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Research paper

Potentiality of clay raw materials from Gram area (Northern Tunisia) in the ceramic industry

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ABSTRACT

The geological study of Miocene clays from Gram area, North West of Tunisia shows an important series of clay materials to use them in the faience ceramic. Selected samples were studied with the objective of analyzing their chemical and mineralogical composition, morphology, particle size, plasticity, thermal analysis and their ceramic aptitude to be used in the faience ceramic. Raw materials are mainly composed of illite and kaolinite are the dominant clay minerals with minor quartz and dolomite.

The plasticity indexes are lower than 15.40%, suggesting that these clays are not plastic. Technical characterization was carried out on one representative mixture of Miocene clay samples. The firing characteristics (shrinkage and water absorption) were measured. The optimum firing temperature of clay mixture (M) has been established. These clays could be used in the manufacture of ceramic pieces.

1. Introduction

Tunisia is considered as one of the new important countries for the ceramic industry. There are approximately 70 Tunisian factories specialized in ceramic manufacturing (26 million m^2 in 2007) (Medhioub et al., 2012) and the exploration of new clay deposits is important to satisfy demand of clay consuming industries. Several studies have been made on clay deposits and their industrial applications, especially in the field of ceramic industry. Furthermore, the Tunisian clay formations have been the subject of several studies and geological researches (e.g. Agafonoff and Jouravsky, 1934; Jamoussi, 2001; Grabowska-Olszewska, 2003; Jamoussi et al., 2003; Felhi et al., 2008; Jeridi, 2008; Jeridi et al., 2008; Mahmoudi et al., 2008; Hajjaji et al., 2010; Mahmoudi et al., 2010).

The main objective of this paper is a study of the chemical–mineralogical compositions and technological behavior that allows an evaluation of the ceramic possibilities of the clay deposits studied.

2. Geological setting

The study area is located in the Mejerda area Goubellat region NW Tunisia (Fig. 1). During the Neogene, the NW Tunisia was deformed and formed large amplitude folds (NS and EW). The Neogene tectonics in Tunisia is known by a succession of compressive deformation, the most important attributed to Atlas phase during the Late Miocene. It is represented by major folds that have affected the whole northern Tunisia and set in most Triassic diapirism (Crampon, 1971; Rouvier, 1977; Perthuisot, 1978). The lower and middle Miocene is characterized by subduction of the African plate under the Eurasian plate at the North Africa — Sicily (Rouvier, 1967; Reuther and Eisbacher, 1985; Bousquet and Philip, 1986; Oldow et al., 1990; Roure et al., 1990). This compressive system is reflected in the implementation of thrust sheets at the same time as the opening of the Algerian marginal basin. During the Late Miocene phase, the EW to N120 faults were reactivated as thrust fault normal component is often associated to echelon folds level (Zargouni and Ruhland, 1981; Boukadi, 1994; Chihi, 1995; Dlala, 1995; Zouari, 1995). The stratigraphic sequence in the study area is divided into three members (Fig. 2). They include from bottom to the top: red clay (200 m) then sandy clay horizons (152 m) and alternation of clay and red sands (450 m).

3. Methods and materials

Ten representative clay samples were collected through a 500 m thick geological section of the Upper Miocene (Messinian) (Fig. 2).

3.1. Analysis

The mineralogical analyses of samples were carried out by X-ray diffraction (XRD). The XRD patterns were obtained with an X'Pert Pro

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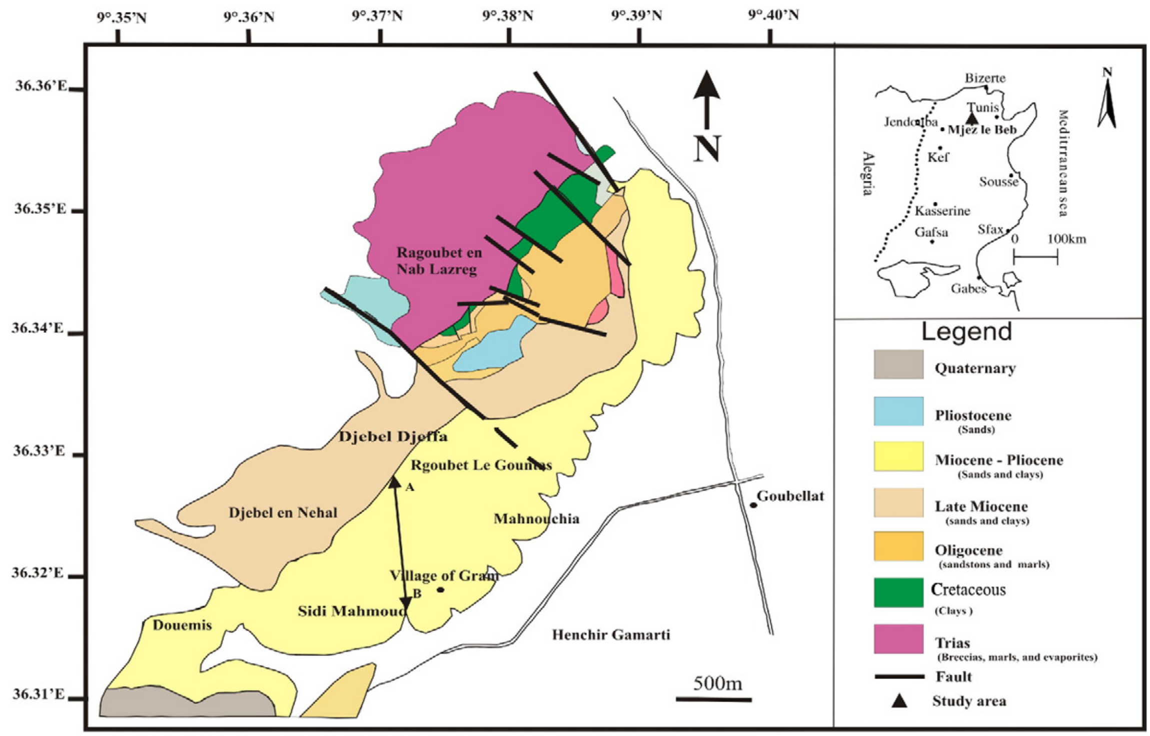

Fig. 1. Generalized geological map of the Gram area.
Extracted from the geological map of Mejez El Bab No. 27 at 1/50,000 scale.

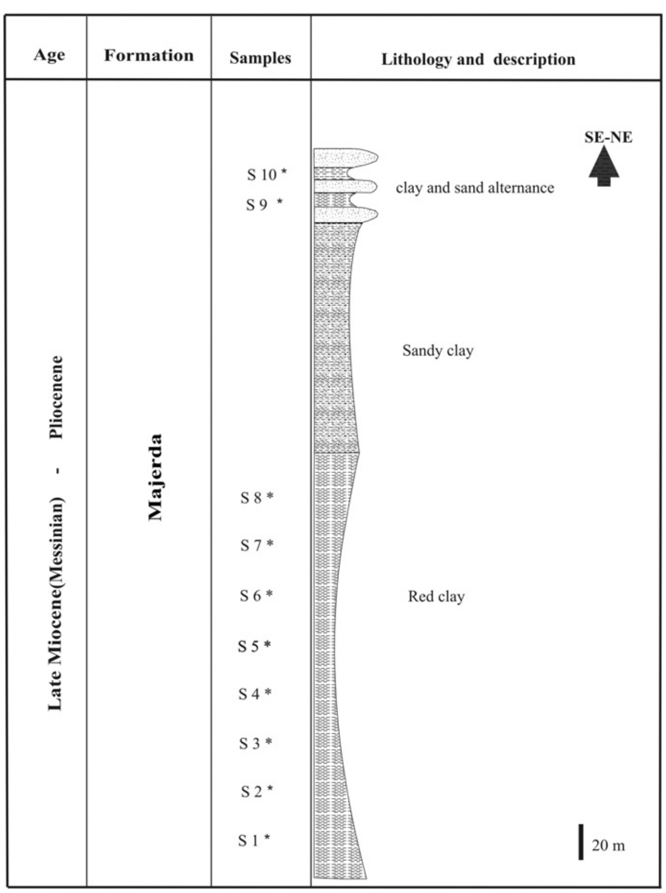

Fig. 2. Lithostratigraphic sequence of the Gram region (Majerda Formation).

PANalytical diffractometer operating at 45 kV and 40 mA using Cu-Kα1 radiation ($\lambda = 1, 5406$ Å). In order to separate the clay mineral fraction for X-ray diffraction studies, the samples were prepared as follows: the <2 μ fraction from each samples separated by centrifugation; and oriented clay aggregates prepared by allowing clay–water suspensions to dry at room temperature on three glass slides. Each sample was scanned in the air-dry state, after glycol solvation and after heating to 550 °C. Diffraction patterns were recorded between 3 and 60° 2θ at a step size of 0.017° 2θ. Quantification of different phases was carried out using the computer program X'-pert High Score. Infrared spectra were obtained using a FT-IR-420 spectrophotometer; 1 mg of the clay fraction was diluted to prepare 200 g of KBr pellets. The cation exchange capacity (CEC) was determined using complex of copper ethylenediamine (Bergaya and Vayer, 1997).

Granulometric analyses were carried out using a Mastersizer Malvern particle size analyzer. The samples were dispersed in deionized water.

Table 1
Mineralogical composition of clay samples.

Total sample							Fraction < 2 μm		
Clays	(Q %)	(Cal %)	(Dol %)	(K %)	(I %)	(S %)	I (%)	K (%)	S (%)
EN1	79	10	7	3	1	0.04	75	10	15
EN2	80	8.50	6.5	3.5	1.5	0.05	73	10	17
EN3	75	9	8	7	1	0.04	74	9	17
EN4	80	10	6	3.5	0.5	0.04	73	9	18
EN5	83	7	5.5	4	0.5	0.05	72	10	18
EN6	79	7	8	4.5	0.5	0.1	74	9	17
EN7	80	9	7.5	3	0.5	0.04	73	9	18
EN8	81	8	7	4	0.5	0.03	74	10	16
EN9	82	6	8	3.5	1	0.04	75	9	16
EN10	78	10	7.5	4	0.5	0.04	73	9	18