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Characterization of masonry bricks from the Medieval castle in Arta, Epirus, Greece

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The castle of Arta possesses a very important position in the medieval and modern history of the city and it is one of the most particular constructions of its kind. It was built in the middle of the 13th century when the city was capital of the Despotate of Epirus. The medieval castle, along with the Byzantine churches of Arta, comprises one of the most important monumental complexes preserved today in Greece, indisputable witness of the last gleam of Byzantium in its twilight years.

In the framework of a research programme supported by the 18th ephorate of Byzantine antiquities for the preservation and restoration of the castle, an extensive investigation on plasters, mortars, and building stones is in progress. Clay brick masonry is a typical feature of Byzantine architecture. A representative number of bricks were sampled by the archaeologists of the ephorate, from different masonry walls of the fortress. The characterization of the samples was accomplished using analytical techniques including petrographic, mineralogical, chemical and physical laboratory test investigations by means of thin-section examination under an optical polarizing microscope (OM) and scanning electron microscopy (SEM) with an energy-dispersive X-ray microanalysis attachment (EDX), X-ray powder diffraction (XRD), X-ray fluorescence spectroscopy (XRF), water absorption and open porosity measurements. The aim of this study is to determine the chemical and mineralogical composition, the texture and the physical properties of the bricks. No prior work has characterized the bricks used in the masonry of the monument up to now.

Macroscopic observations gave preliminary information about colour, hardness, shape and fabric of the examined bricks. The water absorption and the porosity of the studied bricks vary between 12.3 to 23.3 and 15 to 35 vol. (%), respectively. Petrographic observations under the polarizing microscope showed semi-isotropic or isotropic matrixes and changes in the ceramic fabric due to different firing conditions. The most common crystalloclast is quartz, followed by alkali-feldspars crystals. Mica/illite lamellae, calcite grains and ceramoclasts, are sporadically present in the most samples.

The powder X-ray and the chemical analyses data are fully in agreement and confirm that different typologies of brick are present. The samples are featured by at least three different mineral assemblages mainly arising from the composition of the raw materials and their firing conditions. Specific mineralogical phases detected by XRD, like akermanite and hematite (neoformed minerals during the stage of production), serve as firing temperature markers. Hematite clearly indicates firing in an oxidizing atmosphere.

Based on the results of the study, the masonry bricks were classified in three categories: a) bricks produced with carbonate clays as a raw material fired at temperatures between 750 and 850°C, presenting a lack or initial stages of vitrification, b) those derived from Ca-poor clays containing dolomite as the only carbonate, that were produced between 850 and 900°C and c) bricks from Ca-poor clays containing dolomite and calcite, with the latter being observed in an intense red colour claystone matrix as secondary calcite re-crystallized in the porous system, produced with firing above 900°C.