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Alberta Silvestri, Fabrizio Nestola, Luca Peruzzo

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**MULTI-METHODOLOGICAL CHARACTERISATION
OF CALCIUM PHOSPHATE
IN LATE-ANTIQUÉ GLASS MOSAIC TESSERAE**

Alberta Silvestri^{(1)(2)*}, Fabrizio Nestola⁽¹⁾, and Luca Peruzzo⁽²⁾

(1) Dipartimento di Geoscienze, Università di Padova, via G. Gradenigo 6, 35131 Padova (Italy)

(2) CNR, Istituto di Geoscienze e Georisorse, Padova, via G. Gradenigo 6, 35131 Padova (Italy)

ABSTRACT

The present study focuses on calcium phosphate identified into some late-Antique glass tesserae, green or blue in colour, from Padova (Italy) and Tyana (Turkey). It is generally accepted that calcium phosphate is a primary opacifier, probably obtained by deliberate addition of bone powder to a transparent glass. However, no specific crystallographic-chemical-spectroscopic studies have been performed on this important type of opacifier until now. Multi-methodological investigations on calcium phosphate, on its reaction rim and on interactions with surrounding soda-lime-silica glass were carried out in this work by means of scanning electron microscopy (SEM), electron backscattered diffraction (EBSD), electron microprobe (EMPA), and micro-Raman spectroscopy, in order to clarify the nature of these inclusions and provide new insights on the production technologies of such kind of glass tesserae. Our results show that calcium phosphate grains are actually hydroxyapatite characterised by an evident reaction rim, which is enriched in sodium derived from the surrounding glass and replacing calcium of the opacifier. Such cation replacement process between opacifier and glassy matrix is also confirmed by the presence of newly formed crystals composed of sodium calcium phosphate (β -rhenanite) and calcium silicate (wollastonite, polytype 1-T). β -rhenanite and wollastonite are generally found in the proximity of calcium phosphate grains. Notwithstanding the geographical distance between Padova and Tyana (more than 2000 km), comparable results were found in all the tesserae from both sites, suggesting similar and highly standardised production technologies of late-Antique tesserae with calcium phosphate as opacifier.

Keywords: Late-Antique glass tesserae; calcium phosphate; SEM-EDS-EBSD; EMPA; micro-Raman spectroscopy; production technologies.

* Corresponding author: alberta.silvestri@unipd.it, phone number: 0039(0)498279142; fax number: 0039(0)498279134.

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