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The effect of heating on mineral composition and grain size distribution of flux calcined porcelanites from the Gafsa-Metlaoui basin, southwestern Tunisia

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ABSTRACT

The porcelanite rock of Ypresian phosphatic series of the Gafsa-Metlaoui basin (south-western Tunisia), is composed mainly of opal CT, and presents a variable percentage of carbonates and fibrous clays. This rock is treated with flux calcination at different temperatures in order to prepare a specific filter aid for cleaning melting sulfur which can be used for the production of sulfuric acid. This work presents the effect of heating on the mineralogy and grain size distribution of carbonate-rich porcelanite (Tm1) and clay-rich porcelanite (Gh) compared to flux calcined silica-rich porcelanite (CHM3) and diatomaceous filtration aids. The porcelanite samples used in this work come from three localities of the Gafsa-Metlaoui basin: Kef El Ghis (Gh), Tamarza (Tm1) and Mides (CHM3). Flux calcination at 1000 °C provokes a mineralogical transformation on carbonate-rich porcelanite samples. The opal CT transforms to opal C and becomes neater and more stable. The Thermal treatment of porcelanite (Tm1) incites also the apparition of new peaks of wollastonite. However, the structural change of opal CT to opal C by heat treatment is blocked for flux calcination of clay-rich porcelanite. The opal CT of fluxing clay-rich porcelanite becomes more ordered without significant change to opal C. The difference between fluxing carbonate-rich porcelanite (Tm1) and fluxing clay-rich porcelanite (Gh) appears also with granulometric distribution histogram of the tow heated samples. All raw samples have unimodal granulometric distribution (1–100 μm). After calcination with alkaline flux at 1000 °C fluxing carbonate-rich porcelanite displays bimodal granulometric distribution and a new mode appears systematically, between 0.1 μm and 1 μm. This occurs for fluxing silica-riche porcelanite and diatomaceous filtration aids as well and corresponds to the opal C formed after heat treatment. Whereas fluxing clay-rich porcelanite present trimodal granulometric distribution and a third mode appears (100–300 μm), which due to silica glass phase. Since, the granulometric rearrangement of porcelanite during thermal treatment may due to mineralogical transformation of opal CT to opal C and crystal grow.

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1. Introduction

The biogenic silica rocks as diatomite, chert and porcelanite are among the most studied rocks for scientific and economic reasons. The scientific reason poses the problem of genesis of these rocks: origin of the silica, hydrothermal contribution (Jun et al., 2000; Kametaka et al., 2005; Zhou et al., 2006; He et al., 2011; Huang et al., 2013) and diagenesis transformation of the silica phases (Hesse, 1988; Dixit and Van Cappellen, 1998; Dirk, 2000; Bernoullia and Gunzenhauser, 2001; He et al., 2011). On the other hand, these rocks can be used in different domains: like filter in several domains (Martinovic et al., 2006) or in industry (Erdem et al., 2005) and in electronics. These rocks are composed of opal A, opal CT and/or quartz. Their use in industrial filtration requires previous purification and thermal treatment in order to get a silica phase rich in cristobalite. Therefore some authors studied the effect of thermal treatment on the mineralogical and physical characteristics of these rocks (Kouteren, 1994; Hadjadj et al., 2005; Hadjar et al., 2008; Yılmaz and Ediz, 2008; Ediz et al., 2010; Tlili et al., 2012; Arasuna et al., 2013). The thermal treatment studies confirm generally the

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formation of the opal C (opal cristobalite) and/or cristobalite above 850 °C up to 1400 °C. However, the presence of certain impurities or other mineral phases let the structural evolution of silica to opal cristobalite and/or cristobalite become more difficult during heat treatment. On the other hand, many studies have focused on the mineralogical evolution of thermal treatment of silica but a few ones inspect the granulometric distribution transformation after calcinations (Saidi et al., 2012).

The porcelanite rock of Ypresian phosphatic series of the Gafsa-Metlaoui basin, composed mainly of biogenic opal CT, is treated with flux calcination at 600 °C, 800 °C and 1000 °C in order to prepare a specific filter aid of melting sulfur filter used for the production of sulfuric acid. This work concerns the thermal treatment of carbonate-rich porcelanite and clay-rich porcelanite compared to flux-calcined silica-rich porcelanite (CHM3). This work presents also the effect of heat treatment on the variation of the granulometric distribution of those flux calcined porcelanite compared with three industrial diatomite filters, used by Tunisian Chemical Group, These diatomites are imported from French clarcel, Algerian Kieselgur and Spanish diatomite.

2. Geological setting and lithological description

The Ypresian phosphatic series of the Gafsa-Metlaoui basin corresponds to Chouabine formation. This series contains nine distinct phosphate beds that alternate with the layers of the marls, limestone, carbonates and porcelanite intercalations (Fig 1). Phosphatic beds are named layer CIX to C0. In general, porcelanite intercalation is located between CVI and CVII layers. The number of porcelanite intercalation increases significantly in the western part of the basin (Burollet, 1956; Sassi, 1974; Burollet and Oudin, 1980; Belayouni, 1983; Chaabani, 1995), which represents three intercalations in Tarmaza and four intercalations in Mides (Tlili et al., 2012; Saidi et al., 2012; Saidi, 2015). The thickness of porcelanite intercalation exceeds 10 m in Mides section. The porcelanite rock of Ypresian phosphatic series of Gafsa-Metlaoui basin is composed

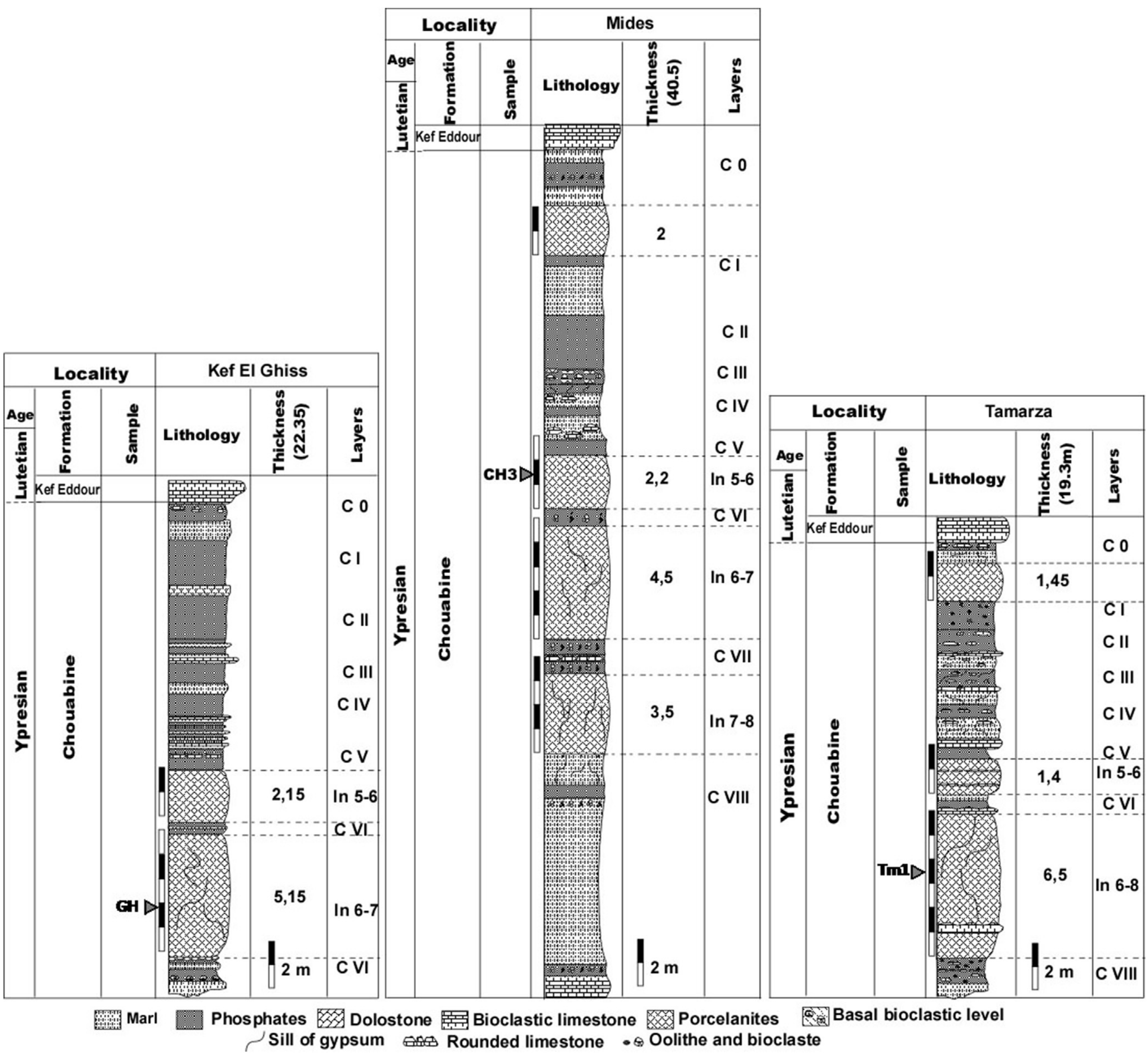

Fig. 1. Lithological sections of the Ypresian phosphatic series in Kef El Ghiss, Mides and Taramza.

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