# Cobalt blue in medieval ceramic production in the Valencian workshops

## Manises, Paterna and Valencia, Spain



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*Summary*

*Cobalt was first used in the production of lustreware, providing improvement in the manufacture of tin glaze earthenware decoration during the first half of the fourteenth century. X-Ray fluorescence analysis suggests a variation in the detected spectrum of blue pigment through the years; this fact, when considered with shape and decorative evolution, allows us to propose a very close dating for some decorative groups produced in Manises and Paterna. That is the main target of this paper.*

### Introduction

In this paper we will discuss the results of the most recent research on the characterisation of cobalt blue pigment and the technical aspects of Medieval blue ware production from Medieval Valencian workshops.

### First archaeological finds

In 1907 a site known as El Testar del Molí was discovered at Paterna. This comprised an enormous deposit of medieval ceramic wasters. Massive excavations financed by antique dealers such as José Almenar, Vicente Gómez Novella and Vicente Petit then began. The following year the ceramics were shown at the Retrospective Exhibition of Lo Rat Penat held in honour of Jaime I, the founder of the Kingdom of Valencia. On celebrating its centenary in 2008, it is particularly appropriate to recall that in González Martí's texts on cobalt blue majolica we find the first careful description relating to its manufacture (González Martí, 1908). The author emphasises that the cobalt was applied under the glaze, and indicates that he has observed evidence of this on tiles and fragments of bowls, plates and jugs in which the design is drawn in black strokes which turn blue where they have been splashed by a drop of glaze.

### Historical references

It is worth recalling here that, as García Porras (2002) has explicitly stated, the earliest blue documented archaeologically, in Hispano-Muslim pottery of the Almohad period, was achieved using not cobalt but copper oxide. This was a turquoise or blue-green pigment obtained by mixing a small proportion of copper oxide with a lead-tin glaze, known since at least the Taifa period, though used at that time only in cuerda seca (dry line or resistware) decoration.

This colour is mentioned in Cardinal Audoin Aubert's contract with potters from Manises and Paterna to make 'regolarum et operis de Melicha sive tebularum terre pictarum invernizatarum colorum videlicet lividi albi viridi et morati' for Avignon (1358–1364). The fact that 'safre' is not used seems to indicate that cobalt was not yet widespread at the time. Indeed, the medieval documentation uses several terms to refer to blue, such as the Latin lividus, which the author believes refers specifically to turquoise, and the Catalan blau, safre, açafre or the Italianate azur or zaffera (Porter 1997; Caroscio 2008) for the cobalt blue.

The first document that mentions cobalt in the Valencian area is dated 1333, and indicates that it was combined with gold pigment: 'opus terra daurati cum safra' (López Elum 1984, 33). Both safre and the Castilian word zafre are apparently derived from the Arabic s'afra or s'oufr, meaning rust-coloured, golden, yellow or shiny, and this is presumably also the origin of al-zâfran. The term could have originated from the Latin word sulphur, associating the name of the pigment, in this case, with the natural colour of the raw material. This seems very likely, bearing in mind that many cobalt-rich minerals utilised in the Middle Ages had a reddish, ochre-coloured or reddish-white colour and a shiny appearance. Perhaps the process of turning the mineral into an artificial pigment through the techniques employed in glazing and in the glass and ceramics industry led to the term safre being associated with the resulting dark blue colour, or even black, bearing in mind the Hispano-Arabic term *çáffra*, recorded by the vocabulist Pedro de Alcalá (Coll Conesa 1995).

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## Archaeological wasters and technical inferences

### Manufacturing process

Good archaeometrical data exists to help us understand the general aspects of medieval ceramic technology in Spain (Molera et al 1999). Nevertheless, turning now to the way in which decorative strokes in that pigment were initially applied to Valencian earthenware, according to the classic hypothesis, was by painting directly onto the layer of tin-glaze. This was applied to the object by immersion when it had already been bisque-fired, which must have been the most common procedure; however it may have required the use of some sort of organic binder incorporated into the glaze (gum arabic, starch, etc.) to avoid imperfections in the brushwork. People have defended this technique while forgetting about about González Martí's views on underglaze cobalt decoration which he stated long ago (Coll and Pérez Camps 1993; Coll Conesa 2002). His views were even refuted by some authors without solid arguments (Mesquida 2001a, 2002, 2004).

Nevertheless, there are abundant examples of bisque fired pieces decorated with blackish strokes of fired cobalt with no tin-glaze (Fig. 1) (Coll and Pérez Camps 1993). González Martí assumed that the piece was thrown, dried and bisque-fired, then painted with the cobalt and later bathed in tin-glaze. It was then ready for the second or 'fine' firing, so that the blue emerged with the glaze if an adequate firing temperature was reached. If not, the blue decoration appeared very faint or faded, as can be seen in some shards. The presence of pieces that have been fired and decorated only with cobalt, without glaze, does not explain the latter evidence, since it implies that the two phases, painting and immersion in the glaze before the second firing, must have been consecutive, and just prior to loading and firing the kiln. Why, then, do we find occasionally pieces painted with blackish designs with accidental splashes of glaze showing the blue colour?

A satisfactory explanation for the phenomenon was found in the excavations carried out by V. Algarra and P. Berrocal (1993) in Manises. Sure enough, in the workshop known as 25 Valencia Street in that town a pottery was found with rectangular workrooms arranged around a courtyard. Inside the buildings, next to the walls, a series of cavities dug into the floor indicated the substructure of the potter's wheels, of a semi-interred type, together with basins which contained clay, and the remains of various fittings. The structures were certainly very similar to those excavated in Paterna by Mercedes Mesquida (2001). The greatest surprise was finding hundreds of fragments inside some of the clay basins from pieces that had been thrown and were already decorated with cobalt (Figure 2); these probably broke during the drying process and were then thrown back into the basin so as to reuse the clay in the next batch. The decorations were exactly

**Figure 1**
Jug decorated with cobalt after first firing, without tin-glaze. Ayuntamiento de Valencia Collection in the National Museum of Ceramics.

**Figure 2**
Unfired fragments of majolica painted in cobalt blue. Museu de Ceràmica de Manises, from Valencia 25 street excavation.

**Figure 3**
Fragment of pitcher decorated with cobalt after first firing, with blue emerging under tin-glaze drops.
Museu de Ceràmica de Manises.

**Figure 4**
Fragment of dish showing the lost of tin-glaze only above the cobalt lines.
National Museum of Ceramics.

the same as those usually found on pieces decorated in blue, and therefore these were objects made in the usual way. This helped to solve the question of why there were bisque-fired pieces painted with cobalt but unglazed, since these were the result of the first bisque firing. Indeed it demonstrates a procedure similar to the common technique of shaping and painting Chinese porcelain decorated with cobalt (one-step firing method after glazing described by Juan, Leung and Jiazhi, 2007).

The splashes explain another interesting technical aspect, given that no boxes (saggars) were found for firing the glaze. In this case the splashes suggest that the pieces to be bisque-fired were placed in the oven so that they formed a sort of protective screen round the pieces being glazed. When the glaze boiled it could have splashed the pieces being bisque-fired, which were sharing the kiln, and thus drops of glaze formed on pieces that were only bisque-fired (Figure 3).

However, on a practical level the foregoing procedure made production less versatile by limiting its ability to respond to the changing demands of the market, since once the pieces were painted the designs could not be erased before they were fired. Perhaps for this reason, other material evidence suggests that on other occasions the cobalt was applied to the bisque after firing. Some objects show that the glaze has only become detached along the line of cobalt oxide, and the only explanation for this is that the cobalt pigment has acted as a barrier between the glaze and the ceramic body causing poor adhesion between the interface and the supporting surface (Figure 4). An excess of cobalt in the previous procedure, applied before bisque-firing, could also cause a similar problem, in which case we ought to find evidence of a blackish line firmly integrated into the supporting surface.

Finally, Gratuze and others (1996, 81) have detected a third procedure for painting with cobalt on tiles produced by one Jehan de Valence (le Sarrasin) at Bourges for the Duc de Berry's chateau of Mehun-sur-Yèvre in 1382. In these the safre is found in a vitreous layer applied under the glaze. One can surmise that in this case the blue came in a vitreous emulsion which remained at the interface between ceramic body and glaze as a clearly independent and distinct layer. This procedure would solve the problem of applying cobalt

to unfired (or bisque) ware by incorporating the actual pigment into vitreous fluxes, but so far it has not been detected in other examples and it could be due to the unusual use of a pigment in a vitreous preparation.

## Cobalt pigment composition detected

### Composition and provenance

Previous studies have considered the nature of the cobalt pigment in order to discover its provenance and so suggest the possible origin of the technique, and the resources and channels of its commercial transmission. Using LA-ICP-MS analysis, Gratuze and others found similarity between the composition of the cobalt pigment used in the glass industry and that used for ceramics, and proposed four chronological groups (Pérez Arantegui et al. 2008).

A research project on cobalt in Valencian ceramics was recently developed using EDXRF spectrometry analysis, led by the González Martí, National Museum of Ceramics and Sumptuary Arts and the Archaeometry Unit of the Materials Science Institute at Valencia University (Coll et al. 2002; Roldán, Coll Conesa and Ferrero 2006 and 2008; Roldan et al. 2004); it was carried out to focus on this issue, as an essential part of the problem, and also to try out non-destructive standardised classification methods. It involved obtaining relevant information on the nature of the chemical composition associated with cobalt between the fourteenth and the nineteenth centuries. An initial study was carried out on 73 fragments to detect the major components associated with cobalt (Mn-Manganese, Fe-Iron, Co-Cobalt, Ni-Nickel, Cu-Copper, Zn-Zinc and As-Arsenic), though without any quantitative approximation; in broad terms it is considered that this technique allows one to correlate the data obtained with the proposals made by the authors mentioned above. From this, four groups of combinations are derived:

#### **A** Fe-Co-Zn combination

This is found in 16 fragments. It presumably indicates a cobalt ore originally associated with Zn. A first rough approximation indicates that the samples could be dated between the fourteenth and the fifteenth century.

#### **B** Mn-Fe-Co-Ni combination

This is where the presence of Mn define the group. This has been found in 16 cases, with the variations Mn-Fe-Co-Ni-Cu in 3 cases, Mn-Fe-Co-Ni in 6, and Mn-Fe-Co in 3. The presence of Mn could indicate that an asbolane was used or added in order to reduce the diffusion of the cobalt, since the latter acts as an antiflux. This association seems to extend from the end of the 14th century to the 19th.

#### **C** Fe-Co-Ni-Cu and Fe-Co-Ni combinations

This is where the presence of Ni defines the group. Co-Ni-Cu is found in 14 samples from the 14th and 15th centuries, whereas Co-Ni appears in 11, dated between the 15th and the 20th century. The basic association allows us to postulate that the original ores could have been erythrite or smaltite, both containing arsenic (As), although this component could have been lost during the process of roasting the ore beforehand at high temperature. However, pyrites are also found with low proportions of Ni-Co and no As.

#### **D** Fe-Co-Ni-As combination

Arsenic is the characteristic element in a group of 16 samples all dating from the sixteenth century onwards. The ore employed could have been the same as in group C, but the preparation involving roasting at high temperature which preserves the As.

Also, the use of EDXRF non-destructive analytical techniques, has enabled us to work out protocols for the detection of underglaze and overglaze decoration (Coll Conesa et al. 2002; Roldán et al. 2004).

Recently the LA-ICP-MS technique has been tried out on part of the group previously analysed in order to compare the validity of the two methods. The results were similar in terms of qualitative measurements, though more precise, since they refer only to samples taken from the glaze. The most notable conclusion is confirmation that Zn, Mn and As are the best discriminants and that elements such as Fe and Ni have less characterising value. However, despite that fact those elements will still be recorded in future evaluations, since in the author's point of view they do not alter the overall reading and at the same time they may add information of interest, particularly in the light of the constant presence of Ni in samples from the 15th century and its clear absence in earlier times.

In the light of this and according to the results of our analyses, the great variability of the samples allows us to suggest the possibility that the cobalt came from a local ore, such as asbolane (Mn-Co and Co-Cu) from Chóvar (Castellón), the closest deposit to both Manises and Paterna, lying 50 km away; erythrite from Guajar in Granada, Málaga and Almería; pyrite with low Ni-Co content from Chodes (Zaragoza); skutterudite and chloanthite with As from Gistain (Huesca) (Porter 1997). However, no medieval documentary evidence exists to prove this.

Apart from this, we are still faced with the problem of whether the technique arrived with the craftsmen who brought the more specialised raw materials, such as cobalt. The 14th century documentary evidence from Manises could be of interest, as it is stated in the earliest contracts for earthenware that the contracting merchant had to provide the main components of the glaze (tin and lead); nothing is said about the

elements which gave it added value, such as copper and manganese pigments, cobalt, or the cinnabar, silver and iron needed to carry out the secret technique of lustreware.

### Valencian Majolica Series decorated with cobalt

The relationship between the majolica series that were manufactured, their dating and the mineral composition associated with the cobalt may perhaps enable us to answer some questions about seriation and relevant technical aspects, which I shall now proceed to break down in detail.

### Lustreware with blue decoration

The first type of production that presents cobalt decoration in the Valencian area has historically come to be known as 'early Málaga style', based on terms that appear in the documentation as 'opus aureum et album' (Manises 1326) or 'operis terre Maleche [...] cum picturis dauratis prout dicte operi pertinebat' (Manises 1332), which were synonymous according to López Elum (1984). A certain confusion is involved in defining Valencian majolica as 'Málaga style' when we know that there are examples of lustreware made in Málaga which do indeed have traditional 'Málaga style' decorations and Hispano-Muslim subject-matter, just as there were in Granada or Almería. In order to standardise the terminology for general purposes an abbreviated nomenclature using acronyms has recently been proposed (Coll Conesa 2004a, b; 2010). Once codified, this enables one to establish comparisons with series produced in other places. It has been also proposed to standardise other types of Valencian medieval majolica production. Of these, listed here are those that present decorations in cobalt, along with their stylistic, chronological and archaeometric characteristics, according to current knowledge.

The reader will find below the acronyms, meaning, and association to a detected blue cobalt pigment composition together with accompanying chronological information about the series.

*Early lustre and blue Málaga-style Valencian lustreware (LVMDA)* (Coll Conesa 2010, 74; Figure 5)

This is characterised by decoration organised in a banded pattern, with one or two borders of intersecting undulating fillets and a medallion in which the axes of the composition are traced in blue, with elongated squares, stars, metopes or bands. Documentary evidence with phrases such as 'opus terre daurati cum safra' (Manises 1333) probably offer the first known reference to the existence of this series, along with the group Loza Valenciana Malagueña Dorada (LVMD: gold Málaga-style Valencian lustreware) (Coll Conesa 2010, 75), cited in references as 'opus aureum et pictum' (doc. from 1325). Both seem to be the early lustreware

**Figure 5**
Fragment of early lustre and blue Málaga-style Valencian lustreware.
National Museum of Ceramics.

products and are the first to appear in archaeological contexts, which must therefore be contemporaneous with the documentation cited.

Pieces from these series have been found both at Manises, in the workshop at 25 Valencia Street (Algarra and Berrocal 1993), and at other urban sites (personal communication from J. Pérez Camps), and are always associated with wares decorated in green and black in the classic style (Pascual and Martí 1986); they are the oldest examples of majolica documented in this city. At Paterna (Mesquida 2001b) individual examples are found on certain urban sites such as no. 93 Molinos Street, where we see bowls with metopes enclosed in blue trefoils in profile, and in Conde Montornés Street, which has yielded designs with heart-shaped leaves and spirals, in lustre only. In Valencia it has been found in the rectangular pit in La Almoina, in the Vall Vell in contexts earlier than 1348 (UE 5111), in the levels covering the Bab al Hanax cemetery, in Palma of Majorca in pit 7 at Santa Catalina de Sena (1311–1343), and in Torre Bofilla (Bétera) (1310–1348/58) (López Elum 1994). A group of Spanish bacini – in our case towers decorated with bowls – such as San Francisco in Pina de Ebro (1325–1350), or Italian ones as the bacini at Santa Susana in Busachi (1330–1342) or San Antonio in Orosei (1330–1350) (Hobart and Porcella 1996); the last two in Sardinia support the dating evidence.

The composition of the cobalt pigment exhibits the combination Fe-Co-Zn, coinciding with oriental pieces from Kashan preserved in the National Museum of Ceramics (Spain), except in one case where Mn also appears.

*Developed Málaga-style Valencian lustreware (LVMDE)* (Figure 6)

This series includes pieces with lower or more open, flared profiles, which sometimes present a darker gold colouring, with decorations very similar to those in the gold and blue series in the previous group. It differs

**Figure 6**
Dish of developed Málaga-style Valencian lustreware.
National Museum of Ceramics

**Figure 7**
Bowl with Pula type decoration, from Manises.
National Museum of Ceramics

from that series in the complexity of the borders, by incorporating zigzag lines or plant-scrolls or bands of heart-shaped palmettes, as well as striped palmettes with internal virgulae, dotted panels, human or animal figures, and by the fact that the star-shaped compartmentalisation occasionally extends over the whole piece, in examples from pottery 1 in Huertas Street in Paterna (Mesquida, 2001b: nos. 30 and 31). It is worth recalling that the pieces from this source include some in the Pula style, which are clearly similar to those in the original group, and others which do not display such clear parallels. Torre Bofilla, abandoned in 1348, features LVMDA and LVMDE pieces, but these are not similar to the group discovered at Pula.

The composition of the cobalt pigment shows the combination Fe-Co-Zn, except in one case where we also find Cu, an element of no great significance, since it is the main constituent of the lustre-red colouring.

*Valencian lustreware from the Pula group (LVDP)*
(Coll Conesa 2010, 75; Figure 7)

This series was originally defined by the collection of Valencian and Malaga lustreware found in the church at Pula (Sardinia), together with the odd piece decorated in green and black. Studies by Van de Put, González Martí (1944), Olivar Daydí (1952) and Blake (1986), among others identified its specific character by establishing that it originally came from Valencia, and especially from Paterna.

The Italian bacini illustrate the early presence of pieces with simple radial decorations which can be assimilated into the Pula group in Santa Maria Novella in Pisa (1330–1332) and in the Ospedale vecchio di S. Giovanni in Rome (1338–1348), which are already combined with pieces exhibiting pseudoepigraphic cartouches and cross-shaped composition in Sant' Ambrogio Nuovo in Varazze (1338–1350) and in San Tommaso in Pigna (1340–1350), to cite a few cases (Berti, 2002). Pine cones with golden tassels are found in Sant'Ambrogio in Varazze, where they apparently date from before 1350. Subsequently numerous locations are recorded, such as Santa Maria Maggiore in Rome (1370–1380), the convent of Sant'Anna in Pisa (c. 1375) and Sant'Antonio Abate at the Steri Palace in Palermo (1350–1382). In Paterna such pieces have been found in contexts at pottery 1 and 4 in Huertas Street, in the Castle moat and in the Clot at the excavation in the Plaza del Pueblo, corresponding to what has been called the first period of production there (Mesquida, 2001b, 2002). In Valencia they have appeared in Unión Street, at a site datable to between 1363 and 1395, and moreover we know of several wrecks in Spanish waters, at El Puig Ibiza and Arenys, containing collections characteristic of the second half of the 14th century (Coll Conesa 2010, 76).

As in the previous groups, the Fe-Co-Zn combination continues to predominate, but Cu is more widespread and in one case Mn appears.

*Classic Valencian lustreware with blue (LVDAC)*

Fifteenth-century lustreware includes at least three major styles, and the corresponding series alternate over time (Coll Conesa, 2004b; 2010, 83–92).

The first displays decorative elements of Islamic or Persian origin (LVDACM [Muhammadan (after Frothingham 1951) classic Valencian gold and blue lustreware, ]), with motifs such as alafias, solid arabesques, borders of fish, spirals and parallel lines, the hom (tree of life) and pine cones, spurs, lattice circles, sebqa tracery, etc. (Figure 8).

The second includes Gothic motifs (LVDACG), with the following series: Ave Maria, IHS, bryony, parsley, dotted flowers, crown, ferns, chestnut, flowers and bow, half orange, fleshy arabesques, thistles, and ivy leaf (Figure 9).

**Figure 8**
Flower-pot, so-called *alfabeguer*, decorated in Muhammadan style, from Manises. Museu de Ceràmica de Barcelona.

**Figure 9**
Dish with briony decoration, from Manises.
Museu de Ceràmica de Barcelona

Levels III–IV at 23 Castillo Street in Paterna offer us lustreware with spirals and parallel lines, Persian rosettes with blue lobes, borders of fish, bands with alafias and large zoomorphic motifs outlined in gold, which can be dated to between 1375 and 1415. Moreover, the Castell Formós site in Balaguer could provide an illuminating insight into the series current at the turn of the century (Pascual and Martí 1985). This castle, the fief of Jaume de Urgell, was destroyed in 1413 by the army of Fernando of Antequera in the course of the wars precipitated by the succession of Martin the Humane. Among its remains there were heraldic pieces attributable to Pere de Urgell or to Jaume and the Infanta Isabel of Aragon (married in 1407), with decorative motifs of vegetal tendrils and small-leaved trefoils, spirals and parallel lines, pieces from the Pula group, plates with Ave Maria epigraphic motifs, dotted flowers, parsley leaves and crowns: series which were to extend over a considerable period of time in the fifteenth century. In the first half of this century, in addition to the styles of Islamic origin, the predomi-nant mode was the Gothic (LVDCG), incorporating naturalistic motifs from this tradition very closely related to series with decorative elements of a vegetal character (bryony, ilex, dotted flowers, etc.)

The categories of chemical composition which arise in series from the end of the fourteenth century until the mid-fifteenth century are:

Fe-Co-Zn in pieces decorated with spiral and parallel motifs and triple blue rosettes.

Fe-Co-Zn-Mn in pottery with motifs of tiny leaves.

Fe-Co-Zn with Ni in crown pieces, some of which also include Cu.

**Figure 10**
Dish with plateresque decoration, silversmith style
National Museum of Ceramics, acc.n. CEI/13030

Fe-Co-Ni in pottery from the Muhammadan group and with large ivy leaves, and also with Cu in the alafia and Muhammadan series.

In the second half of the century decorative styles show a continuity with those of Islamic and Gothic origin. Naturalistic motifs become more abundant, with the appearance of so-called ataurique arabesques, developed ivy leaves, thistle leaves, and also, in the last quarter of the century the silversmith style (LVDCO) which characterises this phase in pieces which seek to

emulate metalwork, with tiny motifs (a diaper pattern of dots and stalks, Frothingham 1951), thistle flowers and florets, lacework, seeds, medium-sized ivy leaves and four-lobed palmettes, etc. (Figure 10).
As regards cobalt we find the following groupings:

Fe-Co-Ni-Cu-Mn, in pieces with ataurique arabesques.

Fe-Co-Ni-Mn-As, associated with pieces clearly belonging to the sixteenth century, according to the conclusions of Zucchiatti, who detects As from 1517 onwards (Zucchiatti et al, 2006).

## Blue majolica

Medieval Valencian potteries in Manises and Paterna, among others, produced an huge quantity of majolica decorated in blue on white during the 14th and 15th centuries, a very widely distributed utilitarian product.

Some years ago it was proposed that the seriation of blue on white Valencian majolica be divided into four groups (Coll Conesa 1995; 2004a; 2010, 76–79):

*Simple Valencian blue majolica (LVAS )* (Figure 11)

This series shows decorations based principally on a radial scheme, although designs with a spiral or concentric rhythm are also common, the latter being confined to fillets forming hoops or rings, occasionally rounded off with some sort of circular medallion. The brushstrokes are careful and assured, fairly fluent and not excessively elaborate. They are tin-glazed on both the obverse and the reverse. Within this group we find pieces in the 'Málaga style' (LVASM) (Figure 12), so called by virtue of their very close similarity to Nasrid models, in that they exhibit radial or central compositions. We can find Islamic motifs directly inspired by blue and gold Málaga lustreware, with stems topped by Muhammadan pine-cones.

The Geometric group (LVASG), consisting of less carefully executed pieces in intense blue with a tin-glaze of very variable quality, some examples even being unglazed on the reverse, dominated by single-motif, highly geometrised radial decorations, such as bowls with palmettes or with spiral-shaped designs of reticulated palmettes, and with circles or squares in the background. It is derived from the previous series and apparently began to be produced from the third quarter of the 14th century, doubtless continuing well into the 15th. Other pieces display concentric fillets usually enclosing a small central medallion with a stylised face (Figure 13) or palmettes, more carelessly made and belonging to the last phase of production, which lies mainly within the 15th century. Finally some pieces with naturalistic motifs occasionally present human or animal figures, clumsily drawn and tending to be geometrised, with small filler elements such as polygons of lines and spirals. In these the design occupies the whole surface, filling the spaces with abundant microelements, though without going so far as to present decoration as dense as that in the following group.

In this group we find the following compositions associated with the blue pigment:

Fe-Co-Ni-Cu, for majolica decorated with small asymmetrical vegetal elements (LVAS) or radial palmettes (LVASG).

Fe-Co-Ni-Mn, in pieces with radial palmettes (LVASG).

Fe-Co-Cu, for LVASG pieces with the large radial palmettes.

The absence of Zn from most of the group analysed indicates that these products can be dated to the 15th century.

**Figure 11**
Small cup of LVAS blue on white group.
National Museum of Ceramics, acc.n. CEI/00747

**Figure 12**
LVASM early group.
Ayuntamiento de Valencia Collection in the National Museum of Ceramics

*Complex Valencian blue majolica (LVAC)*

This type exhibits bands or medallions of considerable decorative density and of a highly geometrical nature. It is very difficult to make out the initial source of inspiration, generally from Málaga-style motifs, adapted in the Nasrid melting-pot from so-called Sultanabad or Ilkhanid pottery. An underlying Far Eastern influence can be perceived in them, given that some bowls in the LVAC series seem to have been inspired by products of the Hongwu era (1368–1399), in that they exhibit decorative elements common in Ming porcelain, such as the 'borders of fish', which recall borders on those kinds of porcelain. The blue is dense and applied with assured strokes. Within this group, the decoration in the geometric series predominantly consists of open forms on the inside and closed forms on the outside, fully occupying the available space. The bowls and plates exhibit one or more horizontal bands arranged in a concentric pattern and generally enclosing a central medallion (Figure 14). In the closed forms the same elements can be seen in horizontal bands and fillets on the outside (Figures 15 and 16). Despite their geometric appearance, one can see that they were inspired by naturalistic, vegetal or epigraphic motifs (alafias, palmettes, etc.) A variant of the geometric series makes sporadic use of naturalistic elements, such as deer, birds or human figures, with frames formed from pavilions of parallel lines and spirals. They seem to have begun in the third quarter of the fourteenth century, although they continued to be produced after this.

Apart from a fragment of a decorated, unfired bowl, we do not have any chemical data on the elements associated with the cobalt in this group.

**Figure 13**
LVASG bowl with radial decoration.
Museo de Cerámica de Paterna

**Figure 14**
LVAC cup with band decoration.
National Museum of Ceramics

**Figure 15**
LVAC decoration on a jug or pitcher.
National Museum of Ceramics

*Schematic Valencian blue majolica (LVAE)*

The identifying feature of this group is that it offers a very simple, fluent type of decoration, generally executed with rapid, careless strokes, in which the elements stand out by virtue of the large empty spaces in the composition and are clumsily drawn, with filler motifs repeated fairly rhythmically. These were doubtless the most inexpensive products among the varieties of majolica decorated in blue cobalt. The glazes tend to have a low tin content and hardly ever cover the reverse. Some authors argue that the schematic series must be contemporaneous with the green and manganese majolica from the end of the thirteenth century or the beginning of the fourteenth, because of the coincidence between their borders of strokes and elements such as the 'Hand of Fatima', castles, the keys of paradise, or heraldic elements, including an abundance of Barcelona coats of arms. However, although they have similar influences, one can see that these ceramics are chronologically the most long-lasting, ranging from the mid-fourteenth century to the end of the fifteenth. Within this group, the naturalistic, epigraphic and figurative series is characterised by the presence of a central element which is not excessively geometrical, though simply drawn. Typical of the epigraphic series are bowls with inscriptions, anthroponyms and sometimes verses from the Qur'an, or religious phrases or polite expressions such as 'May it please you'. Other pieces exhibit non-centred elements, such as human figures flanked by palms or phytomorphs, forming a composition that is symmetrical on a horizontal axis, or a central element and a schematic border with the motifs cited above, or even anthropomorphic or phytomorphic elements enclosed in a border consisting of a double ring with groups of radial strokes extending from it (Figure 17). Sometimes they present a simple central element: small shields reduced to lines or simple motifs such as crosses, X-shaped figures with dots, or superimposed double angles forming a central rhombus, etc. Other pieces display a central element and a band with a schematic border, featuring stylised vegetal elements, sometimes enclosed in stars of double squares, borders of concentric fillets with strokes extending from them in groups of two to five lines, or alternatively borders of little bows (Figure 18) or scrolls of leaves (Figure 19). Finally, we can see decorations concentrated in the border with alternating motifs, a characteristic example being the pseudo-epigraphic motif of the alafia, which seems at present to be typical of Catalan rather than Valencian workshops.

The pieces analysed exhibit Fe-Co-Ni-Cu, Fe-Co-Ni-Mn and Fe-Co combinations, which seems to indicate in particular a late dating in the second half of the fifteenth century, if we compare this result with those obtained in the case of lustreware. The presence of combinations that are not shared with other groups might suggest the possibility that a more inexpensive

**Figure 16**
LVAC decoration on a jug or pitcher.
National Museum of Ceramics.

**Figure 17**
LVAE schematic decoration on a dish.
National Museum of Ceramics.

**Figure 18**
LVAE band of blue bows decoration on a bowl.
National Museum of Ceramics.

**Figure 20**
LVAG tile with human figures traced in solid silhouette.
National Museum of Ceramics, acc.n. CEI/02293.

**Figure 19**
LVAE bowl with blue-line decoration.
National Museum of Ceramics.

**Figure 21**
LVAG cup with zoomorphic figure traced in solid silhouette. National Museum of Ceramics, acc.n. CEI/00740.

type of cobalt, perhaps of local origin, was used in this case, alongside the more formal source of pigment found in lustreware.

*Gothic-naturalistic Valencian blue majolica (LVAG)*

This group displays the typical Gothic-naturalistic decorations characteristic of the fifteenth century, on works that are generally carefully thrown and decorated, with delicate, vigorously drawn designs. Far from being mass-produced, they seem perhaps to cater to the tastes of a more refined clientele with greater purchasing power than the schematic pieces. In them we see birds, wild boars or human figures traced in solid silhouette (Figures 20 and 21), although line drawings are also found occasionally (Figure 22). In the borders and backgrounds can be seen leaves or fruits in a clear Gothic style, an exact transposition of the naturalistic motifs used on lustreware. They apparently began to be produced from the beginning of the 15th century and continued until the beginning of the 16th century.

**Figure 22**
LVAG cup with human figure traced in line drawings.

A single piece from this group, which exhibits a dull blue colouring and a style of manufacture suggesting that it was produced as late as the 16th century, contains the combination Fe-Co-Ni-Mn-As.

## Conclusions

Over the course of the foregoing commentary it is possible to highlight some aspects. The earliest lustreware displays combinations of elements in the cobalt pigment that are close to oriental lustreware production, with the notable presence of Zn. This coincides with the findings of previous studies of vitreous materials and glazes, in that it provides evidence of a relationship with the second group identified by Gratuze, but in addition it clarifies certain chronological questions. This situation is maintained until the beginning of the fifteenth century, with the introduction of series such as those decorated with spirals and parallel lines or trefoils and double rosettes, motifs represented in paintings such as master Jaume Ferrer's painting *The Last Supper* from Solsona, dated in the second quarter of the 15th century, and of which reliably dated examples are found in archaeological sites such as Balaguer castle, destroyed in 1413. The Pula group exhibits two main compositions associated with cobalt (Zn and Mn), and of these the one containing Mn seems to be the later. The presence of Zn continues until Ni appears in series that can be dated to the second decade of the 15th century onwards (i.e decorations with crown pattern), also represented in the Solsona Last Supper. We also find a correlation here with the groups identified by Gratuze, but, as Corvisiero has pointed out, the group containing Ni should be brought forward to the beginning of the fifteenth century (Corvisiero et al. 2002). In pieces produced in the middle of the century Cu is also found, but it disappears in later examples, in which we observe developed ivy leaf motifs and pieces in the silversmith style with musical notes and thistle flowers. The 16th century is notable for the clear presence of As, which we have not found in series from the 15th century, in contrast to what was previously suggested by Gratuze and Corvisiero.

In this general approach we have also seen how employing a non-destructive technique like EDXRF, which is easy to use and reliable, when checked against other methods such as PIXE and LA-ICP-MS, can assist us in the task of classifying medieval Valencian ceramics. We have yet to determine whether the different compositions we have detected reflect particular factors which may allow us to distinguish the provenance of the resources used in the pigment or advances in the historical techniques of processing the ore, but it convincingly indicates an interesting route which we must continue to explore.

Keywords
cobalt in tinglaze and earthenware
lustreware
Manises and Paterna
medieval Spain

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## Résumé

La première mention documentaire d'utilisation du cobalt dans le royaume médiéval de Valence remonte à 1333. Avant cela, aucune preuve n'existe de l'utilisation de pigment de zaffre ou de cobalt. Le cobalt a commencé par être utilisé pour la production de poterie mordorée, preuve de l'amélioration de la fabrication de céramiques décorées de glaçure stannique pendant la première moitié du 14e siècle. L'analyse par fluorescence X suggère une variation du spectre du pigment bleu détecté au fil des ans. Associé à l'étude de la forme, du tracé et de l'évolution des décorations, cela nous permet de proposer une date très précise pour certains groupes décoratifs produits à Manises et à Paterna, ce qui est l'objectif principal de cet article.



### Mots-clés

cobalt dans l'émail stannifère et dans les faïences
Espagne médiévale
Manises et Paterna
reflet métallique



## Zusammenfassung

Die erste dokumentierte Erwähnung des Gebrauchs von Kobalt im mittelalterlichen Königreich Valencia reicht bis 1333 zurück. Davor gibt es keine Beweise für den Gebrauch von Zaffer- oder Kobaltpigment. Das erste Kobalt wurde bei der Herstellung von Lüsterware benutzt und beweist die Verbesserungen bei der Herstellung von Töpferwaren mit Zinnglasur-Steinzeugverzierungen in der ersten Hälfte des 14. Jh. Röntgenfluoreszenzanalyse lässt auf Veränderungen im festgestellten Spektrum des blauen Pigments im Laufe der Jahre schließen. Zusammen mit der Form, dem Zeichenstil und der Entwicklung der Verzierungen betrachtet, erlaubt diese Tatsache es, für einige der in Manises und Paterna entstandenen dekorativen Gruppen eine sehr enge Datierung vorzuschlagen, was das Hauptanliegen dieses Artikels ist.