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Characterization of Silica Sandstone for Photovoltaic Application.

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ABSTRACT — with increasing energy needs and the gradual depletion of fossil energy sources (oil, gas and coal), renewable energies, and particularly solar photovoltaic is the alternative future energy for our country.

The growth of the photovoltaic industry is mainly based on silicon reducing the costs of solar cells and consequently the cost of silicon wafers. However, the incessant growth of the photovoltaic industry encourages the production of high-quality silicon (SoG-Si).

Silicon is obtained by carbo reduction of pure silica, an abundant mineral resource in nature, an inorganic material with a chemical formula SiO_2. The reduction of silica (quartz, sandstone, sand and quartzite) by carbon (wood, coal, coal, petroleum) produces silicon.

The main aim of this work is to characterize sandstones of Jijel region by different characterization techniques (X-ray fluorescence spectroscopy, optical microscopy, X-ray diffraction) in order to identify the morphology, the defects as well as the main impurities existing in the crystal lattice as well as on its surface. Secondly, to recover it as a raw material that can be used for the production of silicon.

The obtained results show that Jijel sandstones present a high purity of silica 97- 98% SiO_2 and can be used for silicon production after it enrichment.

***Keywords**: Characterization, silica, siliceous sandstones, renewable energy, photovoltaics.*

I. Introduction

Algeria is a very large sunny country which makes it an important reservoir of solar energy. This solar radiation can be converted to electricity using photovoltaic solar panels. [1].

The solar panels are carried out starting from various types of semiconductor, the most employed: Crystalline silicon (mono or poly) or amorphous silicon. [2]

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Silicon is produced industrially by reduction of silicon dioxide with carbon in an electric arc furnace at temperatures higher than 2000 °C in the hottest parts, by a reaction that can be written ideally as:

$$SiO_2 + 2C \longrightarrow Si + 2CO \quad [3]$$

Silica is an inorganic material; it is the natural form of silicon dioxide (SiO_2), which is found in many minerals. [4]. It is one of the ubiquitous materials in the earth's crust. Quartz, quartzite, silica sand and sandstone are all grouped together under one genetic name "Silica minerals". [5]

Sandstone is detrital sedimentary rocks composed of sand-size grains of mineral, rock. It also contains a cementing material that binds the sand grains together. [6]

Silica sandstone is composed of quartz grains. It comes from the consolidation of silica sand.

This digenesis occurs through water circulation, filing natural silica cement between the grains and compaction. This gradual cementing may fill all or only partly the spaces between the grains. Therefore, some sandstone retains significant porosity.

Our work is dedicated to study microstructural properties of silica sandstone of El-Aouna deposit in order to secure its raw material supply for PV industry.

II. MATERIALS AND METHODS

The silica sandstone used for this research was obtained from El Aouna deposit.

El Aouana is a town and commune in Jijel Province, Algeria (figure 1, figure 2).

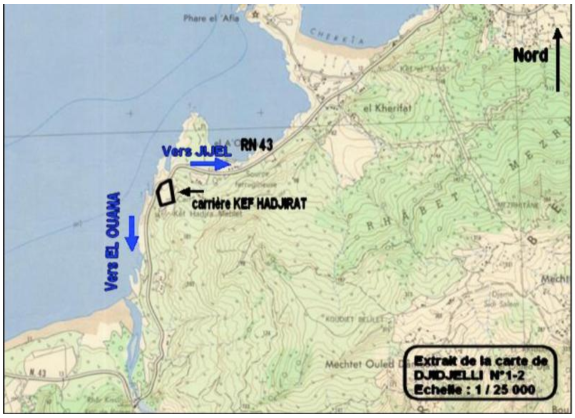

Figure 1. Localization of El Aouna [7]

Figure 2. El Aouna sandstone

For this purpose;

The chemical composition was determined by the X-Ray Fluorescence (XRF).

For our metallographic observations we used an optical microscopy with transmitted and reflected light Axio Scope A1**.**

Powder X-ray diffraction (XRD) analysis was carried out using an X-ray diffractometer (Siemens D500 analyzer Biskra Algeria) with Cu Kα1 radiation and a 6 h scanning range between 5° and 100°. The XRD scans were run at 0.02° per step with a counting time of 4 s.

III. RESULTS AND DISCUSSION

III.1. Optical observations

In order to determine the grain shape and the impurities present in our samples, several micrographs was observed.

From the petrographic point of view this rocks are composed mainly of detrital monocrystalline quartz grains.

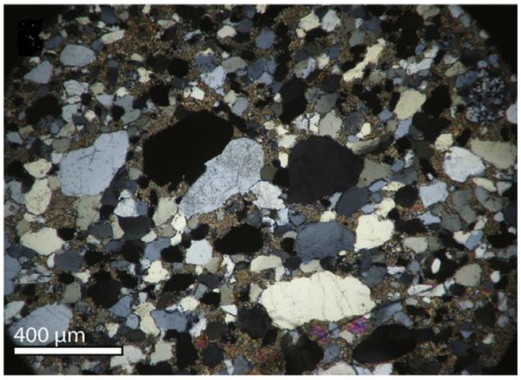

Figure 3. Micrograph of El Aouna sandstone (lower magnitude)

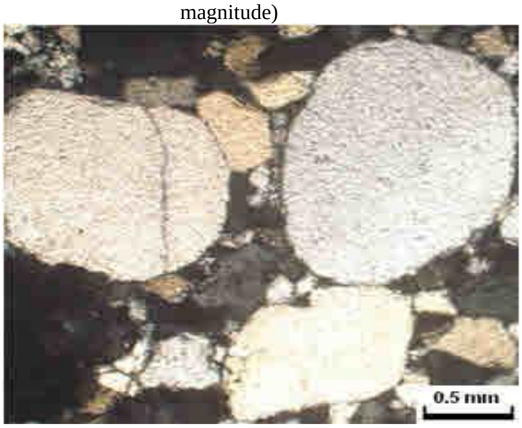

Figure 4. Micrograph of El Aouna sandstone (high magnitude)

The results from the optical microscopy analyses showed in figure 3 and 4 revealed that the samples had a wide range of grain sizes which range from coarse, medium to fine grains with a presence of silica cement between the grains.

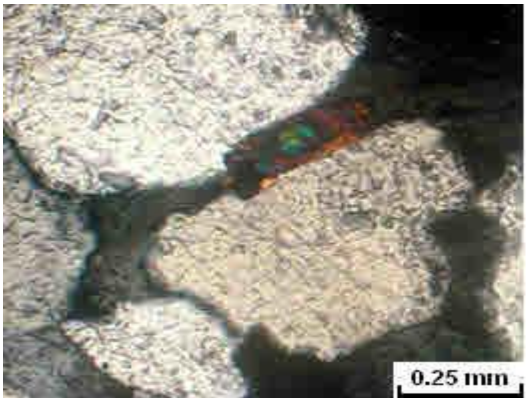

Figure 5. Micrograph of El Aouna sandstone with presence of zircon inclusion

In the figure 5 we show the presence of zircon inclusion $ZrSiO_4$

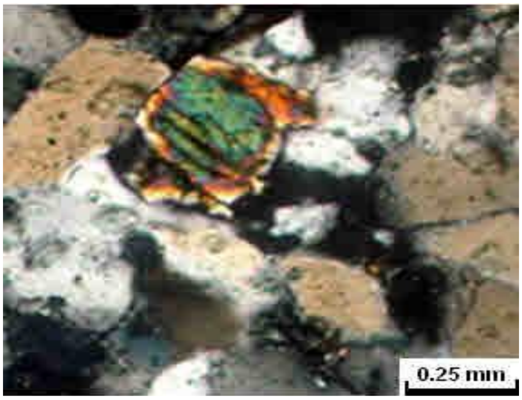

Figure 6. Micrograph of El Aouna sandstone with presence of biotite inclusion

In the figure 5 we show the presence of biotite inclusion $K(Mg,Fe)\ 3AlSi\ _3O\ _{10}(F,OH)\ _2$.

In the figure 5 we show the presence of muscovite inclusion$(KF)2(Al_2O_3)3(SiO_2)6(H_2O)$

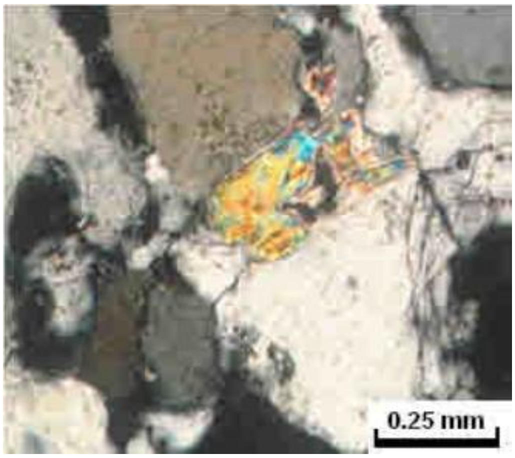

Figure 7. Micrograph of El Aouna sandstone with presence of muscovite inclusion

III.2. X Ray diffraction

In the figure 8 we represent the X ray diffraction of El Aouna sandstone.

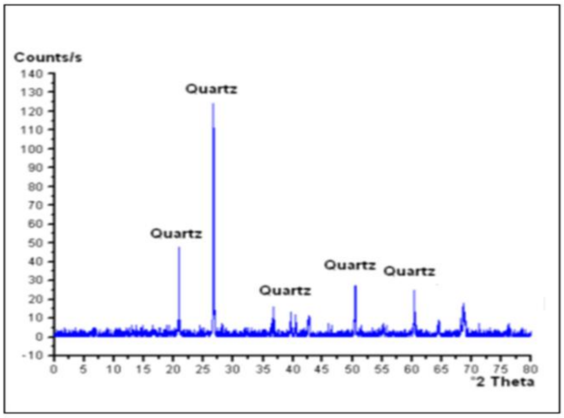

Figure 8. XRD of El Aouna sandstone

The X Ray diffraction analysis revealed that the Quartz (SiO_2) was the major mineral present in all the sandstones, other minerals were not been identified because they were minor in the composition.

III.3. X Ray fluorescence

The XRF results are shown in Table 1. The chemical elements of El Aouna sandstones identified were: Aluminium (Al), Calcium (Ca), Iron (Fe), Potassium (K), Sulphur (S)

Magnesium (Mg), Sodium (Na), Silicon (Si) and Titanium (Ti).

Table 1. Result of Chemical Analysis of El Aouna Silica sandstone

Components	***Concentration (%)***
SiO_2	97.20
Al_2O_3	1.04
Fe_2O_3	0.62
CaO	0.09
Na_2O	0.26
MgO	0.1
TiO_2	0.22
K_2O	0.01
SO_2	0.02

The results in Table 1 revealed a significant presence of Silica in El Aouna sandstone. The XRF results correlate to a very large extent with the XRD findings. This is in particular with regards to the dominance of the silicon species followed by Al and Fe.

IV. Conclusion

The characterization of El Aouna sandstones (Jijel) was successfully achieved. The diffractogram confirmed that the sandstones are quartz based minerals along. Optical microscopy analyses revealed that El Aouna sandstones had grain sizes ranging from fine to coarse grains size. Both XRF results were in good correlation by exhibiting Silicon as the highest chemical element on the sandstones.
The results show finally that the sandstone has got good result in purity but need enrichment for the photovoltaic application.

Acknowledgment

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