Physico-chemical characterization of a limestone rock used as a building material in the SIDI LAMINE region - Province of Khénifra (Morocco)

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ABSTRACT
This short communication studies the physicochemical properties of an abundant natural rock from the Sidi Lamine region of Central Morocco, used as a basic product in several building materials. Using X-ray diffraction (XRD) and scanning electron microscopy coupled with Energy–dispersive X–ray analysis (SEM/EDX), we show that the rock is composed mainly of calcite (CaCO3) and a small amount of quartz (SiO2). From the spectroscopic data, we can ease the work later on this rock for the development of new building products.

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1. Introduction:
Limestone is a sedimentary rock composed of more than 50% carbonate minerals. Limestone, the principal raw material for cement manufacture forms one of the most important mineral deposits of Morocco and provides a solid base for the industrial prosperity of the country [1-3]. Calcium carbonate occurs in three different forms—hexagonal crystal known as calcite, orthorhombic form aragonite and hexagonal form vaterite. Calcite is the most abundant form and widely distributed in the Earth’s crust followed by aragonite, vaterite and comparatively rare dolomite [4]. Most calcite is relatively pure. Common impurities include magnesium, ferrous ion and manganese. The structure of calcite is of more interest because a number of important mineral constituents of sedimentary rocks, including magnesium and iron-bearing carbonate, have structures which are identical with or closely related to the calcite pattern. Therefore, the structure of calcite serves as a logical starting point in describing the structures of such minerals [5-7].

Morocco has a variety of interesting natural materials, among them we find limestone rocks [8]. The existence of these metamorphic rocks mainly in some regions of the Middle Atlas has been known for more than half a century [9]. It was thought at the time that these were Visean limestones recrystallized in contact with volcanic rocks widely encountered in the region. It was necessary to wait until one meets them associated with other pebbles of volcanic rocks and quartzites at the base of the transgressive Viseen to realize that they are limestones antevisieans. The exploitation of the deposits of limestone rocks began in the years of tens of 20th century. The reopening of some of these quarries was done very recently to see new products intended as basic building materials: bricks, paint, mix with cement, ... [9-12]

The purpose of this paper is to highlight a rock in the region of Sidi Lamine (Province of Khénifra, Central Morocco) by achieving a set of physico-chemical characteristics of an abundant natural rock in the hope of encourage manufacturers and public authorities to make appropriate use of this material in compliance with environmental standards.
2. Material and methods:
2.1. Origin of limestone rock:
The sample of limestone rock which were the subject of this study, come from the region of Sidi Lamine (Province of Khénifra, central Morocco). the coordinates geographic are: 32°55'35.1"N 6°03'35.7"W (Figure 1).

2.2. Physico-chemical analysis:
The X–ray diffraction (XRD) patterns of the powdered sample was recorded using Inel equinox-1000 diffractometer. Cu–Kα radiation (λ = 1.5406 Å) source was used to record the samples at room temperature. During the recording of the diffractogram, a narrow slit of 0.1mm was used with a scanning speed of 0.02 /s. The sample was scanned from 0° to 100°. The morphological studies of the products were analyzed using scanning electron microscopy. These measurements were performed on a JEOL- 6610 scanning electron microscope. Energy–dispersive X–ray analysis (EDX) measurement was carried out using Brucker 129 eV, to get elemental composition (%). Before the measurement, the samples were mounted on copper stubs by double sided carbon tapes and the gold is coated using the sputtering technique.

3. Results and discussion:
The diffractogram analysis was done using the PANalytical database of X’Pert HighScore; it shows that the sample is mainly calcite (CaCO₃) (Figure 2). This result is confirmed by the intense peaks observed at d= 29.4628Å, 47.1732Å and 48.5855Å. However, there are peaks on diffractograms, generally of very low intensity, which are attributed to quartz (SiO₂) at d= 26,6737Å [13-16].

The results of the EDX microanalysis are reported in Table 1, which gives the mass percentage of the different elements composing the analyzed sample.
Table 1. Mass and atomic percentage of the elements present on the surface of the sample.

<table>
<thead>
<tr>
<th>Element</th>
<th>Weight %</th>
<th>Atomic %</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>4.9</td>
<td>9.7</td>
</tr>
<tr>
<td>O</td>
<td>37.9</td>
<td>55.9</td>
</tr>
<tr>
<td>Si</td>
<td>1.8</td>
<td>1.5</td>
</tr>
<tr>
<td>Ca</td>
<td>55.3</td>
<td>32.9</td>
</tr>
</tbody>
</table>

Figure 3. Characteristic curve of the elements present on the surface of the sample.

As expected, the results of the EDX microanalysis are in agreement with the different phases identified from the different diffractograms. Thus, the presence of calcite in the sample is confirmed by the high calcium content (55.3%). The silica observed at very low quantity in the sample is attributed to the quartz’s phase as revealed by the results of the X-ray analysis. Scanning electron microscopy observations were carried out on the sample. Figure 4 provides images that show a homogeneous and uniform morphology, so deep pores allow substitution of molecules. The techniques used in this work (XRD, SEM/EDX) allow us to identify the abundant nature rocks is a calcic rock.

Figure 4. Scanning electron microscope observation of the rock.

4. Conclusion:
The experimental techniques used allowed us to highlight the chemical composition of the abundant rocks of the Sidi Lamine region of Central Morocco. We have thus established that this sample consists essentially of Calcite with a percentage more than half. This study was therefore essential before any application of this type of limestone in other industrial uses, either in building materials or other environmental applications.

References:


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