

Below are the characteristic spectra of samples BB (Figure 12) and KT (Figure 13). Tables 3 and 4 show the results of the aforementioned samples by the PXHP software.

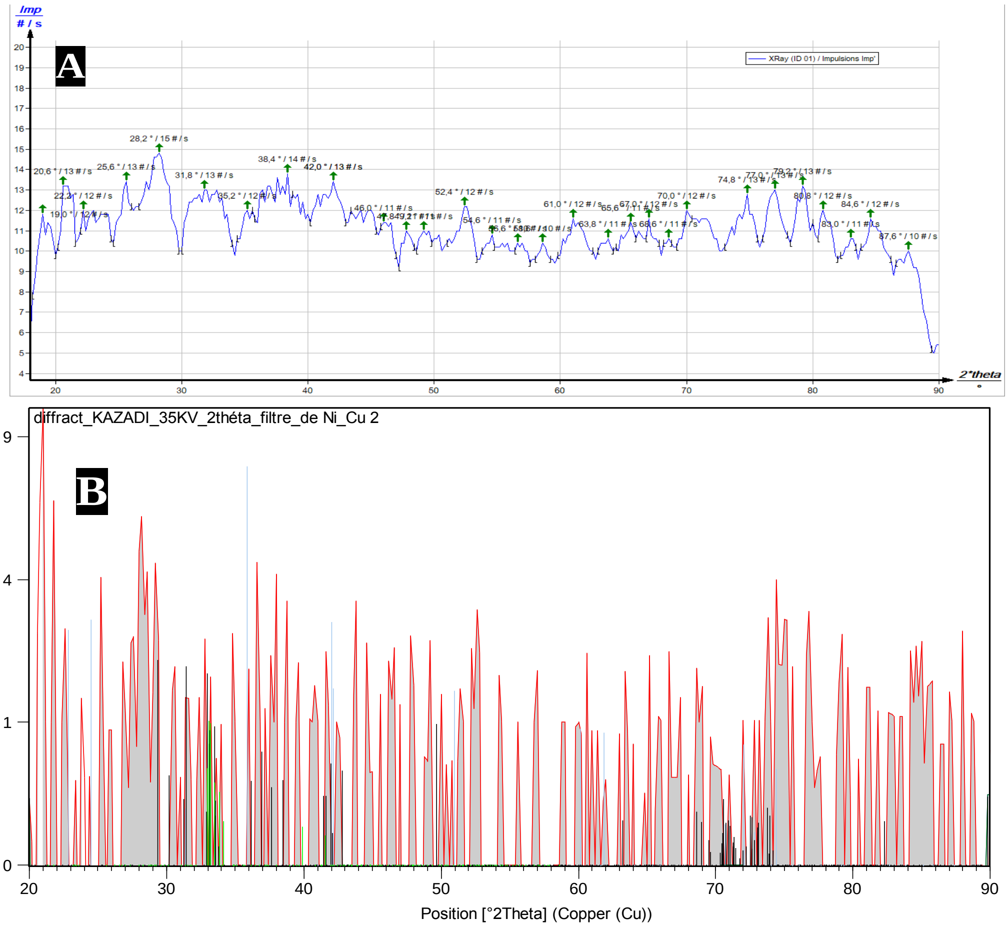

Figure 12: Spectra of sample BB. **A:** Spectrum from PHYWE's Measure software**; B:** Spectrum from Panalytical Xpert Highscore.

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Table 3: Minerals present in sample BB

Ref. Code	Score	Compound Noun	Scale Factor	Chemical Formula
01-076-2047	8	Manganese Sulfide	0,293	$Mn\ S_2$
01-074-1088	10	Aluminum Calcium Silicate	0,094	$Al_2\ Ca_3\ (Si\ O_4)_3$
01-070-1863	7	Calcium Iron Oxide Hydroxide Silicate	0,280	$Ca\ Fe_2\ FeO\ HO\ Si_2\ O_7$
01-087-0044	9	Potassium Aluminum Silicate Hydrate	0,135	$K\ (Al\ Si_3\ O_8)\ (H_2\ O)$
01-086-2352	10	Titanium Oxide	0,081	TiO
00-025-1157	19	Magnesium Titanium Oxide	0,069	$Mg_2\ TiO_4$
01-082-1403	20	Silicon Oxide	0,146	SiO_2
01-075-1573	12	Iron Manganese Oxide	0,176	$Fe\ MnO_3$

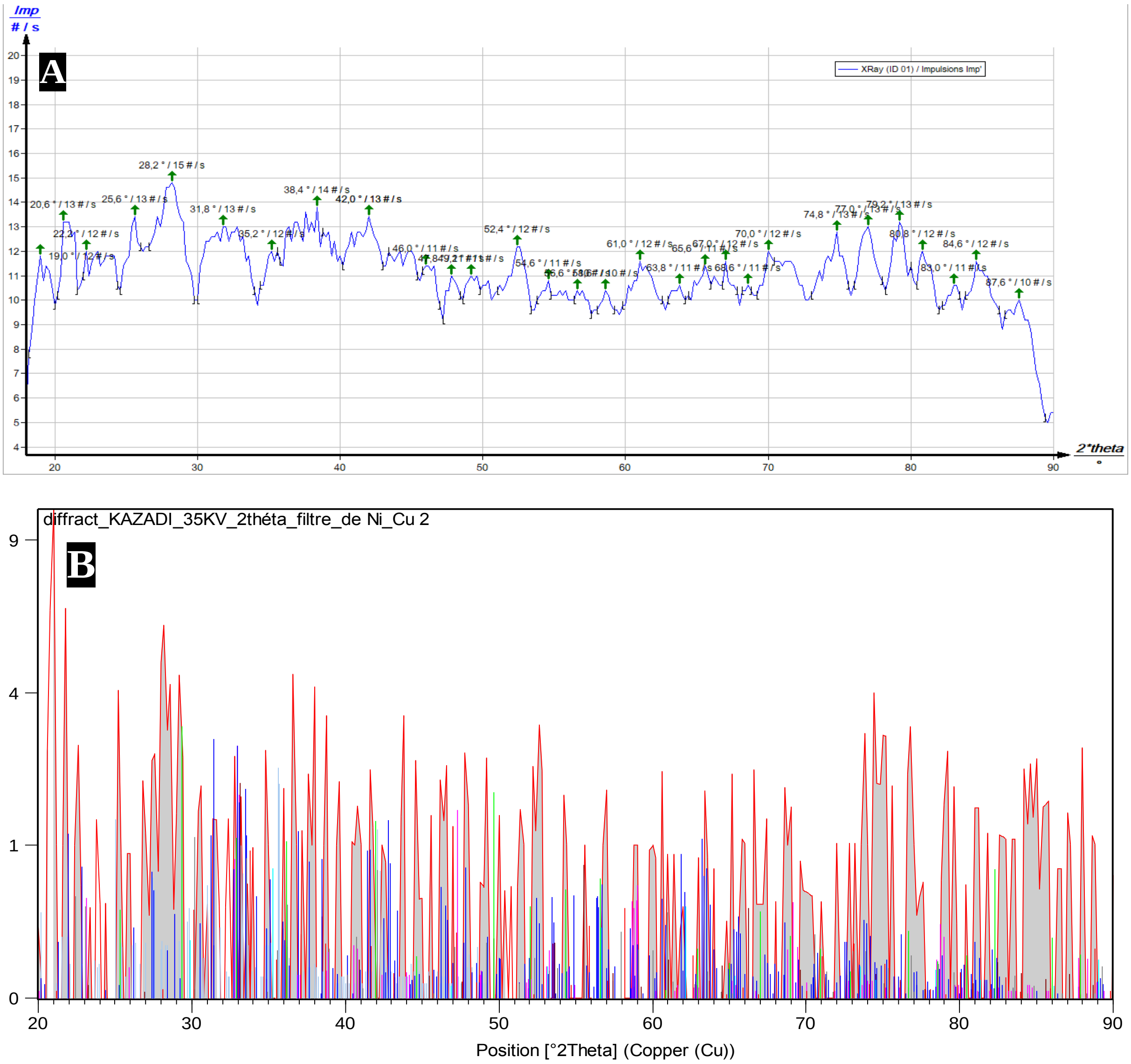

Figure 13: Spectra of the KT sample. A: Spectrum from PHYWE's Measure software; B: Spectrum from Panalytical Xpert Highscore.

Table 4: Minerals present in the KT sample

Ref. Code	Score	Compound Name	Scale Factor	Chemical Formula
01-082-1403	18	Silicon Oxide	0,114	SiO_2
01-086-2352	7	Titanium Oxide	0,069	TiO
01-075-1573	10	Iron Manganese Oxide	0,194	$Fe\ MnO_3$
00-025-1157	10	Magnesium Titanium Oxide	0,071	$Mg_2\ TiO_4$
01-082-0229	8	Calcium Titanium Oxide	0,267	$Ca\ TiO_3$
01-074-1088	9	Aluminum Calcium Silicate	0,092	$Al_2\ Ca_3(SiO_4)_3$
01-070-1863	6	Calcium Iron Oxide Hydroxide Silicate	0,283	$CaFe_2\ FeOH\ O\ Si_2O_7$
01-076-2047	6	Manganese Sulfide	0,310	MnS_2
01-087-0044	8	Potassium Aluminum Silicate Hydrate	0,109	$K(AlSi_3O_8)(H_2O)$

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We are dealing with rocks rich in silica, mainly quartz (70%) but containing plagioclase, orthoclase, and other minerals for the Kinsuka sample while for that of Kimwenza the quartz is at 68%. The 2 samples are rocks rich in silica. The rocks contain 70% quartz for that of Kinsuka and 68% for that of Kimwenza, followed by feldspars, metallic minerals and oxides.

4.3 Geomechanical study

4.3.1 Simple compression test

The paired results of the samples from our two quarries studied are presented below in **Table 5**.

Table 5: Simple compression crush test results

Test	**Cylindrical**						
Origin Of the Sample	Kinsuka				Kimwenza		
Sample Number	NZ01	NZ02	NZ03	NZ04	BB01	BB02	BB03
Nature Of the Rock	Arkose	Arkose	Cgt sandstone	Arkose	Arkose	Arkose	Arkose
Diameter In Cm	4.3	4.3	4.3	4.3	4.3	4.3	4.3
Height Cm	8.6	8.6	8.6	8.6	8.6	8.6	8.6
Volume Cm3	124.82599	124.82599	124.82599	124.82599	124.82599	124.82599	124.82599
Weight G	336	307	330	295	312	305	326
Compressed Surface Cm^2	14.51465	14.51465	14.51465	14.51465	14.51465	14.51465	14.51465
Density	2.6	2.4	2.6	2.3	2.4	2.4	2.6
Breaking Load Kg	70	69	71	68	67	70	65
Breaking Load Kg	7138.01	7036.04	7239.98	6934.07	6832.1	7138.01	6628.15
Breaking Stress (Kg/Cm^2)	491.77	484.75	498.80	477.72	470.70	491.77	456.65
RUPTURE STRESS (N/Mm^2)	48,227	47,538	48,916	46,849	47.07	49.177	45,665

By analyzing the failure mode presented by our specimens (Figure 14), we notice that all present the A or Diabolo mode.

Figure 14: Specimen NZ01, NZ02, BB01 and BB02 after testing.

A or Diabolo failure: this failure mode is characteristic of sandstone rock materials with a reticulated or quartz texture, and crystalline rock materials. Fracture surfaces are clean, shiny, ridged shear surfaces.

Rupture B or separation: this mode of failure results from tensile stress. It affects shale materials with a paste texture. The rupture propagates through the matrix, under the action of traction parallel to the direction of compression. We advise readers to consult the entire study on the site given above for other types of rupture.

The compressive strengths of the formations of our two quarries (Kinsuka 47.8825, Kimwenza 47.304) are included in the interval 20 < Rc < 60 of the resistance of a rock. The compressive strength of our samples is average and are therefore declared favorable to the extent that the construction of the work would be adapted to these formations as supports or even construction materials. These rocks can therefore serve as support for the structure because they can provide adequate resistance to rupture stresses.

According to the mode of rupture, our analyzed samples still retain their original composition, that of a fresh metarhyolite where the alteration phenomenon has not yet disrupted their geomechanical behavior.

4.3.2 Try Los Angeles

Using a table, we have represented the results of the analysis carried out on our different samples (Table 6).

Table 6: Los Angeles trial results

Samples	**NZ01**	**NZ02**	**NZ03**	**NZ04**	**BB01**	**BB02**	**BB03**
Origin of the Sample	Kinsuka				Kimwenza		
Nature of the Rock	Arkose		Arkose	Cgt sandstone	Arkose	Arkose	Arkose
Granular Classes	10-25	10-25	16-31.5	10-25	10-25	10-25	16-31.5
Weight before test (G)	5000	5000	5000	5000	5000	5000	5000
Number of Towers	500	500	500	500	500	500	500
Number of Balls	11	11	12	11	11	11	12
Weight of Balls (G)	0.433×11	0.433×11	0.433×12	0.433×11	0.433×11	0.433×11	0.433×12
Refusal to Sieve 1.6 0mm (G)	3673	3880	3920	3930	3780	3920	3915
Los Angeles Coefficient (La) In %	27	22.4	21.6	21.4	24.4	21.6	21.7

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The Los Angeles coefficient value of our samples (Kinsuka 23.1, Kimwenza 22.5) is within the admissible range (good to average), which indicates that these materials are usable in construction. So as most of our land is covered with arkosic sandstone, we believe we have an adequate reserve of construction materials capable of meeting the needs during the construction of the work. The analyzes carried out on the samples from our two quarries show a similarity of results in the different tests carried out. The mechanical behavior of the samples subjected to geotechnical tests attests that the two quarries are able to provide good materials that can be used in various types of construction.

5. DISCUSSIONS

Petrographic analyzes carried out on sandstone samples from our two sites show a clayey matrix. Many of the samples submitted for analysis at the microscopic scale indicate that the quartz minerals are cracked, which explains the fragility of the rock. This is also observed on the Kakobola sandstone in the town of Kwilu by (Tshiwisa et al., 2023). Minerals such as micas, calcite were not observed. Only the quartz mineral was present in different thin sections examined.

Microscopic observations highlight the presence of cracked quartz grains in a whitish matrix (Kinsuka) and for the Kimwenza samples, we note the presence of fine and medium quartz grains presenting a smooth border in a gray matrix. dark and light gray. The matrix present in these rocks (from our two sites) is clayey in nature. The name of the rock in the Kinsuka site is a quartz arenite according to the classification of Dott, while the name of the rock in the Kimwenza site is a greywacke also according to the classification of (Dott, 2003).

The petrographic descriptions (macroscopic and microscopic) show that in all these quarries, the lithostratigraphy is the same. As highlighted above, this sandstone contains the same minerals. It is called feldspar sandstone or Inkisi sandstone, it presents different facies (sandstone with conglomeratic lithofacies, medium-grained sandstone, fine-grained sandstone, very fine-grained sandstone, etc.).

Macroscopic and microscopic analyzes show no difference from a petrographic point of view. X-ray diffraction shows the abundance of quartz, feldspars and the presence of minerals from the titanium family and manganese sulfides. Geomechanics, through the tests carried out on the crushed samples, we can affirm that the compressive strength of our samples is average and therefore are declared favorable to the extent that the construction of the work would be adapted to these formations as supports or even construction materials, corroborating our research hypothesis. These rocks can therefore serve as support for the structure because they can provide adequate resistance to rupture stresses.

The Los Angeles coefficient value of our samples is within the admissible range (good to average). Therefore, as the majority of our sites are covered with arkosic sandstone, we believe we have an adequate reserve of construction materials capable of meeting the needs during the construction of civil engineering works, also consistent with our research hypothesis. We can confirm through the tests carried out that this sandstone meets the standard geomechanical standards of use. 25% of aggregates do not meet standards. Since geotechnics is based on standards, it is assumed that 25% of recurring damage would come from these materials used in construction either in the construction or rehabilitation of infrastructure in the extent of the City Province of Kinshasa.

6. CONCLUSION

At the end of our study, we can conclude the following:

- From a petrographic point of view, the rock is rich in quartz but cracked with a clayey matrix. Dott 's classification reveals quartz arenites for the Kinsuka site and graywacke for the Kimwenza site;
- X-ray diffraction shows that the samples taken from Kinsuka contain more than 70% quartz and 68% for those from Kimwenza . They also contain feldspars, metallic minerals and oxides;
- geomechanical tests, in particular the simple compression test and the Los Angeles test, show good resistance of these rocks to compression and a Los Angeles coefficient located in the good to average range.

The city province of Kinshasa, through quarries exploiting the Inkisi sandstone formation, can provide good quality materials for the construction of durable civil engineering works with good resistance to geomechanical tests.

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