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THE REDISCOVERY OF COLORS AT *KAINUA*-MARZABOTTO

The city of *Kainua* (Marzabotto) near Bologna, which was inhabited between the end of the 6th century BC and the beginning of the 4th century BC, is one of the most important and best-preserved Etruscan centers in the Po Valley. During the excavations that took place between 2013 and 2019, the University of Bologna[1] team discovered a Tuscan temple consecrated to *Uni* (Roman *Iuno*) and dated between the end of the 6th and the beginning of the 5th century BC (Garagnani, Gaucci, Govi 2016; Garagnani, Gaucci, Gruška 2016; Govi 2017). In the areas located to the E and to the N of the temple (Fig. 1), masses of rare red and blue pigments (Fig. 2) have been found (Baraldi, Natalucci, Rossi 2017), probably inside the sacred *temenos*. In the 2015-2019 campaigns, around 27 samples of blue and red pigments were collected. Because they were discovered together with production scraps, it is likely they came from a nearby production area (Govi 2017, 163). Moreover, it is interesting to note that similar findings occurred also in other sacred contexts in Etruria, such as the sanctuaries of Gravisca (Torelli 1971, 299; Bordignon *et al*. 2007, 32-33), Vigna Parrocchiale in *Caere* (Bellelli 2001, 130; Trojsi 2001, 131), and *Pyrgi* (Melis 1970, 84, note 3), probably because those pigments were used to decorate the architectural terracottas of the temples. In particular, the finding of a pyx, which contained remains of blue pigment (Mattioli in press), finds comparison with two bucchero-ware bowls with Egyptian blue traces from Vigna Parrocchiale at *Caere* (Cristofani 2003, 123-126; Guidi, Trojsi 2003, 260-265).

The archaeometric analysis, carried out by Professor Pietro Baraldi (Università di Modena e Reggio Emilia), confirmed the composition of those pigments as red ochre and Egyptian blue (Baraldi, Natalucci, Rossi 2017). The colors previously attested in the Etruscan Po Valley were only black, white and red (Baraldi 2011; Rossi 2011); this discovery has thus increased our knowledge of the color palette that was used in this period. Therefore, the aim of this study has been to investigate the rediscovered polychromy and the use of Egyptian blue pigment on some architectural terracottas conserved in the National Etruscan Museum Pompeo Aria of Marzabotto. The Visible-Induced Luminescence technique (VIL; Verri 2009) has been applied by Dr. Andrea Rossi (Diar, Modena), while Prof. P. Baraldi has examined samples from

[1] I would like to thank Professor E. Govi for the chance to study these unpublished materials from the excavation of *Uni*'s temple; the Soprintendenza Archeologia dell'Emilia Romagna, particularly Dr. P. Desantis and Dr. T. Trocchi, for the authorisation to study the materials in the museum and in the storage rooms; Professor P. Baraldi and Dr. A. Rossi who did the archaeometric analyses.

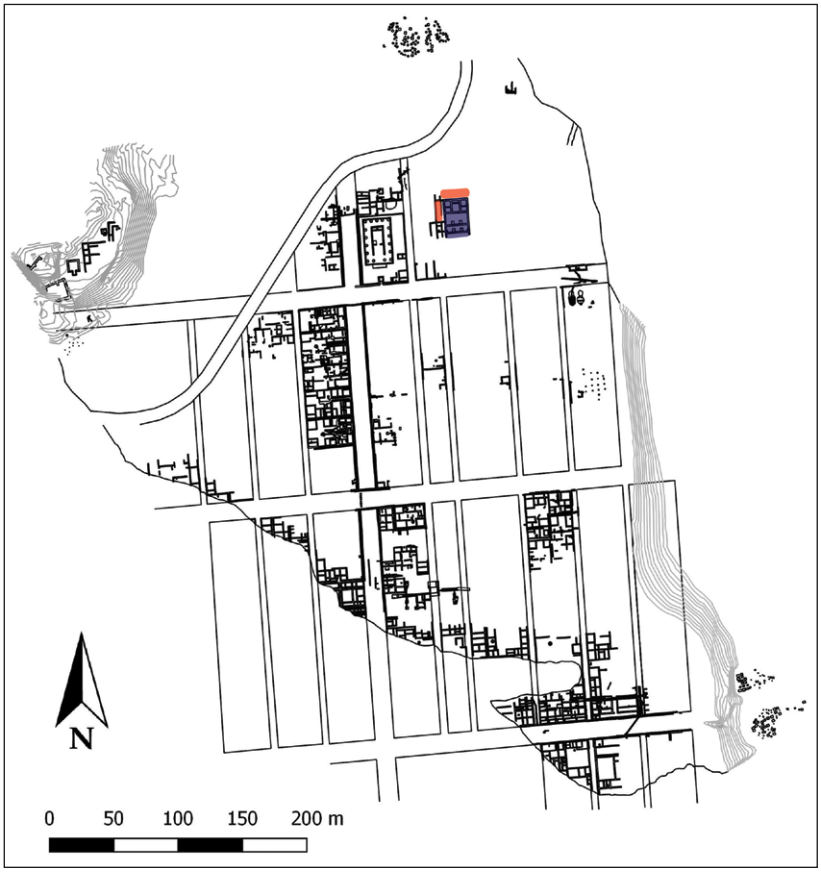

Fig. 1 – Map of the city of *Kainua*-Marzabotto with the placement of the temple of *Uni* and the zones (striped areas) where pigments were found (picture M. Natalucci).

painted tiles with XRF, FT-IR, and micro-Raman[2]. The analyses confirmed that the tri-color decoration is the most applied in Marzabotto. Indeed, black, white and red were detected by means of a Celestron microscope on the palm-shaped antefixes of the temple of *Uni* (Garagnani, Gaucci, Govi 2016, 259,

[2] The VIL technique detects and maps the presence of the Egyptian blue pigment, exploiting its property of absorbing visible radiation and reemitting it as infrared radiation. The X-Ray Fluorescence spectroscopy is a non-invasive technique that identifies and quantifies the elements of the material analysed. The Fourier transform infrared spectroscopy provides information about the molecular spectrum that reveals the presence of synthetic and organic materials in the sample. It is useful to identify the mineral salts and the organic binders. Lastly, the Raman spectroscopy is a technique that identifies the chemical and crystallographic characterisation of each granule in a mixture. Further information about the archaeometric analysis can be found in Baraldi *et al.* 2017.

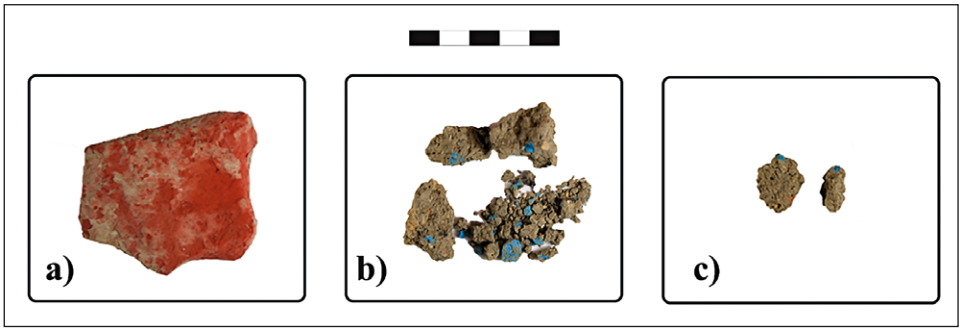

Fig. 2 – Some of the new pigments found out during the 2017 excavation: a) US 1230, inv. 2017/1019; b) US 1213, inv. 2017/2475; c) US 1213, inv. 2017/2498 (picture M. Natalucci).

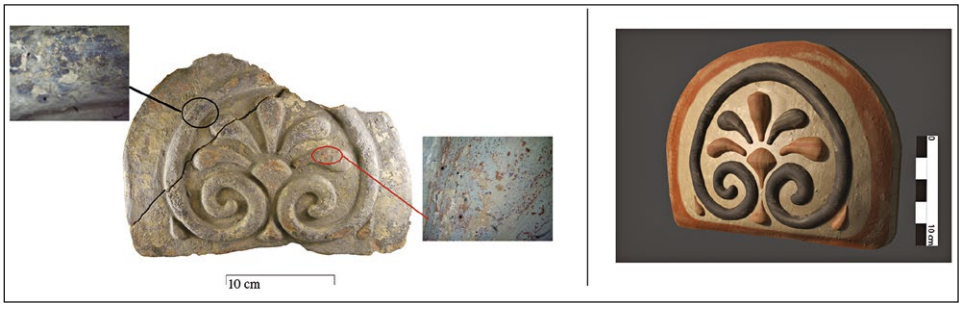

Fig. 3 – Palm-shaped antefix of the *Uni*'s temple (US 1142 inv. 2015/3451): on the left, some pictures taken with a Celestron microscope where traces of red and black pictorial layers are visible; on the right, 3D reconstruction. Scale on the picture: 10 cm (pictures P. Baraldi; reconstruction M. Natalucci).

fig. 6a; Govi 2019, 545-548, fig. 10). In the antefix inv. 2015/3451, traces of black and red pigments were visible on the palmette leaves, the volutes, and the external border. As shown by numerous analogies of other antefixes found in Marzabotto during the excavations of the 19th and 20th centuries (Bertani 1993, vol. 2, 64-81), it is possible to suppose the presence of a red stripe that runs around the external border (Fig. 3). The VIL technique did not detect the presence of Egyptian blue either on the architectural decoration of the temple of *Tinia* (Sassatelli, Govi 2005, 35-36), or on the roof tiles of the well in the center of the *Plateia* D (Sassatelli 1985, 158-160), or on a well curb decorated with dolphins and waves (inv. 568; see Sassatelli 1985, 160-161; 1991, 182). A most sophisticated polychromy characterized some flat shingles, found out in the 19th century and nowadays exposed in the National Museum of Marzabotto. These shingles, together with semi-cylindrical cover-tiles, assembled a mixed Laconic-Corinthian roof that is

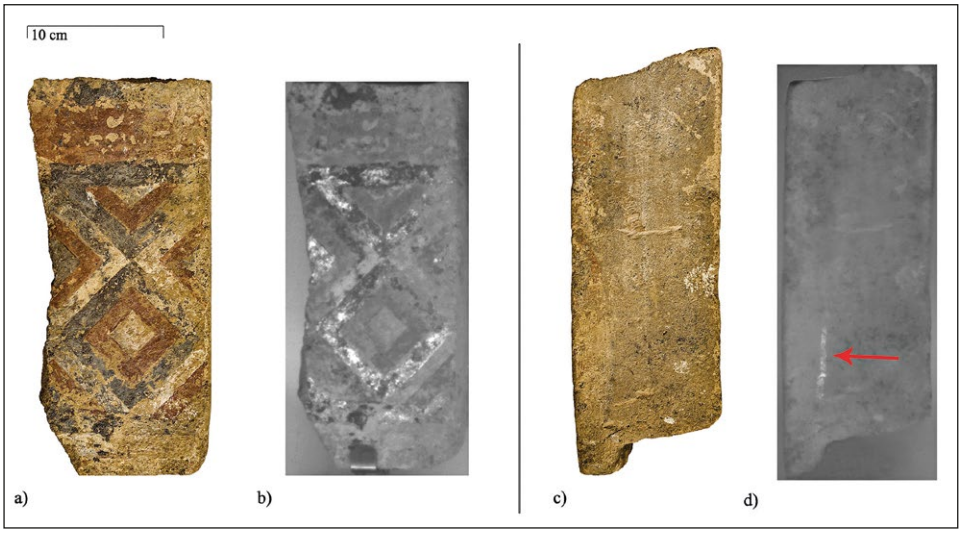

Fig. 4 – Tile fragment inv. 606. Lower surface and external surface of the raised border with a vertical line in Egyptian blue: a-c) reflected visible light; b-d) VIS-induced luminescence, under excitation from a Philips TLD lamp (pictures M. Natalucci and A. Rossi).

very common in the Marzabotto buildings (Gruška *et al.* 2017, 167). In particular, the tiles with a diagonal checkred pattern probably belonged to the pitched roof of the temple C on the acropolis (Vitali 2001, 50-51 and 60-62). In their painted decoration, the analysis attested the presence of red ochre, black, white and Egyptian blue. Thanks to the VIL technique, the use of the Egyptian blue in the Etruscan Po Valley has been proven for the first time, but the study allows us also to make further observations on the pattern and the technique of this decoration.

The position of the decoration and the fragment dimensions have allowed the reconstruction of the tile modules (Schifone 1967, 441, fig. 5; Bertani 1993, 165-167 and fig. 35). The eaves-tiles with nail-holes are decorated on the inferior surface along the shorter side, while the last tiles of the pitched roof present the painted pattern along the longer side and on one of the raised borders to create a sort of raked sima. The descriptions of G. Gozzadini (1865, 27, pl. 10) and E. Brizio (1889, col. 301, pl. IX) about painted tiles in a better state of conservation, found in the 19th century and nowadays lost, allow us to suppose a tile module of 84×44 cm. Indeed, it is possible to hypothesize the presence of four 11 cm-wide squares on the shorter side. Moreover, the nail-hole, that usually is placed at 2/3 of the tile length, is 28 cm far from the inferior edge. This hypothesis finds a confirmation in some flat shingles of *Tinia*'s temple that have similar dimensions of 84×47 cm (Sassatelli 2009, 332).

In the eaves-tiles, the decoration is a 28 cm-wide band, delimited by three horizontal lines (red, white, blue) along the border, and in the inner side by one blue line and a red stripe. The central area is adorned by a series of oblique squares. Each of them is composed of three inscribed squares with alternating colors. In the tile inv. 606 (Fig. 4), the squares continue on the external surface of the high raised border and they are delimited by a vertical line in Egyptian blue, not visible to the naked eye but detected by the VIL. This element highlights remarkable attention also to the non-visible details. The tiles, which were set on the facades, present the same diagonal checkered decoration along the longer side. According to the Gozzadini drawings (Gozzadini 1865, tab. 10.5), the decoration probably ended in the inner part with the same blue and red bands which, however, are not currently preserved in any fragments. D. Vitali has also recognized an example of angular tile with the decoration on both sides in a photograph of the previous Museum in Villa Aria (Vitali 2001, 62). Thanks to these elements, it is possible to suppose a decorated band that ran around the extremity of the roof along the four sides and that included the raked simas on the front and the rear of the temple (Schifone 1967, 441, fig. 5).

The presence of Egyptian blue has been detected in the fragments inv. 604, 606, 608, 609, 611, 612 and 614. The analysis has also permitted us to check the spatial distribution of the pigment on the surface (Figs. 4 and 6). The pigment is no longer visible in some areas, while in other parts its color is altered by a serious state of deterioration. The VIL shows that blue pigments were applied over a black layer, probably in order to obtain a darker blue. This technique has been detected also in other Etruscan architectural decorations that were found in Orvieto (Stopponi 1991, 1154-1155) and Vigna Parrocchiale in *Caere* (Bordignon *et al.* 2007, 33). The same procedure of superposing layers to obtain different hues is attested also in some Etruscan antefixes from *Caere* and Orvieto, currently preserved at the Ny Carlsberg Glyptotek of Copenhagen (Brøns, Hedegaard, Sargent 2016; Brøns, Sargent, Skovmøller 2016). The VIL also led to the hypothesis of different remakes and replacements of the roof decoration. Indeed, the Egyptian blue is not present in some tiles where there is just the black layer (inv. 605, 607, 610, 613, 615, 616). On the contrary, in the fragment inv. 614 blue and red are applied over a white layer and the black color is not used (Fig. 6). We can therefore suppose that the blue would have appeared lighter on this tile. Consequently, the same pattern was reproduced with different techniques, probably to substitute the old and damaged tiles in different periods.

With the high presence of calcite in the analyzed samples it can be supposed that the pigments were mixed with limewater and then they were applied by means of the fresco technique (Baraldi, Natalucci, Rossi 2017, 104; Winter 2009, 521-522). The result is a strong cohesion and a sizable thickness of the pictorial layer with a full saturation of colors.

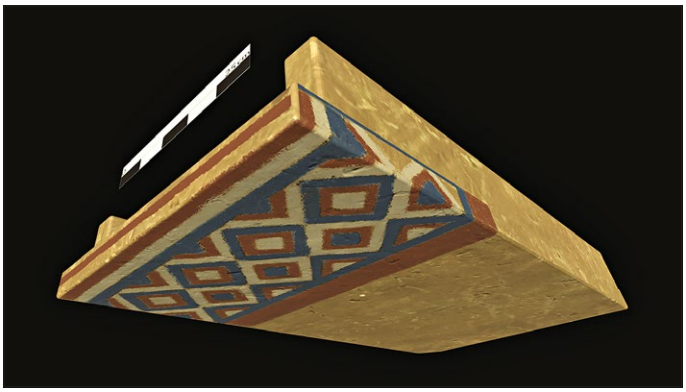

Fig. 5 – Reconstruction of the polychromy of the eaves-tile inv. 606. Scale on the picture: 25 cm (reconstruction M. Natalucci).

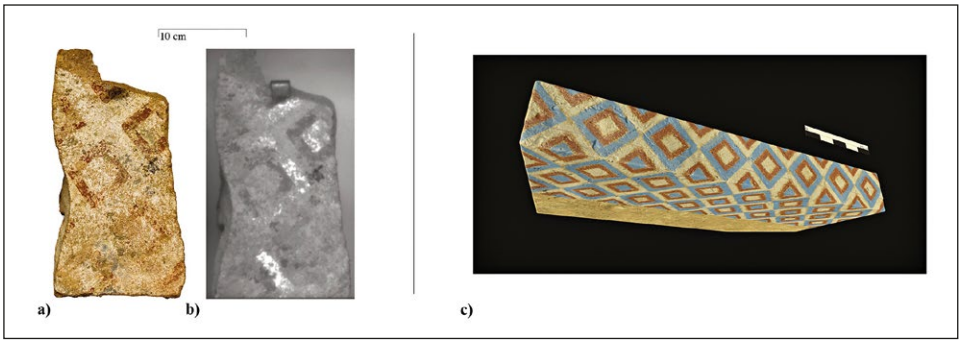

Fig. 6 – Final tile of the sloping roof inv. 614: a) reflected visible light; b) VIS-induced luminescence; c) reconstruction of the polychromy. Scale on the picture: 25 cm (pictures M. Natalucci and A. Rossi; reconstruction M. Natalucci).

At the end of the study, the program Blender 2.78c was used to shape a three-dimensional representation of the antefix of *Uni*'s temple (Fig. 3) and the painted tiles (Figs. 5 and 6). The main aims were the virtual restoration of the artefacts and the reconstruction of the ancient polychromy. The restitution of the original aspect of the architectural terracottas could be useful both for the research and for the dissemination. Indeed, 3D models can be combined to obtain a reliable proposal of the architectural decorations of the city buildings (Garagnani, Gaucci, Gruška 2016, 316). The simulation of the roof reconstruction in a digital environment leads to acquiring information about the complex system of coverage assembly and the congruence of the modules of the roof elements. In accordance with the complexity of the

assembly, specialized artisans and a preliminary project could be supposed, as the finding of an engraved letter on a tile fragment demonstrates (Bertani 1993, 120, pl. XXII.12). Furthermore, the 3D models can help the visitors to appreciate the lost polychromy and to contextualize the terracotta fragments, exhibited in the Museum.

The reconstruction of the antefix was achieved with integrations of the gaps according to the symmetrical composition of the palmette. The painted tiles were shaped based on the real measurements and the reconstructive hypothesis of the module. The main difficulty has been the rendering of the original polychromy. Indeed, it is necessary to consider the method to measure colors, their alteration due to external agents, and the final restitution of the terracotta materiality. The black, white and red hue that was used in the reconstructions was obtained from pictures of the architectural decorations, calibrated by means of the ColorChecker technology. In this way, it was possible to establish that the red ochre used to paint the roof tiles and the palm-shaped antefix had the same hue as the raw pigments found during the excavation of *Uni*'s temple. Since the blue appears degraded in the tiles, its shade cannot be considered for a realistic reconstruction, so the hue of the raw Egyptian blue pigments found on the site was used. To create the texture of the painted decoration applied on Blender, Adobe Photoshop CC 2014 was used. Different layers were added on the terracotta texture and a digital brush, which leaves marks of the brush strokes as it can be seen in the tile fragments, was chosen. The realistic texturing on Blender allows us to paint the decoration pattern without covering up the terracotta texture characterized by a sizable roughness. Because of the material properties and the lime binder, the colors were rendered with a high percentage of opacity. The technique of superposing layers of different colors, detected by the archaeometric analysis, were digitally simulated. To reproduce the dark blue, a blue layer with a transparency, which was set to 50% opacity, was added on a black layer (Fig. 5). Instead, in the reconstruction of the tile inv. 614, blue and red were overlapped on a white preparatory ground, so the colors appear lighter (Fig. 6). The digital reproduction of these two different techniques proves that they determine distinct chromatic effects.

In conclusion, this research retraced all the steps of the production of an architectural decoration, from the raw pigments to the final 3D digital reconstruction. Thanks to the archaeometric analysis, the decoration technique has been detected. Moreover, the study demonstrates that in the 5th century BC, in spite of what was previously thought, the artisans of *Kainua* knew and applied the new colors and the innovative techniques coming from the Tyrrhenian Etruria. This contact is confirmed in other similarities with the sanctuaries of the southern and north-central Etruria, such as the planimetric characteristics of the temples, the decorative systems and the epigraphy of

the votive texts, as E. Govi has recently highlighted (Govi 2019, 546-547). At the same time, it is clear that the polychromy in *Kainua* was not common and it was earmarked only for important buildings such as temples or sacred structures. That is because black, red and white pigments were easily produced or found in the area, while colors like Egyptian blue were probably rare and expressly imported. Finally, the reconstructions offer a better understanding of the decorative system of the city temples, which is usually found in a fragmentary state. They allow us to visualize the various chromatic results obtained with different decoration techniques, which can no longer be appreciated in the preserved fragments. Although many 3D models of Etruscan temples have been elaborated (Baglione *et al*. 2017, fig. 3), the philologically correct restitution of the architectural decorations still presents many difficulties: the fragmentary state of the finds, the lack of the complete decorative system and the different phases of redecoration could impede a complete reconstruction of a building (Taccola, Rosselli 2017, 246-247). Nowadays, numerous proposals of building reconstruction are based on 3D scans of roof elements, such as the house B and zone F of Acquarossa (Lulof, Sepers 2017). The BIM technology, recently applied for the reconstruction of the city of *Kainua* (Garagnani, Gaucci, Govi 2016; Garagnani, Gaucci, Gruška 2016), could represent a new approach to these problems. In the future, the study of the painted architectural terracottas may contribute to improve the restitution of the buildings in *Kainua*, which has already been realized in the project FIR 2013 KAINUA. *Reconstructing, Perceiving, Disseminating the Lost Reality. Transmedial Technologies for the Etruscan City of Marzabotto* (Garagnani 2017; Garagnani, Gaucci 2017).

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REFERENCES

Baglione M.P., Belelli Marchesini B., Carlucci C., Michetti M.L. 2017, *Pyrgi, harbour and sanctuary of Caere: Landscape, urbanistic planning and architectural features*, in Garagnani, Gaucci 2017, 201-210.

Baraldi P. 2011, *Appendice II. Indagine sui materiali neri delle stele orientalizzanti del Museo Civico di Bologna*, in M. Marchesi (ed.), *Le sculture di età orientalizzante in Etruria padana*, Bologna, Comune di Bologna, 231-234.

Baraldi P., Natalucci M., Rossi A. 2017, *Il blu egiziano a* Kainua. *Dai pigmenti alla policromia su terracotta*, «Ocnus», 25, 95-112.

Bellelli V. 2001, *II.A.3.3*, in A.M. Moretti Sgubini (ed.), *Veio, Cerveteri, Vulci: città d'Etruria a confronto. Catalogo della Mostra (Roma 2001-2002)*, Roma, L'Erma di Bretschneider, 130.

Bertani M.G. 1993, *L'architettura domestica dell'Etruria Padana nell'età della seconda colonizzazione: materiali e problemi*, Tesi di Dottorato, Sapienza Università di Roma.

Bordignon F., Postorino P., Dore P., Guidi G.F., Trojsi G., Bellelli V. 2007, *Pittura etrusca su terracotta: studio della policromia con tecniche analitiche*, in C. D'Amico (ed.), *Atti del IV congresso nazionale AIAR (Pisa 2006)*, Bologna, Pàtron, 25-35.

Brizio E. 1889, *Relazione sugli scavi eseguiti a Marzabotto presso Bologna dal novembre 1888 a tutto maggio 1889*, «Monumenti Antichi. Accademia Nazionale dei Lincei», 1, col. 249-426.

Brøns C., Hedegaard S.S., Sargent M.L. 2016, *Painted faces: Investigations of polychromy on Etruscan antefixes in the Ny Carlsberg Glyptotek*, «Etruscan Studies», 19 (1), 23-67.

Brøns C., Sargent M.L., Skovmøller A. 2016, *Egyptian blue: Modern myths, ancient realities*, «Journal of Roman Archaeology», 29, 371- 387.

Cristofani M. (ed.) 2003, *Caere 4. Vigna Parrocchiale: scavi 1983-1989. Il santuario, la residenza e l'edificio ellittico*, CNR, Roma.

Garagnani S. 2017, *Archaeological Building Information Modeling: beyond scalable representation of architecture and archaeology*, in Garagnani, Gaucci 2017, 141-149.

Garagnani S., Gaucci A., Govi E. 2016, *ArchaeoBIM. Dallo scavo al Building Information Modeling di una struttura sepolta. Il caso del tempio etrusco di* Uni *a Marzabotto*, «Archeologia e Calcolatori», 27, 251-270 (https://doi.org/10.19282/AC.27.2016.13).

Garagnani S., Gaucci A., Gruška B. 2016, *ArchaeoBIM: An innovative method for archaeological analysis of an Etruscan temple in Marzabotto*, in J.L. Lerma, M. Cabrelles (eds.), *Proceedings of the Arqueológica 2.0 - 8th International Congress on Archaeology, Computer Graphics, Cultural Heritage and Innovation (Valencia 2016)*, Valencia, Editorial Universitat Politècnica de València, 314-317.

Garagnani S., Gaucci A. (eds.) 2017, *Knowledge, Analysis and Innovative Methods for the Study and the Dissemination of Ancient Urban Areas. Proceedings of the KAINUA 2017 International Conference in Honour of Professor Giuseppe Sassatelli's 70th Birthday (Bologna 2017),* «Archeologia e Calcolatori», 28.2 (http://www.archcalc.cnr.it/journal/idyear.php?IDyear=20172-01-01).

Govi E. 2017, *La dimensione del sacro nella città di* Kainua-*Marzabotto*, in E. Govi (ed.), *La città etrusca e il sacro. Santuari e istituzioni politiche. Atti del Convegno (Bologna 2016),* Bologna, Bononia University Press, 145-180.

Govi E. 2019, *Terrecotte architettoniche dal santuario urbano di Marzabotto*, in P. Lulof, I. Manzini, C. Rescigno (eds.), Deliciae Fictiles V. *Networks and Workshops. Architectural Terracottas and Decorative Roof Systems in Italy and Beyond*, Malta, Oxbow Books, 541-549.

Gozzadini G. 1865, *Di un'antica necropoli a Marzabotto nel Bolognese*, Bologna, Tipografia Fava e Garagnani.

Gruška B., Mancuso G., Zampieri E. 2017, *Building Materials and Virtual Models of the Etruscan City of* Kainua, in Garagnani, Gaucci 2017, 165-176.

Guidi G.F., Trojsi G. 2003, *I residui delle attività produttive: caratterizzazione chimico-fisica*, in Cristofani 2003, 259-265.

Lulof P.S., Sepers M.H. 2017, *The Acquarossa Memory Project. Reconstructing an Etruscan town*, in Garagnani, Gaucci 2017, 233-242.

Mattioli C. in press, *La produzione ceramica locale di Marzabotto*, in L. Cappuccini, A. Gaucci (eds.), *Officine e artigianato ceramico nei siti etruschi dell'Appennino tosco-emiliano tra VII e IV sec. a.C. Atti I Convegno Internazionale di Studi sulla cultura materiale etrusca dell'Appennino (Arezzo-Dicomano 2019)*.

Melis F. 1970, *La tecnica di fabbricazione*, in *Pyrgi: scavi del santuario etrusco (1959-1967),* «Notizie degli Scavi di Antichità», 24, suppl. 2, 83-85.

Rossi A. 2011, *Appendice I. Indagini multispettrali sulle stele orientalizzanti del Museo Civico Archeologico di Bologna*, in M. Marchesi (ed.), *Le sculture di età orientalizzante in Etruria padana*, Bologna, Comune di Bologna, 225-230.

Sassatelli G. 1985, *Schede*, in M. Cristofani (ed.), *Civiltà degli Etruschi. Catalogo della Mostra (Firenze 1985)*, Milano, Electa, 158-161.

Sassatelli G. 1991, *Opere idrauliche nella città etrusca di Marzabotto*, in M. Bergamini (ed.), *Gli Etruschi maestri di Idraulica. Atti del Convegno (Perugia 1991),* Perugia, Electa editori umbri, 179-207.

Sassatelli G. 2009, *Il tempio di* Tina *a Marzabotto e i culti della città etrusca*, in G. Cresci Marrone, M. Tirelli (eds.), Altnoi. *Il santuario altinate: strutture del sacro a confronto e i luoghi di culto lungo la via Annia. Atti del Convegno (Venezia 2006),* Roma, Quasar, 325-344.

Sassatelli G., Govi E. 2005, *Il tempio di* Tina *in area urbana*, in G. Sassatelli, E. Govi (eds.), *Culti, forma urbana e artigianato a Marzabotto: nuove prospettive di ricerca. Atti del Convegno di Studi (Bologna 2003),* Bologna, Ante Quem, 9-62.

Schifone C. 1967, *Terrecotte architettoniche*, «Studi Etruschi», 35, 431-444.

Stopponi S. 1991, *Un acroterio dal santuario di Cannicella ad Orvieto*, «Archeologia Classica», 43, 1103- 1161.

Taccola E., Rosselli L. 2017, *Understanding Etruscan art and architecture trhough 3D modeling: The case of Volterra*, in Garagnani, Gaucci 2017, 243-252.

Torelli M. 1971, *Gravisca (Tarquinia) - Scavi nella città etrusca e romana. Campagne 1969 e 1970*, «Notizie degli scavi di antichità», 25, Appendice 2.

Trojsi G. 2001, *III.A.3.4*, in A.M. Moretti Sgubini (ed.), *Veio, Cerveteri, Vulci: città d'Etruria a confronto. Catalogo della Mostra (Roma 2001-2002)*, Roma, L'Erma di Bretschneider, 131.

Verri G. 2009, *The spatially resolved characterisation of Egyptian blue, Han blue and Han purple by photo-induced luminescence digital imaging*, «Analytical and Bioanalytical Chemistry», 394, 4, 1011-1021.

Vitali D. 2001, *La scoperta e i primi scavi dell'acropoli*, in D. Vitali, A.M. Brizzolara, E. Lippolis (eds.), *L'acropoli della città etrusca di Marzabotto*, Imola, University press Bologna, 11-92.

Winter N.A. 2009, *Symbols of Wealth and Power: Architectural Terracotta Decoration in Etruria and Central Italy, 640-510 B.C.*, Ann Arbor, University of Michigan Press.

ABSTRACT

The city of *Kainua* (Marzabotto), inhabited between the end of the 6th century BC and the beginning of the 4th century BC, is one of the most important and best-preserved Etruscan centers. During the excavations performed by the University of Bologna in the area of the temple of *Uni*, masses of rare red ochre and Egyptian blue pigments have been found. After this discovery, a series of analyses has been carried out in order to study the polychromy of the architectural terracottas of the site. Thanks to spectroscopic analysis, it has been possible to examine the composition of the pigments that were employed. Moreover, the Visible-Induced Luminescence (VIL) technique not only confirmed the use of Egyptian blue, but also allowed to rediscover the decoration pattern of some painted tiles which belonged to one of the temples of the acropolis. This discovery is very important because the use of Egyptian blue had never been attested before in the Etruscan Po Valley. Lastly, the study has allowed to create a 3D reconstruction of some painted architectural elements, which are preserved nowadays in fragments.