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3rd European Mineralogical Conference Cracow Poland

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ABSTRACT BOOK

29 August - 2 September 2021

Book of Abstracts
3rd European Mineralogical Conference
EMC 2020, Cracow, Poland
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ANCIENT BRICK MANUFACTURING TECHNOLOGIES TO CERAMIC INDUSTRY: PHYSICAL BEHAVIOUR AND DURABILITY ENHANCEMENT BY H-T PHASES AND SECONDARY CALCITE

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The production technologies of yellow and beige bricks with uniform and heterogeneous textures and a rather good conservation state that shape ancient constructions of the city of Padua (north-eastern Italy) have been addressed through a multi-analytical approach based on spectrophotometry, XRF, XRPD, MOP, and FESEM-EDS analysis. The influence of the production processes on the physical behavior and durability of bricks, defined by means of ultrasounds, uniaxial compressive strength hydric tests, and salt crystallization and freeze-thaw tests, were also stated. Abundant high-temperature phases formed during the firing process: chiefly, Mg-silicates -with a melilite composition rims- and a Ca-aluminosilicate matrix where pyroxene-type crystals developed. Such data reveal that calcium- and magnesium-rich illitic clays were used and that firing temperatures exceeded 900 °C. Secondary calcite, precipitated throughout the groundmass, filling partially or totally the porosity. This calcite most likely comes from the binding lime mortars, although the own carbonate-rich clays might entail another source of the lime required for the secondary calcite precipitation.

An early sintering stage was achieved, since the melting process was blocked by the formation of the high-temperature phases, yielding rather porous ceramic bodies. In the heterogenous textured bodies, such early sintering yielded bricks rather prone to decay. However, the bricks display an overall quite good physical performance and durability, mainly fostered by the high-density phases formed during firing and by the precipitation of secondary calcite. The amount of both types of mineral phases significantly influence the mechanical behavior of bricks, while the absorption and drying capacity, as well as the resistance to salt crystallization and frost action, are mainly controlled by the porosity. The high-temperature phases have provided strength to the bodies, enhanced in turn by the calcium and magnesium contents of the raw clays. Equally positive were the changes induced by the formation of secondary calcite, increasing the cementation of the ceramic bodies.

The data obtained builds the ground for future comprehensive studies on ancient bricks towards the understanding of their physical behavior and resistance over time from the manufacturing process. In that, the high-temperature phases and the precipitation of secondary calcite have enhanced the physical performance and durability of bricks with early vitrification, the knowledge achieved may provide green solutions to the current ceramic industry. Therefore, the use of Ca- and Mg-rich clays may allow the production of quality and endured bricks by means of a low sintering achievement, hence the consumption of energy and CO_2 would be decreased. The study performed aims to highlight the important role of ancient bricks in Padua and to be part of the collective awareness for the enhancement of the built heritage of the city.