



# Chemical and Textural Characterization of Tin Glazes in Islamic Ceramics from Eastern Spain

Judit Molera and Mario Vendrell-Saz

*Dept Crystallography and Mineralogy, University of Barcelona, c/Martí i Franquès s/n, 08028 Barcelona, Spain*

Josefina Pérez-Arantegui

*Dept Analytical Chemistry, Faculty of Sciences, University of Zaragoza, 50009 Zaragoza, Spain*

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Several productions of Islamic tin glazed pottery from eastern Spain have been studied under the chemical and microstructural points of view by means of WDS, SEM/EDX, XRD and XRF analyses. Samples of Islamic pottery from the workshops of Murcia 10th, Zaragoza 11th, Mallorca 11th, Denia 13th, Granada 14th and Córdoba 10th, which represent a wide range of local productions from medieval eastern Spain, have been studied in order to obtain the trends of the technical and compositional evolution. From the experimental data, some common features can be established, as well as some differences. All the Islamic Spanish opaque glazes are lead glazes with PbO contents from 37 to 56%, opacified with tin oxide in the range 4–15%. In all the cases, they were applied on a previously biscuited body made with a Ca-rich clay, probably to produce a buff colour less apparent through the glaze. The thicknesses range from 100 to 150 microns and the opacification is achieved by small crystals of SnO<sub>2</sub> (under a micron of size). The main differences are the size and distribution of such small crystals, being smaller in the early Islamic productions (Zaragoza and Murcia) and bigger in the late productions.

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## Al-Andalus In The Early Medieval Age

**A**l-Andalus (or the Muslim area of the Iberian Peninsula) became part of the Islamic world in 711, when a Muslim army crossed the Straits of Gibraltar, conquered the Visigoths, and established most of the peninsula as a western province under the rule of the Umayyad caliph in Damascus (Arié, 1984; Reilly, 1993). Perched at the edge of the Islamic west, al-Andalus took an autonomous existence under the rule of the early emirs.

Political developments in the 10th century brought an end to the somewhat subservient status of al-Andalus in relation to the eastern Islamic world. When the Umayyad ruler Abd al-Rahmân III declared himself caliph in 929, Muslim Spain became a major player on the stage of Mediterranean politics and culture (Figure 1).

After nearly two and a half centuries of relatively stable centralized Umayyad rule in al-Andalus, the dynasty crumbled in the early 11th century (usually dated to 1031) in the face of disputes over succession

and civil war. In its place, smaller independent states emerged called Taifas or *Mullllúk al-tawâ'if* ("Party Kingdoms"), as Toledo, Badajoz, Sevilla, Córdoba, Granada, Murcia, Zaragoza, Valencia, Denia, Mallorca, etc. This period corresponds to a flourishing cultural and economic development of these small kingdoms.

Because of the need for military assistance after Christian pressure to the south and the loss of Toledo in 1085, Almoravid armies (a Berber dynasty based in Marrakech) arrived at the Iberian Peninsula in 1086 and shortly established Almoravid control over both the peninsula and North Africa. Unified Almoravid rule marked the end of Taifa diversity, and established al-Andalus as part of a huge single kingdom. Internal dissent gradually led to the disintegration of Almoravid power in the early 12th century and the brief reappearance of Taifas before another Berber dynasty, the Almohads, incorporated al-Andalus into their North African empire in 1147. Christian conquests during the first half of the 13th century brought an end to Muslim rule in most of the south.



Figure 1. Map of Islamic Spain in Mediaeval ages. — Islamic border in the 11th century; --- Islamic border at the beginning of the 13th century.

### The Production of Tin Glazes in the Islamic World

The beginning of glazed pottery can be dated back to the Middle Assyrian period (13th century BC) in Mesopotamia, though glazes on small objects of quartz-frit body—Egyptian faience—are much older (Kaczmarczyk & Hedges, 1983; Kleinmann, 1986). But the recipes of the old traditional glazes were modified to produce a new type, an opaque white alkaline-lead glaze, with tin oxide as opacifier to get a white ware. However, the exact nature and timing of the first development of tin-opacification in the Islamic world is still being explored.

According to Allan (1991), the import in the 9th century of Chinese white wares and high-fired porcelains into Iraq led the local Arab potters to experiment in reproducing the whiteness of the Chinese originals in their own low-fired pottery. The Iraqi pottery bodies (earthenware) exhibit a yellowish buff colour after firing and one of the ways developed by the potters to achieve the white colour was to cover it with tin glaze (a glaze containing suspended particles of tin oxide which make the glaze opaque white). The same author (Allan, 1971) says that the potters of the Parthian period commonly using alkaline glazes often added tin oxide to the recipe to make them white and opaque, anticipating the extensive use of these materials in the Islamic period.

Mason & Tite (1997) propose a progressive development in the technology to produce opaque glazes in the Islamic world, from the 8th to the 10th centuries. Building initially upon the traditional glaze-making technology in Iraq, this development involved an increasing reliance on tin oxide as opacifier, together with an increase of the lead content in the glaze. So that, keeping in mind the link between the former tin-opacified wares and earlier white opaque-glazed wares of pre-Islamic Iraq, these authors

question the development of Islamic tin-opacified glazes attributed to the need to copy imports of Chinese whitewares.

The technology to produce tin-opacified glazes spread from Middle East to Iran, Egypt, northern Africa, Spain, and ultimately into later medieval Europe. In this context, al-Andalus produced and exported ceramics, as well as imported ceramics from other areas of the Islamic world and beyond. Thus, a constant trade of objects was established throughout all Muslim's world. The evidence for trade of Andalusí ceramics comes both from documents and existing examples (Constable, 1994: 167–168, 189–191, 222–223).

There were no tin mines in the Islamic Near East and the tin oxide had to be imported by sea from southern Burma and Malaysia (Allan, 1991). Meanwhile, the Iberian Peninsula was rich in metals and several of the Andalusí ores and minerals were exported to other Mediterranean regions, among them tin was one of the exports (Constable, 1994: 186–187). Accordingly, the development in the making of tin-glazed ceramics could be provided by the chance of availability of raw materials.

### Tin Glazes in Islamic Ceramic From Eastern Spain

Two different styles were used for decorating objects with white glaze in Islamic ceramics. In the beginning, designs were painted over the glaze with metal oxides: blue (cobalt), green (copper), purple (manganese) and yellow (antimony forming a lead-antimoniate— $Pb_2Sb_2O_7$ —stable in the glaze). The second and more important style of decoration found on tin-glazed wares is lustre painting, often associated to blue decoration.

The tin-glaze technology developed in the Iberian Peninsula since the 10th century, started with green and brown designs painted on white glazes (the so-called “*verde y morado*”), which flourished during the Caliphal period, a period of political and cultural summit (Rosselló, 1992; Rosselló, 1995). The former “green and brown” pottery was a palatial production associated to the splendour of Madīnat al-Zahrā’ (‘Abd al-Rahmān III palace, 5 km from Córdoba) and it was probably made in workshops attached to the caliphal palace. Although this ceramic production from Madīnat al-Zahrā’ involved an extraordinary advance in Andalusí pottery production, the “green and brown” style was spread to other areas of al-Andalus, as proved by its wide diffusion (Retuerce & Zozaya, 1986) which over time reached all the Taifa kingdoms and continued after the Christian conquest.

Lustre pottery appeared quite early (around the 11th century) but few workshops have been found, meanwhile 13th century and subsequent workshops have been documented. The Nasrid kingdom of Granada

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