Available online at www.sciencedirect.com

ScienceDirect

Procedia Technology 22 (2016) 211 – 218

Procedia Technology

9th International Conference Interdisciplinarity in Engineering, INTER-ENG 2015, 8-9 October 2015, Tirgu-Mures, Romania

# Geochemical Assessment of Limestone for Cement Manufacturing

Noureddine Bouazza[a,]*, Abdelaziz El Mrihi[a], Ali Maâte[a]

[a]*Department of Earth Sciences, Faculty of Sciences of Tetouan, P.B 2121, Mhannech II, 93002, Tetouan, Morocco*

**Abstract**

The El Mashar Unit of Triassic-Quaternary successions from limestone deposit of Cement Lafarge quarry (North, Morocco) is characterized by the occurrence of several sedimentary rocks. This study, based on chemical composition of more than 1600 samples of drill cuttings provides insight into the chemical parameters controlling the use of limestone in cement making. El Mashar formation can subdivided into twelve facies based on the chemical composition and geological position of different lithostratigraphic successions, being: dolomite Triassic limestone, Rhaetian limestone marl, Hettangian nodular limestone, Hettangian limestone with low magnesium, Hettangian limestone with silica, Hettangian limestone with high magnesium, Sinemurian brecciated limestone, basal Sinemurian limestone, central Sinemurian limestone, sommital Sinemurian limestone, Eocene marl and Quaternary topsoil. This study documents the importance of geochemical assessment of limestone for cement manufacturing.



*Keywords:* EL Mashar Unit; geochemistry; limestone; cement.

## 1. Introduction

Limestones are one of the most important of all the sedimentary rocks. Limestones are composed mostly of the mineral calcite ($CaCO_3$). They may also contain some other carbonates minerals and several non-carbonate impurities. Limestones are the raw materials widely used by throughout industry, although the limestone is the first raw materials for cement making industry where chemical properties are important. Portland cement is produced by

* Corresponding author. Tel.: +212-656-595-118; fax: +212-539-994-500.
*E-mail address:* bouazzanor@yahoo.fr


doi:10.1016/j.protcy.2016.01.046

calcining finely ground raw meal consisting of a mixture of about 75% limestone and 25% of clay, at about 1450°C in a rotary kiln to form a calcium silicate clinker which is then ground and mixed with a small amount of gypsum which acts as a setting retardant. The compositional chemistry of cement depends largely on geochemistry of its raw materials, i.e., limestone. Approximately 75% of the cement's raw material consists of lime (CaO)-bearing material [1]. Representative sampling of the raw materials used to make Portland cement [2], Chemical Study of the Raw Material [3-5], Raw mix designing [6], correct calculations for the possible clinker mixtures, sufficient reserves of the raw materials and selection of the correct infrastructure for the location of a cement factory [2], are essential to the protection of the great investment in the factory. The Moroccan cement industry is a major player in the development of the country because growing needs for cementing products for the construction of buildings and communication infrastructures are considerable. According to the specifications of the Moroccan standard NM 10.1.004 [7], Portland cement clinker is a hydraulic material which must be composed of at least two-thirds by mass of calcium silicate $[(CaO)_3.SiO_2]$, $[(CaO)_2.SiO_2]$, containing the remaining part of iron oxide ($Fe_2O_3$), aluminum oxide ($Al_2O_3$) and other oxides. The mass ratio (CaO)/ ($SiO_2$) should not be less than two. The magnesium oxide (MgO) must not exceed 5% by mass. Evaluation of limestone deposits for cement manufacturing involve study of the geological setting and determination of the physical, mechanical, mineralogical and chemical properties of the stone. However, the content of limestone is fundamental in cement making, although geochemical assessment should, therefore begin with an initial field investigation involving field mapping, section measuring and sampling. In this paper we evaluate the geochemical contents of majors oxides in limestones from northwest Tetouan (Morocco) in order to assessment their suitability for use in the cement manufacturing.

## 2. Geology

The study area is a limestone quarry of the cement plant in at Tetouan, north of Morocco located near the Saddina village, and belongs to El Mashar Unit of the Dorsale Calcaire Complex (Fig. 1a). Earlier researches have provided a first geological background on these rocks, established the first geological maps and defined all units in the calcareous ridge [8]. Later, research work was mainly focused on sedimentology, biostratigraphy, depositional environments of the dolomitic, calcareous successions and structural geology [9-11].

El Mashar Unit displays a stratigraphic succession mainly made of: Triassic dolomite followed by Rhaetian marl-limestone alternations and dolomitic, which are covered by Hettagian massive limestones, followed by Sinemurian thin-bedded cherty limestone succession overlying the external platform and finaly topped of siliciclasticmarls, conglomerates and Eocene-Oligocene breccias and quaternary topsoil (Fig. 1b). Many tectonic structures such as faults and folds are clearly visible in the El Mashar Unit well as numerous structures to small dimension such as fractures and folding. The average dip of the stratigraphy (Sinemurian, Hettangian and Rhaetian) is about 45 degrees to the northeast; its direction is 140 degrees north. The sedimentary formations in the study area are represented by two distinct scales separated by a major tectonic thrust. The sedimentary formations of El Mashar deposit, is in places, covered with topsoil exceeding 2 meters thick. Also the Karstic structures characterize the surface of these formations which often extend to a depth of over 20 meters especially in the Hettangian limestone. These karst structures are frequently filled with clay sediments. However, the volume of karstification is very difficult to assess in this deposit. We can also see that the sedimentary formation represented in the deposit of El Mashar was strongly affected tectonically. Since few studies have attempted the geochemical assessment of limestone from The Haouz Dorsale Calcaire, the goal of this research is first to determine if discrimination between different bedrock is possible, using geochemical analyses samples. Consequently These limestone formations has been assessed to elaborate their geochemical characteristics.

## 3. Methodology

More than 1600 drilling limestone samples were collected at different stratigraphic levels along the sampled stratigraphic succession of El masher Unit (Fig. 1a). The samples collected during field work were taken to laboratory for treatment and standard laboratory preparation prior to analysis. Geochemical analysis of major elements was done using an X-Ray Fluorescence Spectrophotometer (XRF) at the Portland Cement LAFARGE factory Laboratory, Tetouan. Analytical precision is better than 3% for the major oxides. Total iron was expressed as