MS45 O1

Where, when and how many times did the Islamic artists discover quasicrystalline tiling? Emil Makovicky
University of Copenhagen, Denmark
E-mail:emilm@geol.ku.dk

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The first unambiguous occurrence of a quasicrystalline pattern are panels covering the walls of Gunbad-e-Qabud, a tomb-tower in the town of Maragha,,NW Iran, dated 1196-1197 CE. Here and later the Islamic artists worked the aperiodic patterns as (portions of) cartwheel patterns, with N-fold point-group symmetry. The tiles involved, pentagons, butterflies and rhombs, as well as their compositions and 5-fold rotation-symmetric composite tiles were frequently used in 12-13th century but their quasicrystalline composition in Maragha appears unique and was repeated only later, in ~1450's in Isfahan and other Iranian localities. The Maragha tiling and later quasicrystalline varieties display inflation/deflation, allow drawing of Ammann bars and at Maragha even geodesic walks were constructed by the artists themselves. However, the quasicrystalline discs are embedded in periodic designs, with overall frieze- or plane groups of symmetry.

The artists of Eastern Islam constructed their designs on a polygonal basis, composing the above tiles or using simpler underlying polygons. Those of western Islam, in Islamic Spain and Maghreb, used a different approach which can be called 'star-studded quasilattices'. The leading creations from this region contain systems of Ammann bars in quasiperiodic alternation of unit and τ intervals in the case of decagonal patterns and unit and $\sqrt{2}$ intervals for octagonal quasicrystalline cartwheels. This geometry is accentuated by white stripes. Suitable bar intersections are decorated by 5- and 10-fold stars/rosettes or, alternatively, 8-fold stars. If required by ornamentation, phason excitations may be introduced by flipping portions of adjacent bars with unit and τ (or $\sqrt{2}$) widths up to several times in the same interval in those places where quasiperiodicity allows it. The 10- or 8-fold rotational symmetry of the cartwheel is usually accentuated by colouring of the background fields.

Variations include central discs, omission of white stripes, insertion of central rosettes with fancy configurations, and 'averaging' of 1- and $\sqrt{2}$ bars creating a new stripe configuration. Most probable dating of these patterns is between 1320 and 1370 CE. Later examples in Morocco stress a division into a kaleidoscope of colourful fields combined with large rosettes while keeping the underlying pattern of quasiperiodic bars. Beauty of all these creations cannot be reflected in this dry geometric description. The intricate web of references and claims will be addressed during the talk.

MS45 O2

Polychrome Etruscan glass: a non destructive study by µXRF, µXANES and XRPD Rossella Arletti[a], Giovanna Vezzalini[a], Simona Quartieri[b], Daniela Ferrari[c], Marco Merlini[d], Marine Cotte[e]. [a] *Department of Earth's Science, University of Modena and e Reggio Emilia, Italy.* [b] *Department of Earth's Science, University of Messina, Italy.* [c] *University of Bologna, Italy.* [d] *OGG, c/o ESRF, GILDA CRG, Grenoble, France.* [e] *ID21, ESRF, Grenoble, France.* E-mail: rarletti@unimore.it

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Archeometrical research recently carried out allowed obtaining previously unavailable information on glass composition and production technology. Several Roman age [1] and Bronze age finds [2] have been analysed, but no data are available in literature on the Etruscan period. This work is specifically devoted to the characterization of a new group of very rare, both transparent and opaque, highly decorated glass artefacts-in particular a suite of glass beads and vessels, belonging to the iron Age (from 7th to 4th B.C.), which have never been archaeometrically studied up to now .The most serious difficulty in developing this study was that any destructive sampling was absolutely forbidden, due to the perfect conservation state of the samples. The mineralogical and chemical nature of the chromophores and opacifiers used in Iron age glass manufacture were identified by means of micro-X ray fluorescence, micro X-ray absorption at the Fe and Mn K-edges and X-ray powder diffraction. The samples, deeply coloured and decorated, can be divided into three groups on the basis of their appearance: i) dark blue glass with yellow and light blue decoration, ii) black glass with white decoration, iii) violet glass with white decoration.

The µ-XRF mapping allowed the qualitative composition to be determined for each colour, highlighting the high level of Pb and Sb in yellow decoration and the presence of only Sb in the white and light blue ones. Violet and black glasses present higher amount of Mn and Fe, respectively. The XRPD analyses confirmed the presence of lead antimonates in yellow decoration and of calcium antimonates in white and light blue parts, whereas no crystalline phases were detected in dark blue, black and violet bulk glass. Fe and Mn K-edge µ-XANES were collected on several points enabling the mapping of the oxidation state of these elements across the samples. In general, the Fe XANES evidenced that iron is present in its reduced form in the bulk glass of the all vessels, while in the oxidised one in the decoration, indicating that these glass were produced in two distinct working steps. Due to the extreme dilution of Mn in most of the samples, the Mn K-edge XANES analyses was performed only on violet and black portions of the samples, where the collection of a good signal was possible. The results show that almost all manganese is present in the glass in its reduced form.

[1] Arletti R. "The ancient Roman Glass: an archeometrical investigation", PhD thesis, University of Modena and Reggio Emilia (2005).

[2] Angelini I., Artioli G., Bellintani P., Diella V., Gemmi M., Polla A., Rossi, A. J. Arch. Sci, 2004, 31, 1175,