A contribution to a physiochemical study of the sands of the Tamanrasset region, Algeria

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Abstract:

In this work, we have studied the physical and chemical properties of the sand of Tamanrasset region by granular classification, FTIR spectroscope, scanning electron microscope SEM. It was found Tamanrasset region is very coarsz sand with a percentage of 29.88%. Also, FTIR analysis showedthe presence of quartz (SiO_2) as the main and predominant component in the studied sand sample, with the appearance of other compounds, namely: dolomite, wollastonit, lead carbonat and water. The results of the X-ray fluorescence technology showed that sand of Tamanrasset region contains 63.35% of quartz (SiO_2) and alumina (Al_2O_3) in good proportions with the presence of other oxides in small proportions.

SEM and EDX analysis confirmed that the sample contains oxygen (O) and silicon (Si) in large portions, which refer to the quartz compound (SiO_2), as well as large proportions of the elements; Aluminum (Al) and Iron (Fe) and small proportions of the elements: cobalt (Co), titanium (Ti), magnesium (Mg), potassium (K) and calcium (Ca).

keywords: Sand, Quartz, Granular classification, FTIR spectroscope, Scanning electron microscope SEM.

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1. Introduction

There are many types of sand in the world, and each differs in terms of its composition and its own characteristics. For example, we find white sandy beaches in the tropics consisting mainly of limestone, while black sands are either volcanic in origin or contain magnetite inside them. We can also find a yellow color in sand in many other regions of the world that are rich in iron, which gives it this color [1]. And from this we can find sand in many different colors ranging from black to bright red, due to the presence of certain chemical compounds [2-3]. Although the components of sand grains depend in their formation mainly on the primary sources of them, in addition to the local conditions subjected to them during formation, we will find that they mainly consist of prominent minerals, the most important of which are quartz (SiO_2), feldspar ($CaAl_2Si_2O_8$, $KAlSi_3O_8$, $NaAlSi_3O_8$), As well as carbonates, in addition to that, we also find that they contain large proportions of aluminum oxide (Al_2O_3) and iron oxide (Fe_2O_3), without forgetting the presence of some heavy metals [4-5]. Algeria is a country rich in solar energy, where we can convert this solar radiation into electrical energy by using solar panels, and the latter are mainly made of silicon cells, which are expensive and economically expensive, this is on the one hand, and on the other hand, we have huge amounts of Quartz (SiO_2) found in the sand dunes, for which Algeria did not find producers from its sand, is of great economic importance to the country. Algeria possesses huge reserves of sand dunes called Erg, which extend from the east to the west of the Algerian desert, where the Great Eastern Erg and the Great Western Erg stand out [6], as shown by Figure 1. Therefore, in order to keep pace with the era of development, especially in this field of research, and to value some of the natural resources available in our country, We decided to take samples from an area known for its abundance of sand dunes, located in the southeast of Algeria, this region is named: Tamanrasset which is located within the following geographical boundaries: 13″ 47′ 22° North, 38″ 31′ 5° east, as shown in Figure 2 of the map of the country of Algeria.

Figure 2. Tamanrasset location on the map of Algeria.

Figure 1. The grand oriental and occidental erg.

2. Experimental work

We took a sample from the sands of the Tamanrasset region, to study its physical and chemical properties, using physiochemical techniques; we prepared the sample as follows:
The sample destined for the study was crushed by an electric grinding device for a quarter of an hour, until the sand becomes soft in texture, after that we take three samples of this crushed sand, where each sample weighs 100 g. We directed them to the following techniques.

2.1. FTIR infrared spectroscopy

Infrared spectroscopy is one of the most important branches of spectroscopy, which is concentrated in the infrared region of the electromagnetic spectrum, the infrared spectrum falls between the visible spectrum and the microwave spectrum. This technique allows us to identify the chemical bonds involved in the molecular structures of organic and inorganic substances, as well as crystalline and amorphous materials, without prejudice to its properties.
The principle of infrared spectroscopy depends on the interference between the spectrum of these rays and the chemical bonds of materials, when these rays are absorbed by matter, the atoms of the material vibrate, as a result of these vibrations, the length of the bonds and the angles between them change. Thus, by knowing the absorption energy of these rays, it is possible to know the type of atoms and bonds in the substance.

2.2. X-ray diffraction technique

X-rays have the same nature as visible light but with a much shorter wavelength, its wavelength ranges from (0.01–10) nm, which makes it easier for her to penetrate objects. The principle of diffraction of these rays depends on shining a beam of x-rays of one wavelength on the material, where these rays will suffer interference in the atoms of the material, x-ray diffraction will allow us to find the composition of the crystal by determining the positions of the atoms within the crystal lattice. The most important unknown that is determined in this technique is to find the distance between the parallel planes represented by Bragg's law.

$$2dSin\theta = n\lambda \quad (1)$$

Where: θ is angle of incidence of x-rays, λ is wave length, n is diffraction order, d is interstitial distance of group levels.

2.3. X-ray fluorescence spectroscopy

It is one of the phenomena of brilliance, fluorescence rays appear to us when materials are exposed to light or rays, where the atoms and molecules absorb the energy of the incoming rays, if the energy is sufficient, it allows the electrons to be excited to higher levels, it can also ionize and she will become agitated and unstable, it must return to its original state by subtracting radiation. For that we used a device of type phililps Cubix-XRF, where two or three drops of the organic substance Triethanolamine ($C_6H_{15}NO_3$) are added for about a 3g of sand. This material helps to cool the device and the cohesion of the material, the sample is then mechanically compressed with a force value 150 kN, to form a drop disc 3 cm.

2.4. Scanning electron microscope technique SEM

A scanning electron microscope is a type of electron microscopes, which produces images of the sample surface at high resolution, where he works to produce various signals that contain information about the topography of the surface and its composition and examining the structural properties of the studied material to show the three-dimensional sample.

3. Results and Discussion

3.1. Granular Classification Results

We passed a sample of 914.71 g through sieves arranged from the largest aperture to the smallest aperture, then we weigh the remaining sand in each sieve, let's then calculate the percentage remaining in each sieve with the following relationship:

$$\frac{\text{remaining weight in each sieve}}{\text{total weight of the sample}} \text{ x100 = remaining sand in each sieve \%} \quad (2)$$

The table shows the granular classification results obtained.

Table 1. Granular classification results.

sand class	Sieve hole (mm)	remaining mass in each sieve (g)	remaining mass in the sieves group (g)	Percentage (%)	total mass of the sample (g)
Gravel	2.5	161.65	161.65	17.67	
Very coarse sand	2	43.35	273.32	29.88	
	1	229.97			
Coarse sand	0.8	75.97	148.24	16.20	
	0.63	59.15			
	0.5	13.12			
Medium sand	0.4	72.14	167.20	18.27	
	0.315	41.62			
	0.25	53.44			314. 71
Fine sand	0.2	37.62	108.57	11.86	

	0.16	34.74			
	0.1	36.21			
Very fine sand	0.08	30.87	41.46	4.53	
	0.063	10.59			

It is clear from Table 1 that the studied sand sample Consists of gravel 17.67%, and very coarse sand 29.88%, while the percentage of coarse sand is estimated 16.20%, while the percentage of sand of both types, fine and very fine, was 11.86% and 4.53% respectively. On this basis, we can conclude that this sand is dominated by coarse sand, and that is in a greater proportion.

3.2. FTIR Infrared Spectroscopy

Figure 3 shows us the absorption spectrum of red rays from a sample of sand in the Tamanrasset

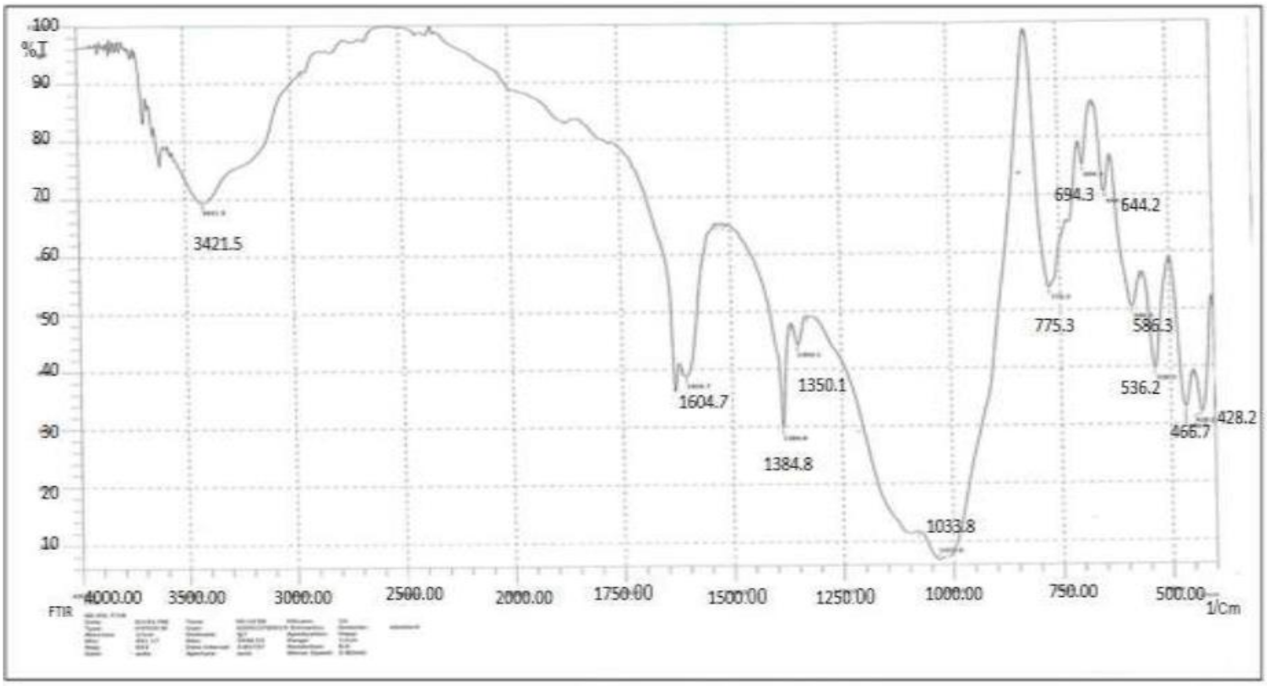

Figure 3. Infrared absorption spectrum of Tamanrasset sand dunes.

Infrared spectroscopy allows the identification of distinct groups of atoms (functional groups), which exist in molecules and chemical bonds between atoms. The infrared spectrum produces a recording of the amount of light that passes through the material. Some frequencies of radiation will pass through directly without being absorbed by the material, while other frequencies of radiation will undergo an absorption process as a result of the chemical bonds between the molecules, these results in a curve that relates the infrared transmittance as a function of the wave number. From Figure 3, absorption regions can be divided into:

Strong absorptions: which ranges the value of its leverage 0 to 35% and that stands out in frequencies 1384.8, 1604.7, 466.7, 1033.8, 562.2 cm^{-1}.

Medium absorbency: which ranges the value of its leverage 35 to 75%, it appears in frequencies 3421.5, 586.3, 644.2, 694.3, 775.3, 1350.1, 536.2 cm^{-1}.

Low absorbency: which ranges the value of its leverage 75 to 90%.

When a substance absorbs infrared radiation, atoms of matter are excited as a result of this energy, which is in the form of vibrations, where this vibration is transmitted from one molecule to another, this leads to a change in the length of the chemical bonds between the molecules or a change in the angles between chemical bonds.

After comparison and matching of the spectrum obtained with previous studies (Anbalagan et al. [7]; Andersen and Brecevic [8], Gnanasaravanan and Rajkumar [9], Leng [10], Petre et al. [11], Ramasamy et al. [12]; Razva et al. [13], we found that most of the existing bonds belong to the element quartz, which is represented in the following absorption tapes:

absorbent tapes: 466.7, 536.2, 775.3, 1033.8, 3421.5 cm^{-1} which is due to the flexural vibration of the bond Si-O, as for the tape 428.2 cm^{-1} it is due to vibration to stretch the bond SiAl-O, while tape 694.3 cm^{-1} to a symmetrical expansion vibration of the bond Si-O.

tape 586.3 cm^{-1} indicate to bond C-O Symmetric vibration of a Dolomite ($CaMg(CO_3)$) composite, and tape 644.2 cm^{-1} to a Wollastonite ($CaSiO_3$) compound, as for tape 1384.3 cm^{-1} refers to the bond stretching vibration C-O of lead carbonate ($Pb(Co_3)$), and tape 1604.7 cm^{-1} of the hydroxyl bond OH-H related to water. By comparing the results obtained with previous studies of the sands of Ouargla [3], we note the similarity and convergence in the frequencies of the absorption peaks, which indicate the predominant quartz element in the sample.

3.3. X-Ray Fluorescence Spectroscopy

Analysis by X-ray fluorescence and using ED-XRF is a special method used to determine the percentage of chemical elements in a sample, where this method depends on the interaction of the sample with the source of X-ray excitation, we used a device in this technique **Philipls Cubix**, which allowed us to know the chemical elements present in the sample and their concentrations and the results obtained are listed in Table 2.

Table 2. X-ray fluorescence spectroscopy Technique Tamanrasset sand dunes.

Oxide	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	K_2O	SO_3	Na_2O	Cl
Concentration (%)	63.35	12.37	1.87	3.83	0.51	3.68	00	3.18	0.01

The results of Table 2, confirm that the sands of the Tamanrasset region are naturally composed of quartz (SiO_2) in the rate 63.35%, we also record a ratio of 12.37% of Aluminum oxide, this last value is considered the largest proportion of the oxides present in the sample the lack of (SO_3) compound indicates the absence of gypsum in these sand.

3.4. Scanning Electron Microscope Technique SEM

The pictures (a), (b), (c) in Figure 2 show accurate pictures of the sand of the Tamanrasset region, by scanning electron microscope SEM, using a scale 20µm, 100µm, 200µm respectively.

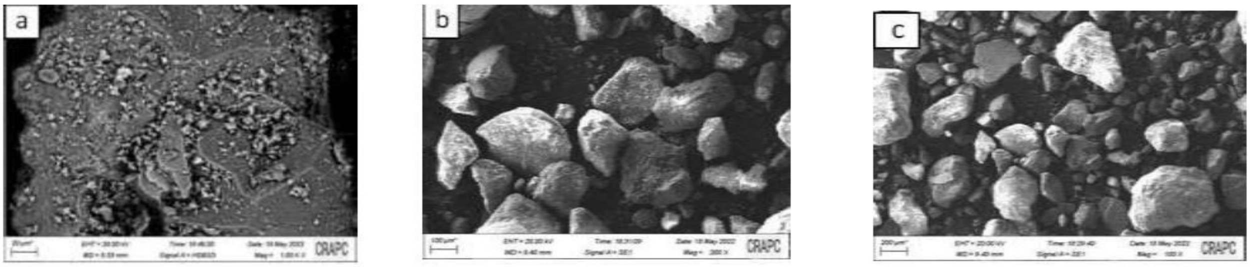

Figure 4. Pictures of different scales of sand in Tamanrasset sand dunes.

In the picture (c), we notice that this sand contains different shapes of sand grains, including circular, flat and longitudinal as well, and their sizes range from large to small.

As for the quantitative analysis we calculate it by EDX see Figure 5, which gives us the mass and atomic concentration of the elements present on the sample surface. The results showed that the sample contains a large percentage of oxygen (O) 44.89% and silicium (Si) 19.41%. Also, each of the aluminum (Al) and iron (Fe) metals had a significant presence, while we note the existence of a modest for the rest of the elements (K, Mg, Ti, Co, Ca).

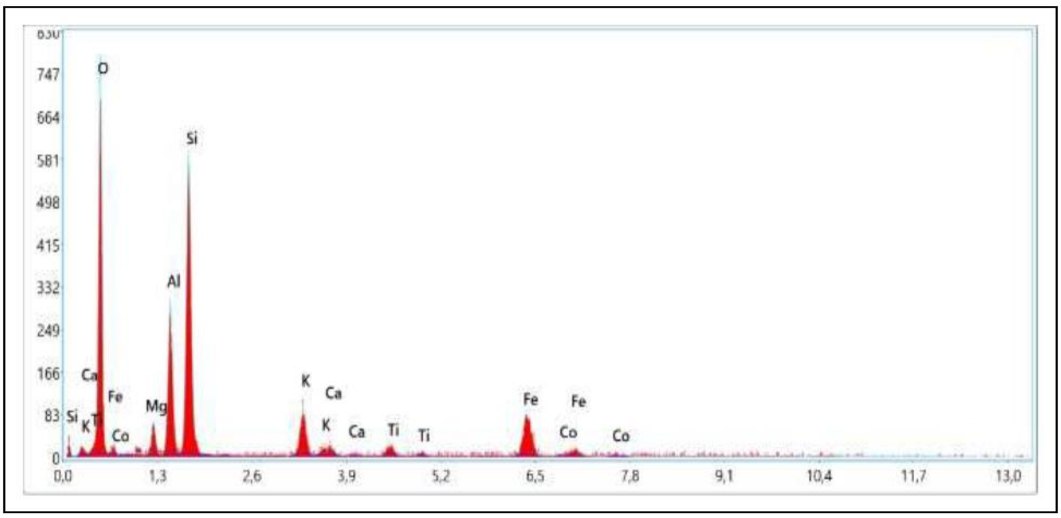

Figure 5. spectrum Tamanrasset sand dunes by EDX.

Table 3 also shows the results of the quantitative and mass analysis of the Tamanrasset region by EDX technique.

Table 3. Quantitative and mass analysis of the Tamanrasset sand dunes by EDX technique.

chemical element	atomic concentration (%)	mass concentration (%)
O	63.07	44.89
Mg	2.41	2.61
Al	8.68	10.42
Si	15.54	19.41
K	2.89	5.02
Ca	0.74	1.33
Ti	0.90	1.91
Fe	5.26	13.06
Co	0.52	1.36

And by comparing the calculated results with previous results for the Ouargla region [3], it turns out that they have the same ratio of the oxygen (O) element, while they differ in the ratios of other elements.

4. Conclusion

In this work, we studied the physicochemical properties of the sand of the Tamanrasset region, using physiochemical techniques, represented by the granular classification, Infrared spectroscopy FTIR, X-ray fluorescence ED-XFR and a scanning electron microscope SEM, it is in order to know the most important chemical elements that make up the sample.
We got the following results:

- The sand of the Tamanrasset region is characterized by being coarse sand with a percentage 29.88%.
- Technique FTIR showed the sand of this region consists mainly of quartz (SiO_2) and that's on the tapes: 466.7, 536.2, 775.3, 1033.8 and 3421.5 cm^{-1}.
- The results of x-ray fluorescence were shown this sand contains quartz (SiO2) 63.35%, also contains a significant amount of aluminum oxide (Al_2O_3).

- Quantitative analysis was given by EDX the sand contains a large percentage of oxygen (O), which is important in the formation of quartz (SiO_2).
- Through all these techniques, it can be said that the sand of the Tamanrasset region is rich in silicon, as it is a very common element in various modern industries.

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