Preliminary Archaeometric Investigation of Opus Sectile Glass Fragments from the Roman Villa of Aiano-Torraccia di Chiusi (San Gimignano, Siena)

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INTRODUCTION

The Roman Villa of Aiano – Torraccia di Chiusi (III-IV century A.D., San Gimignano, Siena, Italy) represents a unique archaeological context in the panorama of Central Tuscany, as it geographically and chronologically belongs to a context which was generally considered poor of large roman residences by archaeologists (Fig.1*a*). The recent findings of a consistent amount of *sectilia* fragments in the context of the "*VII Regio. Le Valdelsa pendant l'époque romaine et l'Antiquité tardive*" project provided important insights on the study of the diffusion of *opus sectile* during the Late Roman period [1].

The extent of the corpus of glass objects immediately suggested interesting perspectives on both archaeological and technological issues. Almost 7000 glass fragments, comprehensive of *opus sectile* glass slabs and mosaic *tesserae* were excavated in a restricted area where the re-cycling of these materials during the late phase of the Villa was suggested by archaeological evidences (furnace, glass slags and beads). The large number of slabs, in particular, suggested these elements to be part of wall panels (*emblemata*), despite the evidences about the presence of panels were probably removed during the late phases of activity of the Villa (6th-7th centuries AD) [2].

SAMPLES AND METHODS

The opus sectile corpus investigated during the present project is characterized by slabs (2000 ca.). The repertory is highly articulated as it is characterized by glass of different colors used alone or as a mixture to reproduce the impressive colors of nature, such as veined marbles and the shades proper of marine scenes (Fig. 1 *b-d*). Portions of highly articulated marine species (such as fishes, cuttlefishes, etc.) are also present (Fig.1 *e* and *f*) and provide clues of the high skills reached by glass industry during Late Roman times [3].

Due to their flexibility and low analytical costs, portable and non-invasive analytical techniques were thus considered during this preliminary phase in order to provide a fast and quite accurate definition of the chemical and mineralogical properties of each sample and a first classification of the large amount of pieces in compositional clusters. Portable X-Ray Fluorescence (p-XRF) and Fiber Optics Reflectance Spectroscopy (FORS) allowed a first definition of the chemical variability within the repertory and provided indications about both manufacturing and coloring techniques. Scanning Electron Microscopy (SEM-EDS) was also performed on selected samples for an in-depth structural, chemical and mineralogical investigation of selected glasses

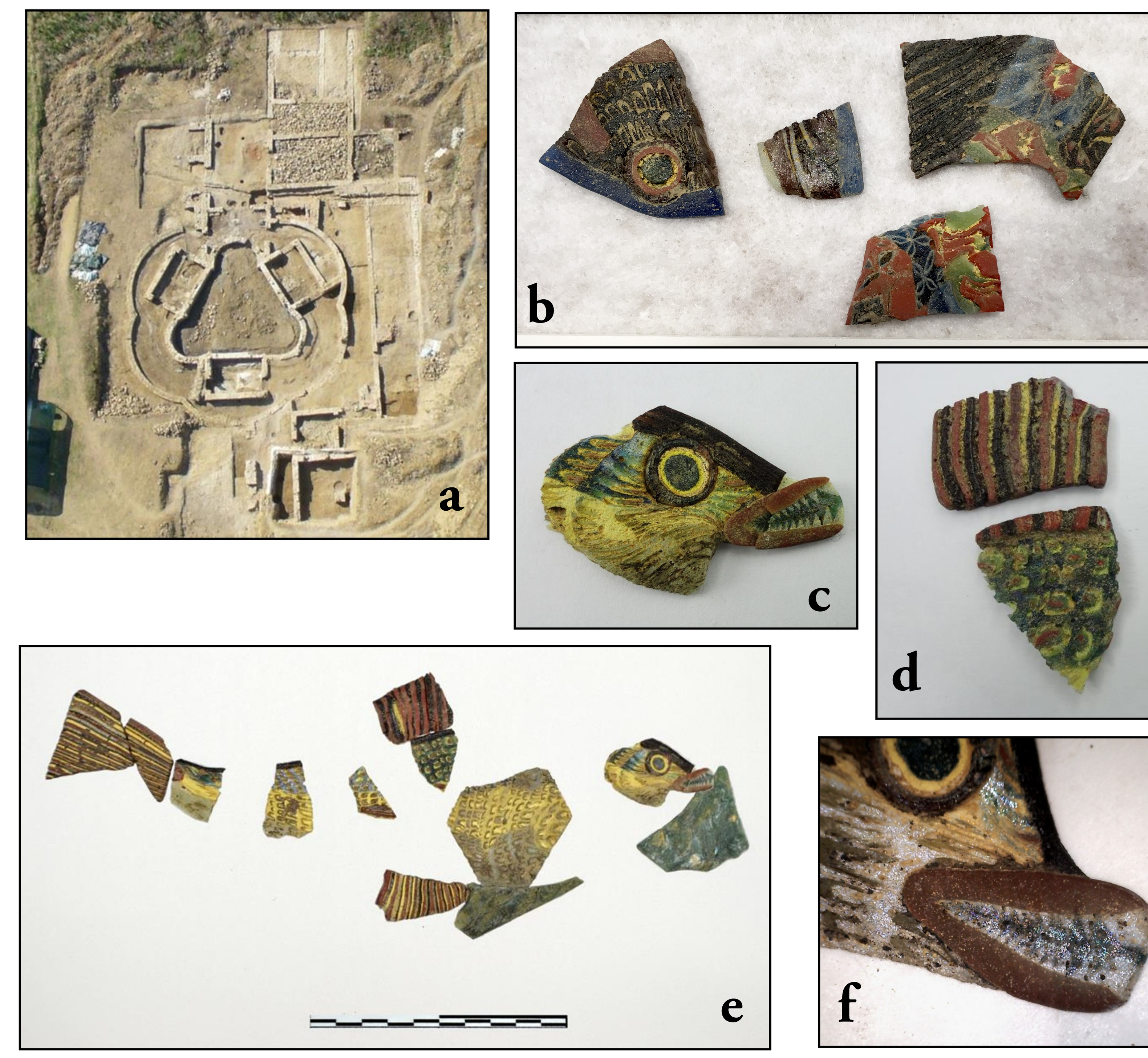

Fig. 1- The Roma Villa of Aiano-Torraccia di Chiusi (a). Some examples of the most elaborated slabs (b, c and d). Partial reconstruction of a marine scene (e). Particular of a fish (f) .

RESULT AND DISCUSSION

The aim of this preliminary phase of investigation was to cluster the large amount of opus sectile fragments according to their color and chemical composition (especially concerning coloring agents and opacifiers). The results suggested the use of coloring agents typical of Roman glass industry and twelve main groups have been identified:

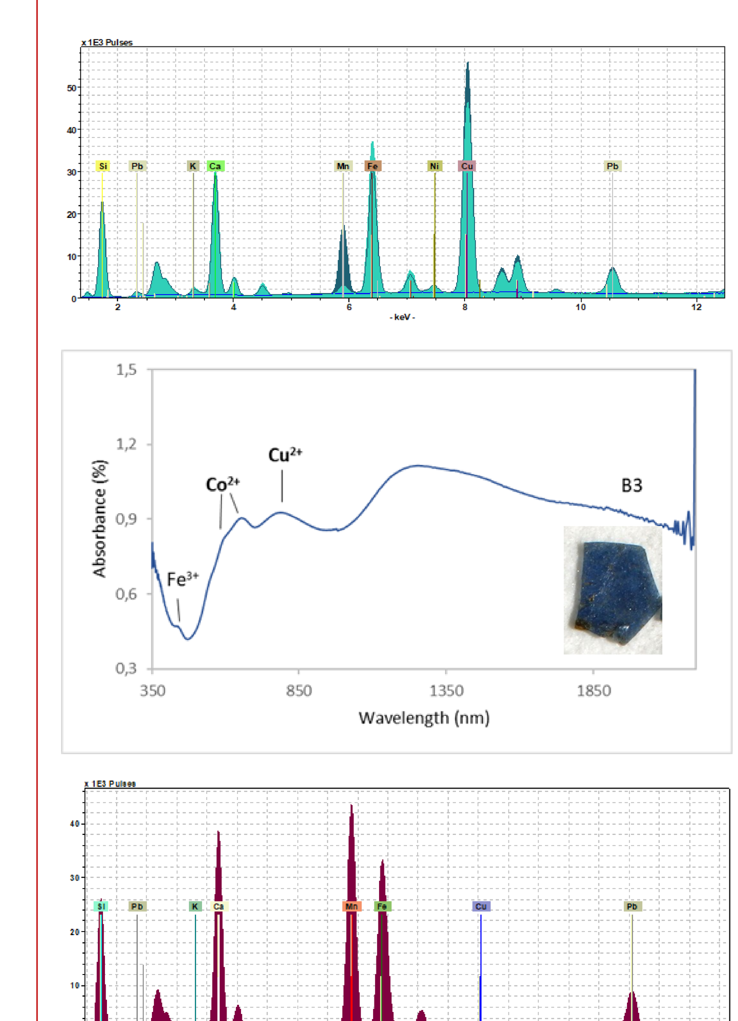

Fig. 2– Top: XRF spectrum of blue glasses from groups B1 and B2 (blue and turquoise spectra respectively). Center: FORS spectrum of a blue tesserae from group B3. Bottom: XRF spectrum of a purple glass.

Group A1 (opalescent light blue): the light blue color is due to Mn/Fe~1.

Group B1 (ultramarine blue) and B2 (turquoise): B1 Cu/Fe 2,0-2,5, B2 Cu/Fe 1,4-1,8. The turquoise color of group B2 is due to a lower manganese content in the glass responsible of a higher contribution from Fe^{2+} ions (Fig. 2). Zinc and lead detected in the samples suggested the use of a copper alloy (brass, bronze or a mixture of the two) as a source for copper [4].

Group B3 and B4 (intense blue): The color is mainly due to Co^{2+}, but copper and iron have been also detected imparting a slight green shade (Fig. 2) The presence of manganese suggested the use of a manganese-rich cobalt ore as a source for cobalt.

Group VB1(purple and white) and VG1 (purple and yellow): This group is characterized by a high Mn/Fe ratio (1,3-1,6). The excess of manganese, as Mn^{3+}, is responsible of the purple color (Fig. 2).

Group G1 (dark green with yellow decorations) and G2 (yellowish green): the green color of these groups is mainly due to a difference balance between Fe^{2+} and Fe^{3+} as a consequence of low Mn/Fe (G1 0,8-1,0; G2<0,3) and Cu/Fe (G1 0,3-0,5; G2 0,7-0,9). Low amounts of Co^{2+} are responsible for the dark shade of slabs from group G1 (Fig. 3).

Group R1 (red) and R2 (red with white veins): the coloring agents for both R1 and R2 are represented by copper nanoparticles (Fig. 3). Cassiterite and malayaite inclusions have been observed via SEM-EDS.

Finally, concerning ***yellow*** *(Fig.4)*, lead-tin oxides were used for bright yellow decorations applied on the surface of green slabs, while lead-tin antimoniates have been detected via XRD in pale yellow glasses. [5]

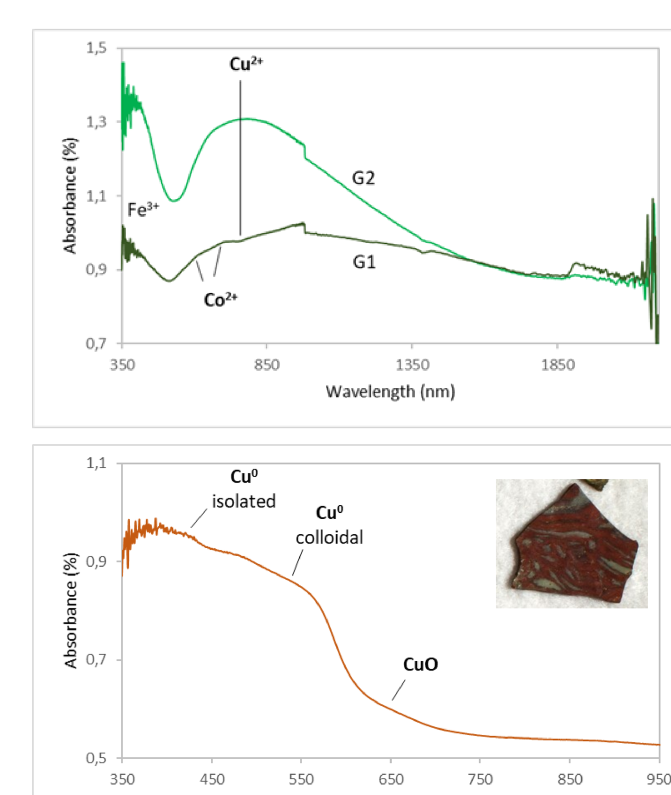

Fig. 3- FORS spectra. Top: dark and light green tesserae (G1 and G2, respectively). Bottom: red tessera with white inclusions. .

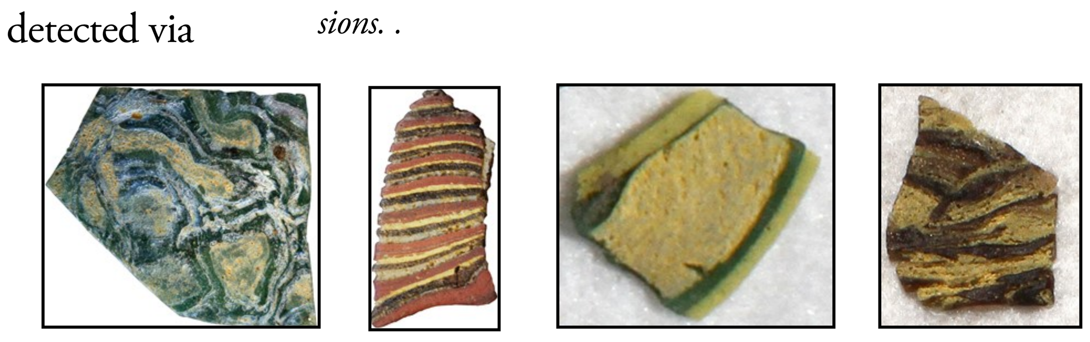

Fig. 4- Some examples of the different use of yellow glass .

CONCLUSIONS

The good potentialities of non-invasive analytical techniques used during the preliminary study suggested a possible application to a wider amount of samples, even if their specific properties do not allow obtaining results suitable for a detailed study of textures and provenance. The few, but consistent, information about chemical and technological properties of the fragments, however, strongly supported the relevance of a more detailed investigation on the whole repertory. Due to the large amount of samples, however, the definition of ad-hoc analytical strategy is required in order to provide an appropriate characterization of the glass, answer to questions from archaeologists and suggest possible conservative solutions.

The implications of the archaeometric study of the glass corpus could be relevant for a more precise chronological and technological contextualization of the decorations and to better understand the socio-economic organization of the Villa.

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