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Geotechnical interattraction of granites from Ouaddai region (East-Chad) for use in civil engineering

Al-hadj Hamid ZAGALO[1,2], Maurice KWEKAM[2] and Bozabe Renonet Karka[3*]
[1]Université des Sciences et de Technologie d'Ati, Faculté des Sciences de la vie, de la Terre et de l'Aménagement du Territoire - Ati, Chad
[2]Université de Dschang, Faculté des Sciences – Dschang, Cameroun
[3]Ecole Nationale Supérieure des Travaux Publics - N'djamena, Chad
bozabe_k@live.fr

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Abstract

Achklun and Amgala are located in the North and South of Abéché, region of Ouaddaï (Eastern Chad). In Achklun and Amgala crop out, granites which are cross cut by diaclases and veins. Petrographic investigation of rocks shows that granites are of two types: (1) fine grains biotite granites constituted of quartz, orthoclase, plagioclase biotite andopaque minerals and (2) coarse grains amphibole biotite-granites made up of quartz, orthoclase, plagioclase biotite amphibole and opaque minerals. Structural feature investigated are diaclases and veins. Diaclases are observed in biotite granite and amplibole biotite-granite. They display NE-SW trend direction. Veins are observed in amplibole biotite-granite. They have granitic composition and pegmatitic texture. Veins display NE-SW dominant trend direction. The NE-SW trend direction suggests that their emplacement benefited from diaclase network. Geotechnical studies indicate that fine grains biotite granite is more resistant than amphibole biotite-granite. The resistant may vary from one station to another in the same rock type. This variation is due to mineral composition grain sizes and the intensity of fractures (diaclases). Base on field observations laboratory investigation the present work permitted to select the granite more adapted for various building.

Keywords: Granite, petrographic study, building, geotechnics parameters, ouaddaï, Chad.

Introduction

Man has always used natural materials for the construction of his habitat and the development of his environment. From these two basic necessities arise, today, three main sectors of activities which are: Quarries industries, building materials and public works buildings[1].

Modern society has more and more construction-related activities. This perpetual evolution means that roads, highways, bridges, railways, houses, dams, etc. are built every day[2]. Granitic formations occupy most of the earth's crust. Their knowledge and enhancement had become increasingly important to researchers. By the importance of their use around the world, the aggregates constitute after air and water, the third substance consumed by man[3].

In Chad, geotechnical work has been much more focused on soft and soft materials as well as foundation engineering[4]. Very little work has been done on the geotechnical characteristics of rocks. The present study was initiated to contribute to the identification and the geotechnical characterization of granites in Ouaddaï's region (Figure-1).

It uses the results of thin sections made at the Institute of Geological and Mining Research (IRGM) of Yaoundé and the results of geotechnical tests carried out on 8 samples in the building and public works laboratory in Chad.

Methodology

Location of interesting sites and sampling: Fieldwork requires a rigorous method because the results of laboratory tests depend on it. The method adopted is the location of interesting sites of investigation and their sampling.

In order to evaluate the quality of the aggregates in the studied area for use in civil engineering, selected sites were those with an apparent diversity in terms of color and size of the minerals.

A total of eight (8) samples were collected, eight (8) for geotechnical testing (Los-Angeles Trial, Micro-Deval and Dynamic Fragmentation) and six (6) for thin sections.

Experimentation: Geotechnical study was carried out on 8 rock samples flush on the surface. Prior to the geotechnical experiments, the samples were crushed and then sieved to obtain 10/14 mm fraction to determine the mechanical characteristics. The Los-Angeles trial was performed according to the prescriptions of standard NF P 18-573[5]. Micro - Deval test was determined according to standard NF P 18-572 and that of the dynamic fragmentation was carried out according to standard NF P 18-574[6,7].

The specific density is determined according to NF P 18-554 and NF P 18-555 by the liquid pycnometer method[8].

Results and discussion

Petrographic study: Granites petrographic study in the interesting area was carried out on six (6) samples. The granites of two studied sites are exposed in blocks and slabs on the flanks and at the top of hills (Figure-2a). It arises from this description two types of granite: fine-medium-grained granite and medium-grained and coarse-grained granite.

From a microscopic point of view, we have biotite granite and biotite and amphibole granite. The percentage estimation was made using the abacus of the relative proportions of minerals in a rock by Michel Levy[9]. The results obtained are shown in Tables-1 and 2.

Mineralogical composition and grain size of the studied area play an important role in rock's resistance. The more the rocks are homogeneous (almost the same minerals and sizes), the more resistant they are and vice versa. Petrography directs a geotechnician to make a good choice on a resistant material. According to recent work quartz is capable of accumulating large amounts of energy of elastic deformation, giving them greater resistance compared to other laminated minerals (mica and clay)[10,11].

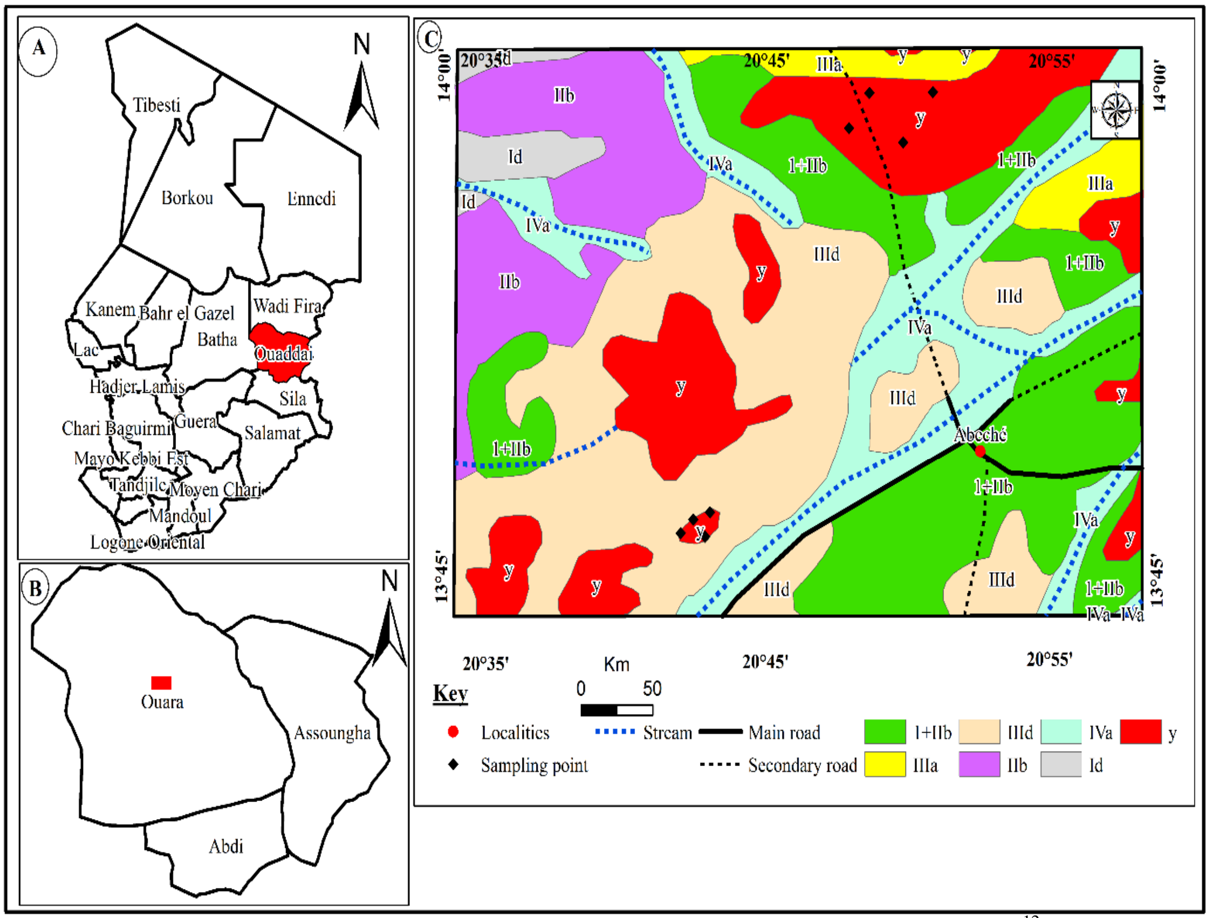

Figure-1: Map of location and sampling (Sketch extracted from the geological map)[12].

Table-1: Summary of percentages of minerals in the first sector.

Designation		Quartz	Orthose	Plagioclase	Biotite	Blackout
Amgala's Granite	Sample 1	40%	25%	25%	5%	-
	Sample 2	35%	22%	23%	5%	5%
	Sample 3	40%	32%	18%	-	5%
	Averrage	38,33%	25%	20%	3,33%	3,33%

Table-2: Summary of percentages of minerals in the second sector.

Designation		Quartz	Orthose	Plagioclase	Biotite	Blackout
Achklun's Granite	Sample 1	35%	25%	15%	15%	5%
	Sample 2	40%	20%	20%	10%	5%
	Sample 3	35%	20%	15%	20%	5%
	Averrage	36,66%	21,66%	16,66%	15%	5%

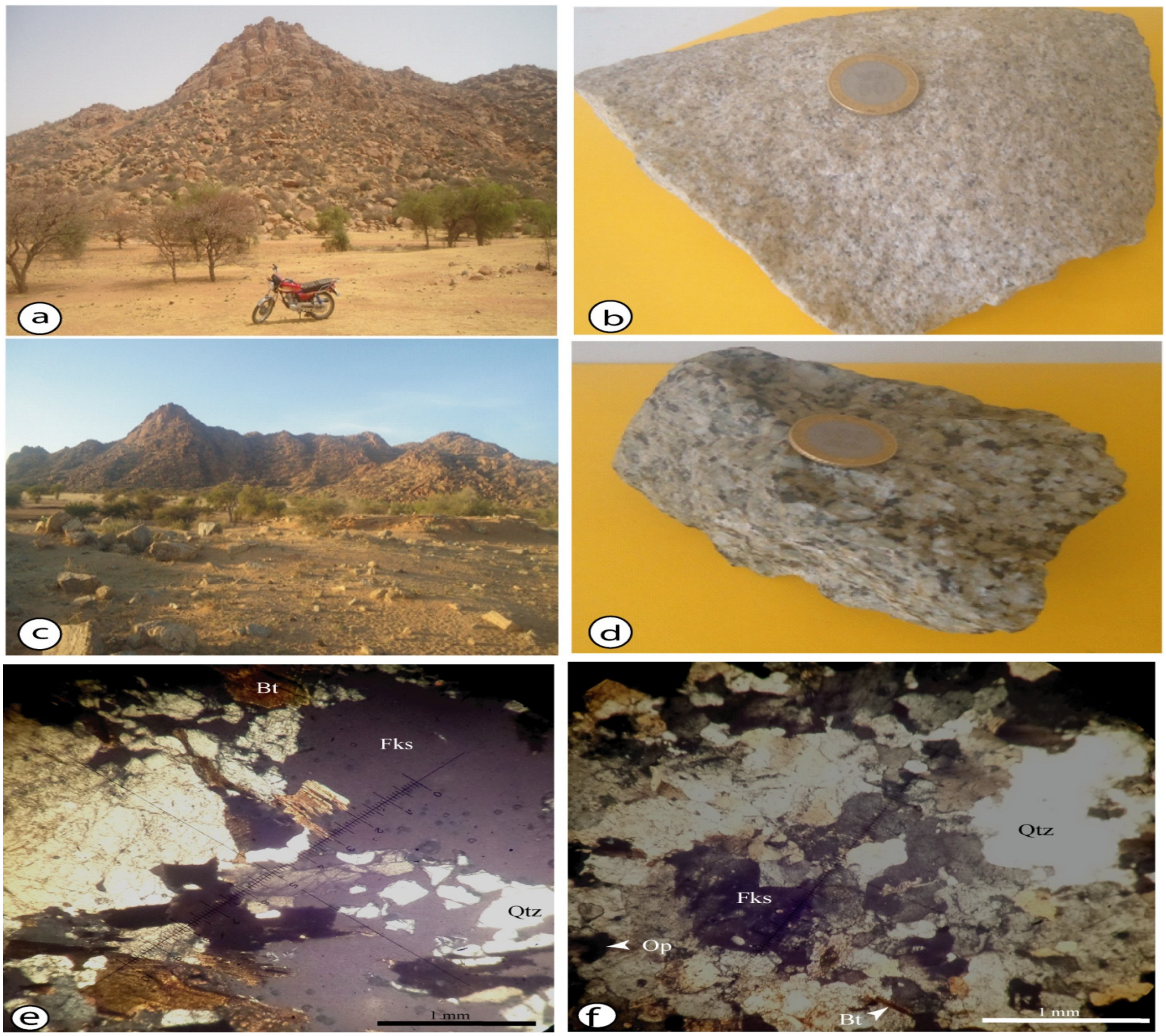

Figure-2: Photography and microphotography of granites in the studied area.
a) Bulk outcropping and granite slabs on the flanks and at the top of the hills at Achklun. (b) Fine-grained biotite granite flush at Achklun (Abéché-Biltine axis). (c) Bulk outcropping and granite slabs on the flanks and at the top of the hills at Am-Gala. (d) Medium-grained granite flush at Am-Gala (e) microscopy of biotite and amphibole granite. (f) Microphotography of biotite granite.

Structural study: Structural elements observed in the geological formations in the studied area are represented by veins and fractures.

Diaclases are observed in biotite and amphibole granite (Figure-3a) and in biotite granite (Figure-3b) while veins are observed only in biotite granite (Figure-3c). Break plane measurements show several directions in both biotite and amphibole granite and in biotite granite. In biotite and amphibole granite (Figure-3d) there is a main direction NE-SW and a secondary direction N-S. In biotite granite only one major direction oriented NE-SW is observed (Figure-3e).

This structural study shows that granites in the studied area are intensely fractured, affecting the geotechnical qualities of these materials.

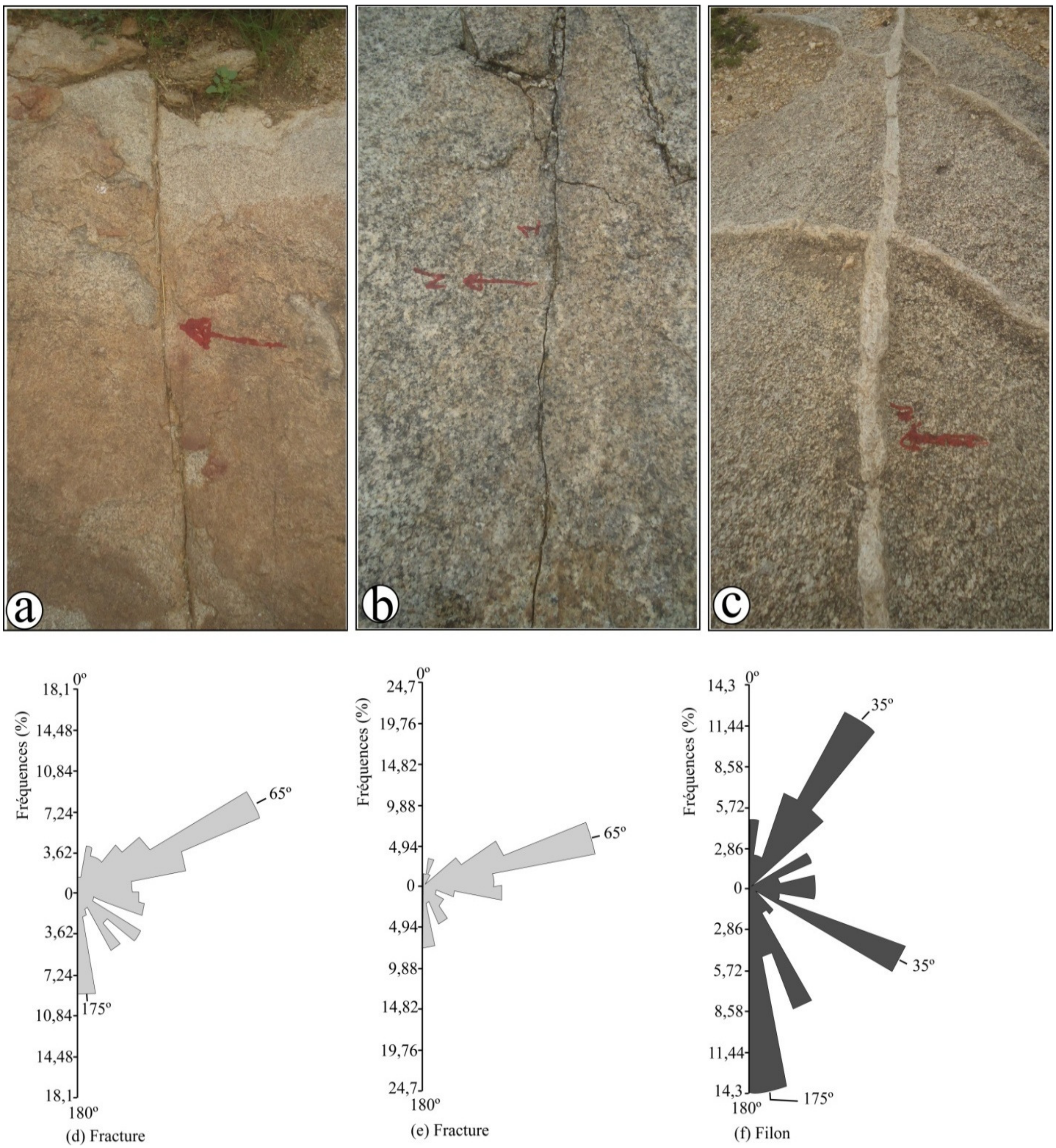

Figure-3: Photography of diaclases.

a, b, c Photography of diaclases in (a) biotite and amphibole granite and (b) biotite granite and vein photography in biotite granite. d, e, f Rosace of diaclases in (d) biotite and amphibole granite and (e) biotite granite and (f) rosace of veins in biotite granite.

Gotechnical study: Mechanical parameters : The granites studied (biotite granite on the one hand and biotite and amphibole granite) have respectively a los-Angeles coefficient of 31% and 41%, a microdevalence coefficient of 7% and 23.5% and a dynamic fragmentation coefficient varying between 19% and 27%. These results are not consistent with the work of Baron and Sauterey[13]. Showing that the granites have a Los Angeles coefficient between 15-20% and a Microdeval coefficient between 10-15%. This discrepancy would be due to their mineralogical nature and the degree of alteration.

Geotechnical tests have made it possible to highlight the granites that enter the constructions of the structures. According to the results of the physico-mechanical tests obtained, the fine-grained biotite granites have a remarkable resistance to biotite and amphibole granite. However, the wear resistance varies slightly depending on the variation of the grain size (texture) and cohesion between the grains.A rock made of quartz or fine-grained minerals has good resistance to that of coarse-grained or medium-grained ferromagnesium minerals. This resistance is linked to their mineralogical composition and degree of weathering.

Resistance of all rocks depends on the water content in the rock, the texture and the mineralogical composition[14].

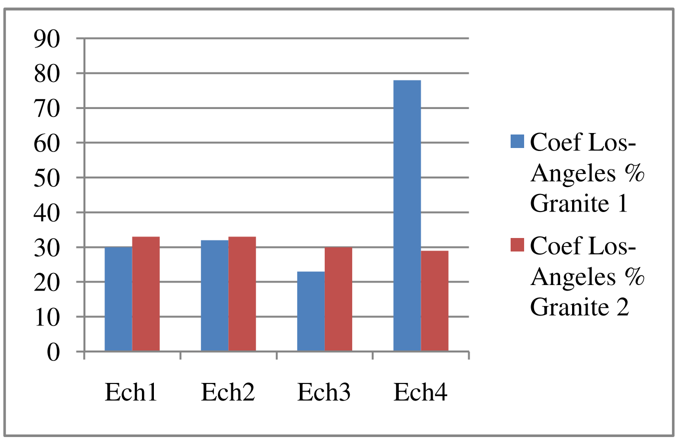

Figure-4: Histogram of Los Angeles Coefficient**.**

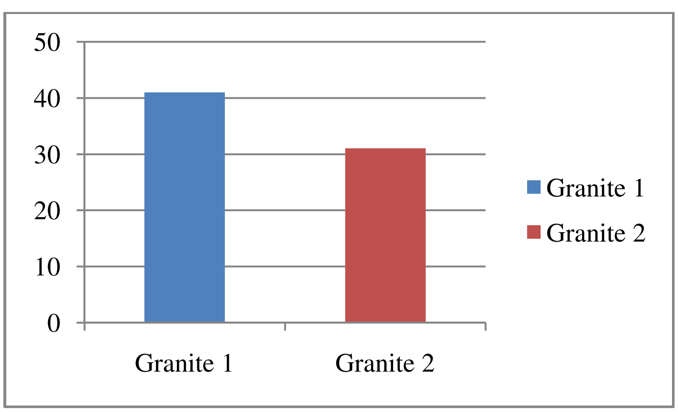

Figure-5: Histogram of Los Angeles average in %.

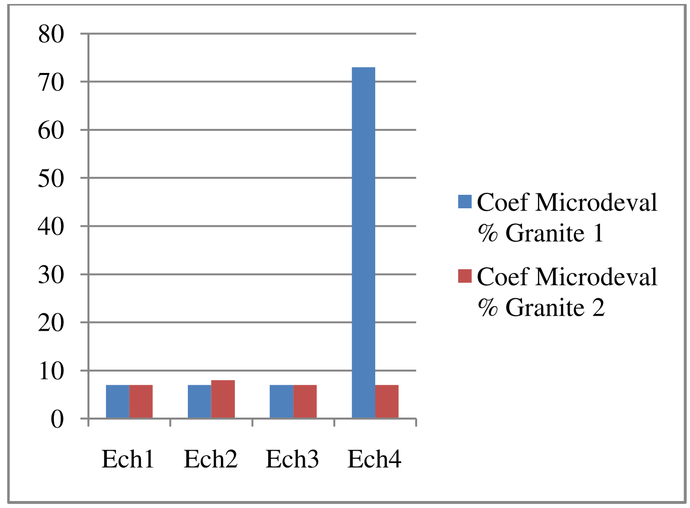

Figure-6: Histogram of MicroDeval Coefficient**.**

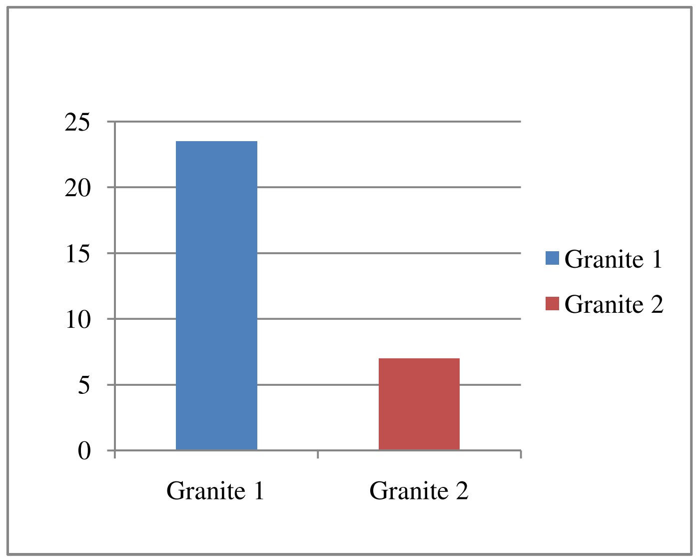

Figure-7: Histogram of MicoDeval Average in %.

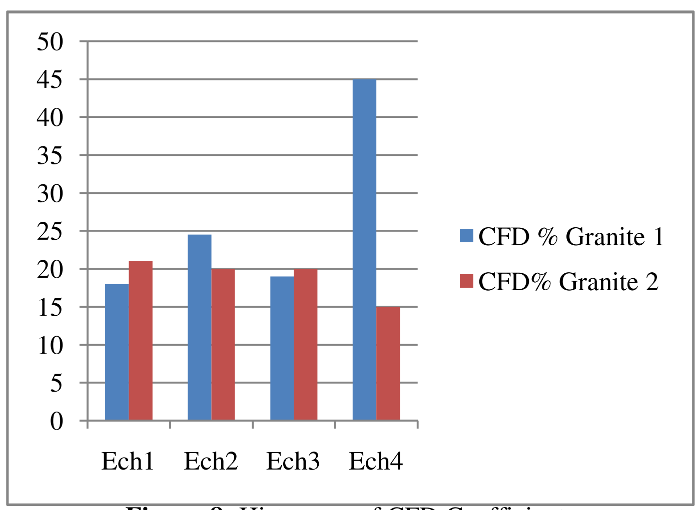

Figure-8: Histogram of CFD Coefficient.

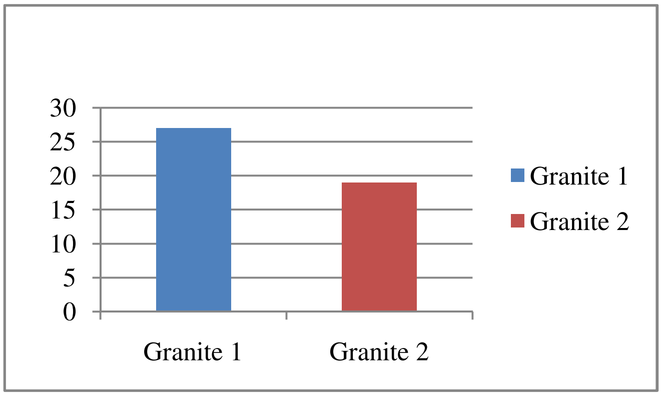

Figure-9: Histogram of CFD average in %.

Granite 1: Achklun biotite granite and Granite 2: Amgala biotite and amphibole granite.

Physical Parameters: Specific density and apparent density: According to the results of geotechnical analyzes, granites in the studied area have a satisfactory density value: 2.64 (biotite granite) and 2.62 (biotite and amphibole granite). This value obtained is linked to the low porosity of these rocks. This is why the porosity in a rock causes a decrease in the specific density.More porous the rock, the less resistant it is.

These granites also have a relatively high apparent density value of 2 (biotite granite) and 2.68 (biotite and amphibole granite).These apparent density values are related to the size and mineralogical composition of these beds. Indeed, the more the rock is made up of dense minerals, the more resistant it is and vice versa.

Generally, low-density rocks are easily deformed and require relatively low explosive charge while high-density rocks require explosives at high speeds, detonation and pressure.

The specific density value and the apparent density value make it possible to formulate the concrete, in this case the determination of aggregate in absolute volume, apparent volume and in dry mass.

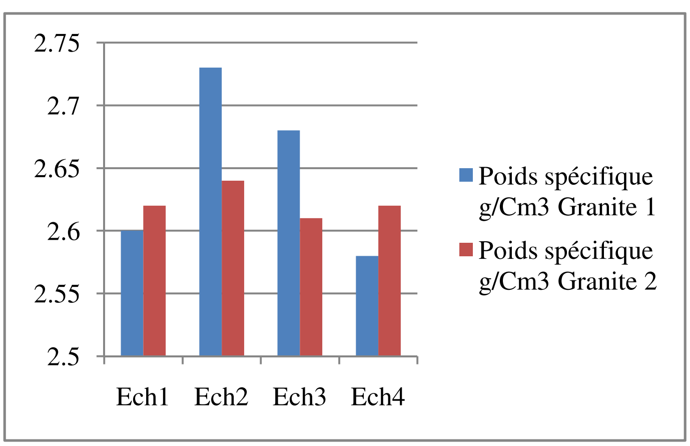

Figure-10: Histogram of specific gravity.

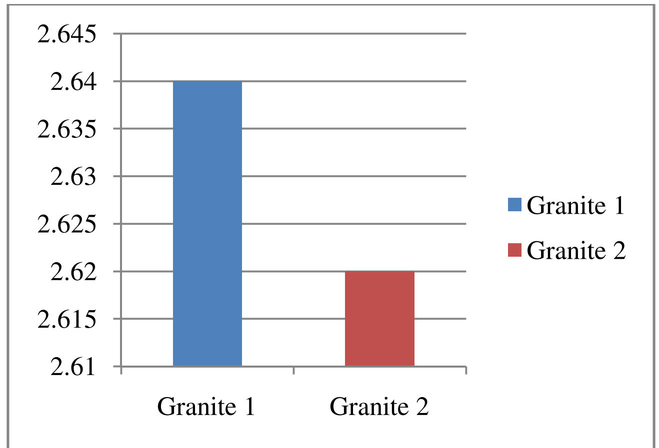

Figure-11: Histogram of average specific gravity in g/cm^3.

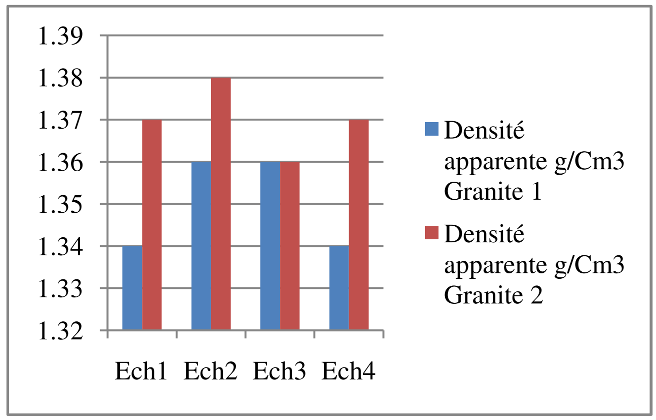

Figure-12: Histogram of Average apparent density.

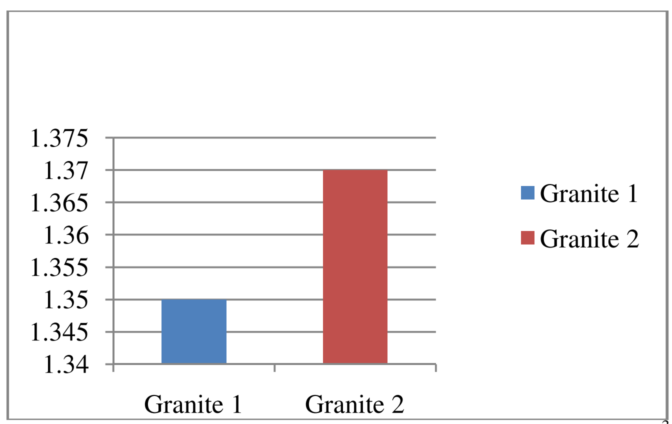

Figure-13: Histogram of Average apparent density in g/cm^3

The obtained specific density results of the sites studied vary from 2.62 to 2.64g/cm^3. These data do not agree with those of Manseur Nébil which are from 2.67 to 2.68g/cm^3[3,15]. These differences are explained by the mineralogical nature, the degree of alteration and the bond between the particles.

Moreover, they do not agree with those found by HOUGA Abdelbasset and SOLTANA Abdallah (2.61 to 2.68g/cm^3)[16]. This discordance shows that the rocks are of a different nature and that these high values characterize a dense limestone rock.

Conclusion

The present work is done to characterize the granites of Ouaddaï's region on the one hand and to know their resistance in the constructions of the various works on the other hand.

The objective was to know the geotechnical and geological characteristics to guide a rational choice on the granites used in the field of civil engineering. For this, the study was conducted on the petrographic, structural and geotechnical levels.

The petrographic study shows that biotite granites consist of fine and medium grains while biotite and amphibole granites consist of medium grains.

The structural study indicates that the two sectors have fracturing without relative displacement of the compartments but also the presence of the veins in the biotite granite. It allows to orient the geotechnician on the quality of the material.

The geotechnical tests carried out on the granites reveal values of 2,62 and 2,64 for the specific density and 2,59 - 2,68 for the apparent density.

As for the mechanical characteristics, they are 31% - 41%; for the resistance of the rock to friction. Therefore, the resistance of the rock to wear is 7% -23.5% and the measure of dynamic fragmentation is 19% and 27%.

Examination of the results shows that biotite and amphibole granites can be used in the field of civil engineering. If we compare the two massifs as a whole, we can see that biotite and amphibole granite has a good geotechnical quality than biotite granite because it consists of fine grains (in well-defined areas) and medium grains (which predominates) which decreases the geotechnical quality of the massif.

In addition, mineralogical composition, grain size, weathering and fracturing influence the quality of the material and the choice of firing mesh in case of exploitation. In addition, the petrography gives an orientation to make the choice of the tests. Here is the need to do a petrographic and structural study before doing the geotechnical tests.

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