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Study Physico-Chemical of the Sand of the Western Erg of the Area of Saoura (Western South Algeria)

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Abstract: This study lies within the scope of a physico-chimic characterization of the taken sand of the Western Erg of Algeria, in order to determine the rates and the nature of its various components and to discover a layer rich in silica containing of the sufficient reserves to feed nutriment from the manufacturing units of pure silicon starting from silica and of the current and future economic importance of the silicon applied in the field of solar energy (photovoltaic cells). This material can be used in several fields as the civil engineering, engineering mechanical, electronic, renewable energy and to thereafter develop it in the development of a material with ultra high performance.

Key words: Sand, analyze physicochemical, MEB, DRX, western Erg, silica

INTRODUCTION

We choose the important one of this problem which is the sand of dune (Western Erg) mainly, if we think that meadows of 6% of the surface of the Algerian Sahara are covered by its sands which absorb the grounds, palm plantations, by threatening so unquestionable villages and oasis where invade.

The new research undertaken for different backgrounds and the first already known data, poses from now on the problem to use the sand of dune in another way in which we test by this study, to putting you at the image of the one they, by touching of advantage the significance of this sand, its place under consideration in the industry whose only research tasks currently undertaken will be able, from here a few years, of saying to us.

Our study is primarily related to the determination of the percentages of the various components of the sand of the Ergs. For that one is brought to make a physico-chemical characterization of this type of material.

To classify sand, the test sample selections are carried out on the various areas according to the Western Erg of the Western South of Algeria (Taghuit, Igli, Beni-Abbes, Timimoune and Adrar) Fig. 1.

This study is carried out with an aim of exploitation of the sand of dune in several fields like micro-electronics, solar enErgy (photovoltaic cell), metallurgy and civil engineering like building material. Its application and exploitation are bound by the percentage of the silica which could be contained in the sand of dune. A physical study is undertaken to thus determine the granulometry of this type of material the aspect and the shape of the grains which constitutes it. By a chemical analysis we could determine the elements which constitute the sand of dune and their percentages thanks to the analysis by diffraction of x-rays and the observation under the scanning electron microscope.

Fig. 1: The central northern sahara 5. Ergs

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Our analysis is to determine the percentage of silicon contained in the sand of dune in order to confirm its exploitation.

MATERIALS AND METHODS

Definition of sand: It is a product of the slow disintegration of the rocks under the action of the agents of erosions such as the air, rain etc sands ground, of sea, of river, sands of the desert.

Sand is regarded as a clastic rock furnish made up, in the total absence of cement, jointed grains but free, whose size lies between 2 mm and 64 μm Pettijohn[1], the value of this variation differs besides for certain authors: 2 mm with 20 μm for Folk[2], 5 mm with 50 μm for Weydert[3]. Any sand knowing beginning of cementing, such a weak is it is by convention considered as sandstone. The sand term is in fact very general, the qualification referring to the only granulometry criterion. Thus the term sands, employed under qualifier indicating the origin, is unsuitable, we speak about quartzes sand when it is composed of quartz grains, of lime sand, if the components are limestone grains, amifére, micaceous… etc.

The Ergs are located in the vast basins of spreading or of powerful alluvial accumulations concentrated, by great flows related to the important rain ones of the beginning of the quaternary one. The great Ergs coïncidents with zones or seasonal winds of varied directions are compensated. The wind is limited to alter, almost in situ, of the powerful alluvial accumulations concentrated in the vast basins of spreading or locates the Ergs. The dunes exist in three forms: the barkhanes are small dunes in the form of crescents. The siouf are dunes in the shape of saber are longitudinal undulations slimming towards an end Chavalillon[4].

Various components of sand: Sand comprises various varieties of minerals, such as silicates, silica, the carbonates and clays. The silicates which are the most abundant family in nature (90% weight of the Earth's crust), carbonates and clays find in the form of trace in our sand Polycopie[5].

Silica: The dioxide of silicon or silica occupies, among oscydes, an exceptional place SiO_2. The many industrial applications (optics, electronics, production of refractory materials, etc) which know this mineral family still increase the interest of the studies.

The quartz, which one finds in a natural colourless large-sized crystal state, homogeneous it is one of the most abundant minerals, the Earth's crust contains 12% of its weight of them. The silica glass exists in a natural state under the name of lechateliérite. One obtains it at the laboratory by cooling silica molten or hydrolysis of $SiCL_4$.

Silicon: Silicon is an element of symbol Si, atomic number 14, atomic weight 28.08 it is never in a native state, but constitutes, in the form of silica and of silicate, the most abundant element of the Earth's crust (27.2%) after oxygen. The silicon crystallized with a metal aspect, because of its hardness it polishes glass but it is polished by emery. The density with 25°C is 2.33 it melts with 1410°C and boils with 2680°C. One uses it more and more for obtaining the semiconductors Derruau[6].

Physical properties: The color is variable; a monocrystal appears blue steel or blue slate when the light through a thin film, this one takes a brown dye clearly. Silicon is made o f three isotropic stable: 28(92.27%), 29(4.68%) and 30 (2.07%). Silicon is cubic like diamond and germanium and presents moreover a rare and unstable hexagonal form.

- The density is worth 2. 326 + 0,003 with 0°C and 2.325 with 25°C.
- Mohr hardness is equal to 7.
- Brinelle hardness is evaluated with 240 kg fmm^{-2}.
- It is no ductile, very breakable.
- The modulus of elasticity is worth 11495 kg fmm^{-2}.
- The module of torsion is worth 4050 kg f mm^{-2}.
- The atomic radius is equal to 1.172 A°.
- Tf depends on the state of purity, on average 1412+2 °C and Teb = 2477 °C
- Silicon is diamagnetic with $Xs = -0.19\times10^{-6}$, not very sensitive to the effect of the temperature.
- These particular properties are conferred to him by the impurities (donor and acceptor). The principal donors are antimony and the phosphorus which transforms the crystal into silicon N; the receivers are boron, gold, aluminium, the gallium which gives P. silicon.
- The constant dielectric one is close to 13.

Chemical properties: Silicon, at equal distance between two rare gases, has a little marked electro-affinity; one classifies it among the non-metal elements. Almost all the combinations are ensured by connections covalences, the reactions of silicon depend moreover on its state of division. Amorphous, it reacts better than crystallized; it burns in O_2 giving silica, when it is crystallized, it is necessary to heat at least with 850°C. The layer of silica prevents any later oxidation quickly[7].

TECHNIQUES OF CHARACTERIZATIONS AND CONDITIONS EXPERIMENTAL

The experimentation is carried out with an aim of a physicochemical characterization of the samples of the taken sand of the Western Erg. For the physical characterization, we carried out an analysis granulometry by sifting of which the goal to determine the percentage of the various fractions of the grains. The observation under the optical microscope gives the shape and the nature of the grains.

Granulometric analysis: We chose to carry out our analysis by sifting, because it is thanks to this method that one can separate sand from the gravel, silt and clay according to the scale of Wentworth and Pettijohn, the gravel (diameter of grain higher than 2 mm), the sandy fraction (between 2 mm and 64 μm), the silt and clay (grains lower than 64 μm), Krumbein[8]. The grain size analysis is carried out at laboratory LSGM of the USTHB in Algiers (Algeria). The samples are filtered dry during 15 minutes in a mechanical sifter.There are various indices which make it possible to characterize in a quantified way the results of a granulometric analysis, in particular starting from the cumulative grading curve. Quartile 1 (Q1) is the value of the diameter with 25% of the curve, the median (Q2) is the value of the diameter with 50% of the curve, quartile 3 (Q3) is the value of the diameter with 75% of the curve. Always starting from the cumulative curves, an index of classification so (sorting-index of Trask) can be calculated:

$$So = \sqrt{\frac{Q3}{Q1}}$$

This So index makes it possible to appreciate the degree of classification of sediment.

For the samples whose histogram of the relative frequencies is plain modal, another index can be calculated. It is about the index (or coefficient) of asymmetry Sk (Skewness de Trask). It expresses the symmetry of the mode of the histogram compared to the median Intes[9].

$$Sk = \frac{Q1 \times Q3}{Q2^2}$$

Table 1: The classification of sediment

Value of the so index	Degree of classification
So<0,5	Classified extremely well
0.5<So<1	Classified very well
1<So<2.5	Classified well
2.5<So<3	Normally classified
3<So<4	Slightly classified
4<So	Very badly classified

If Sk<1, The classification is maximum towards fines;
If Sk = 1, Symmetry is perfect;
If Sk>1, The classification is maximum towards the coarse ones.

The classification of sediment is shown in Table 1.

RESULTS AND DISCUSSION

Five taking away were carried out according to various areas along the Western Erg Fig. 1.

- Area of Taghuit (W. Bechar).
- Area of Igli (W. Bechar).
- Area of Beni-Abbes (W. Bechar).
- Area Ouled Said (Ksar Fatis) (W. Timimoun).
- Area Charouine (Ksar Agdal) (W.Adrar).

The Fig. 2 gathers the results of analyze granulometric for the 5 samples in the form of cumulative curves. Table 2 gives the various indices deduced from the cumulative curves and those calculated. The samples all are well classified, with indices of classification lower than 2.5 then the distribution is perfect and thereafter the finest distribution is sorted better than the coarse part by Riviere[10].

Table 2: Indices deduced from the cumulative curves and those calculated various samples

Echantillons	Q1	Q2	Q3	So	Sk
Taghuit	0.12	0.15	0.18	1.23	0.94
Igli	0.20	0.25	0.32	1.27	1.00
Beni-abbes	0.13	0.18	0.27	1.40	1.08
Timimoune	0.14	0.21	0.29	1.40	0.94
Adrar	0.13	0.16	0.21	2.50	1.00

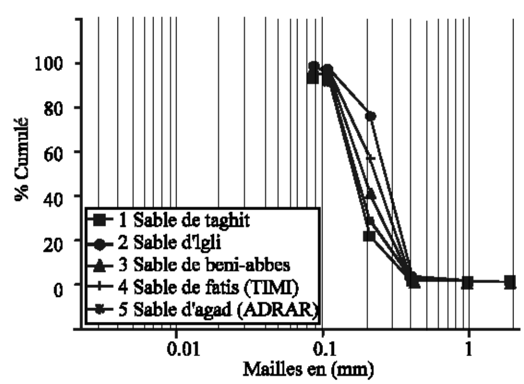

Fig. 2: Cumulative curves of the various samples

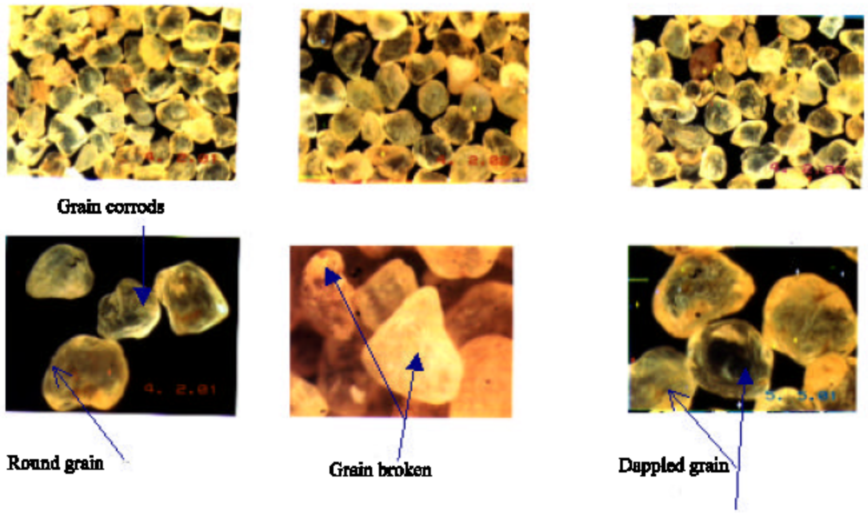

Fig. 3: Observation of the grains under the optical microscope

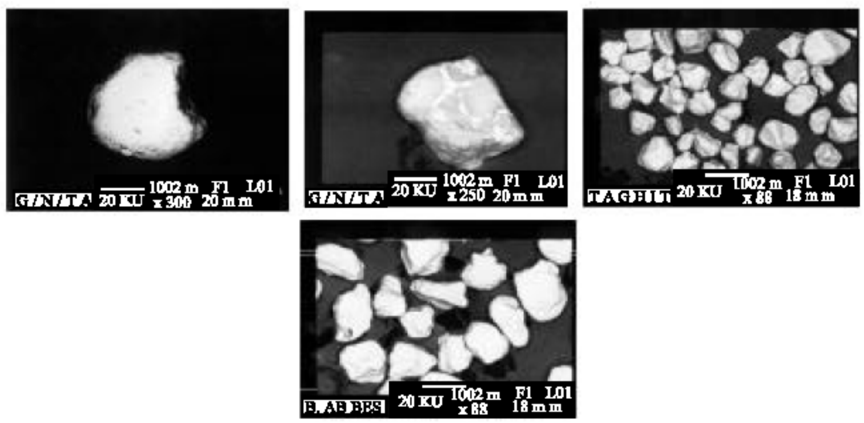

Fig. 4: Observation of the grains with the MEB

According to the cumulative curves of the various samples, one can conclude that in all the areas of taking away of sand, we have same granulometry. Observation under the optical microscope and the MEB. The observation under the optical microscope enabled us to identify following minerals:

Quartz: Appears in a white color or under a yellow dye if the blade is a little thick >0,03 mm) Fig. 3.

Iron oxide: They are presented in the form of independent grains, where they coat the grains with quartz and of the times are in the form of inclusions in quartz. The iron oxides are opaque and appear under a black color with reddish Fig. 3. In the observation of the sand grains, we see dappled grains of forms, grains of broken forms and others of forms rounded and subbarrondis Fig. 4.

ULTIMATE ANALYSIS BY SPECTROMETRY OF X-RAY FLUORESCENCE

The spectrometry of x-ray fluorescence is a method of analysis of elements of Z = 11 until Z = 92 in the range of concentration 3 ppm at 100% (10^6ppm) .it studies the processes of diffusion, absorption and emission of x-rays.

Indeed, when a sample is bombarded by photons X this radiation causes the emission of its spectrum. This spectrum is known as fluorescence because the mode of excitation is the photons. The spectrum is made of lines characteristic of the various elements present in the sample. The nature of transmitting element is reduced by the value wavelength corresponding to the line or the angle 2θ of a given crystal. Moreover, the concentrations of the elements can be calculated thanks to the measurement of the intensity of the lines.

Table 3: Elementary chemical results of analysis by x-ray fluorescence

Fraction	%SiO2	%Al2O3	%Fe2O3	%CaO	%MgO	%SO3	%K2O	%Na2O	%P2O5	%TiO2	%MnO	%Cr2O3	%P.F	%TOT
0.040	81.61	3.78	2.24	3.92	0.63	0.18	1.08	0.48	0.10	0.96	0.04	0.01	4.58	99.6
0.100	92.42	2.05	0.99	0.87	0.17	0.19	0.59	0.20	0.02	0.56	0.03	0.01	1.61	99.7
0.125	95.18	1.41	0.59	0.27	0.02	0.16	0.33	0.09	0.01	0.25	0.02	0.01	1.09	99.4
0.160	96. 33	1.00	0.30	0.33	0.47	0.18	0.10	0.09	0.01	0.07	0.01	0.01	0.75	99.6
0.200	97. 33	0.83	0.24	0.07	0.41	0.18	0.04	0.09	0.01	0.05	0.02	0.01	0.65	99.9
0.250	97.15	0.79	0.21	0.11	0.05	0.14	0.02	0.18	0.00	0.05	0.01	0.01	0.58	99.3

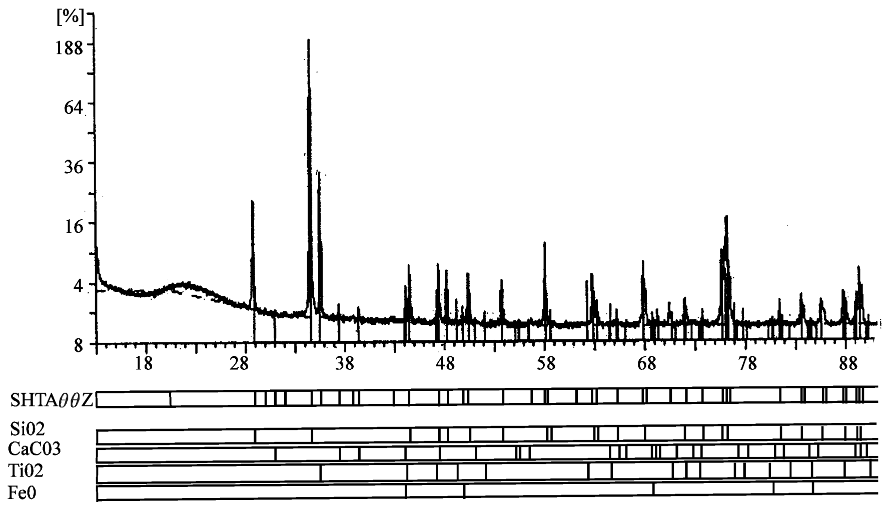

Fig. 5: Analyze by x-ray fluorescence

One cannot analyze the light elements like B, C, H, O… etc., because the values wavelengths λ of these elements are very large (field of the optical spectrum)[11].

Preparation of the samples: To carry out an analysis of x-ray fluorescence we proceed as follows:

- Crushing of the sample.
- Preparation of the pearls or pellets.

Analyze by fluorescence: The results of ultimate analysis are presented graphically for the variation of each element in each fraction, we note: Fig. 5. A predominance of silicon in all the fractions, in second position we have aluminium, then iron, calcium and potassium, the elements such as Ti, P, Mn, Cr, Na are in the form o f traces (<0,1%). In addition we notice that the percentage of silicon decreases by fraction 0.250 with 0.04 mm, while (Fe, Al, Ca, P, Mg, K, Na, Ti), except for S, Mn, Cr increase expressed as a percentage who remain almost constant in the various fractions Table 3.

CONCLUSION

This study enabled us to determine the chemical nature of existing minerals in the sand of the Western Erg, like some physical characterizations (forms, aspect of surface, etc). The analysis granulometry showed that this sand is classified and sorted well according to the cumulative curves. The observations under the microscope showed that the samples primarily made up of quartz (SiO_2) in the form of grains are rounded and subbarrondis, as well as the presence of iron oxides (Fe_2O_3), either in the form of independent grains, or they coat the grains with quartz or in the form of inclusions.

The elementary chemical composition and the percentage of each element of the various fractions of sand were determined by the chemical analysis of x-ray fluorescence. It revealed us the prevalence of silicon (SiO_2>98%) then (Al, Fe, Ca<1, 5%), the other elements such as (Ti, Mn, Mg, Cr, Na, S, K) are in the form of traces (<0,1%). The fraction between (0.250 and 0.160 mm) is the best from the purity point of view. One can conclude that the sand of dune of the Western Erg of the western south of Algeria is a layer rich in silicon which can be to exploit.

LIST LEGENDS

Xs : Diamagnetic coefficient.
Q1 : Quartile 1 value of the diameter at 25% of the curve.

Q2 : Median value of the diameter at 50% of the curve.
Q3: Quartile 3 values of the diameter at 75% of the curve.
So: Index of classification.
Sk : Index of asymmetry.
2θ : Angle of the incidental radius.
λ: Wavelength.
B: Boron.
C: Carbon.
H: Hydrogen.
O: Oxygenate.
Ti: Titanium.
P: Phosphorus.
Mn: Manganese.
Cr: Crome.
Na: Sodium.
Fe: Iron.
Al: Aluminum.
Ca: Calcium.
K: Potassium.
Si: Silicon.
Fe_2O_3: Iron oxide.
SiO_2: Silicon dioxide.
Tf: Melting point.
b: Boiling point.

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