Journal of Archaeological Science (2002) **29,** 803–810
doi:10.1006/jasc.2000.0576, available online at http://www.idealibrary.com on IDEAL®

Chemical Composition and Manufacturing Technology of a Collection of Various Types of Islamic Glazes Excavated from Jordan

Ziad al-Saad*

Institute of Archaeology and Anthropology, Yarmouk University, Irbid-Jordan

A collection of Islamic glazed pottery shards that were excavated from the archaeological site of Dohaleh/Northern Jordan were chemically analysed. The glazes belong to three different decorative styles. The chemical analysis of the glazes was carried out using energy dispersive x-ray fluorescence. The chemical analysis results enable the classification of the glazes into the three distinct compositional groups with reference to their principal modifier, these are: the alkaline glazes, the high lead glazes and the lead–alkali glazes. In some cases the body fabric was analysed by a combination of petrographic and chemical analysis techniques. The study show that inherited traditional techniques were combined with innovative Islamic techniques were used for the production of the glazes.

Keywords: ISLAMIC, AYYUBID/MAMLUK, JORDAN, GLAZE, ENERGY DISPERSIVE X-RAY FLUORESCENCE, ATOMIC ABSORPTION SPECTROMETRY.

Introduction

The date of the first man-made glaze is not known for certain. However, there is strong evidence that it originated from the Near East some time around 4000 BC (McCarthy, Vandiver & Gibson, 1995). In the first instance glaze was applied to stones such as steatite and quartz. Glaze on faience soon followed utilizing a similar technology to that of glazed stones. Approximately 2500 years is believed to have passed after the introduction on faience before glaze was used on clay substrate material.

The first examples of glazes on pottery vessels are dated to the 15th century BC, about the same time that glass vessels are believed to have developed (Hamer, 1975: 145; Lilyquist & Brill, 1993; Moorey, 1994; McCarthy, Vandiver & Gibson, 1995).

From 1500 BC onwards the glaze industry developed in many respects and various formulations of alkaline and lead glazes were used in various parts of the world. The Romans spread the secrets of glaze making throughout their Empire. From Rome the idea of lead glaze on pottery spread to Han China where the combination of it with the porcelain materials already known resulted in wares of a remarkable richness and quality. The existing recipes served the potters of the Byzantine Empire throughout its duration and from there spread back into Europe where they survived without much alteration up to the 18th century (Frierman, 1970).

The Muslims inherited glaze making traditions from their predecessors. In addition, a number of innovations occurred. Lead–alkali–silicate and lead–silicate glazed wares were introduced along side the alkali–silicate glazes in the early Islamic period. At the time of the rise of Islam in the 7th and 8th centuries a small amount of lead glaze ceramics was made in the Near East, in Egypt and Byzantium. The prevalent ceramic tradition was one in which relief-decorated unglazed slipware predominated. The Muslims revived the old glaze tradition and gave it strong impetus with perfection and innovation. The glaze industry flourished during the Abbasid period when brilliant developments of ceramic art and technology were achieved. Different glaze formulations of lead glazes and alkali silicate glazes were used to produce local imitations of the wonderful Chinese T'ang ceramics (Frierman, 1970; Kleinmann, 1986).

The Seljuk Turks introduced a new school of pottery making. They made what may be the most colourful and beautiful ceramics made outside of the Far East. Lustre was raised to a high art in Iran, especially in Kushan. The old T'ang three-colour wares were reinterpreted and faience reappeared in new forms. However, this dramatic flourishing was to be short lived. During the first half of the 13th century the Mongols swept in from Central Asia and this caused the discontinuation of the most sophisticated types and techniques. A slow but persistent artistic recovery occurred in the late 13th and 14th centuries; the most symptomatic ware was the blue or black painted wares, which were covered with a transparent glaze that ran the colours a little and had a crackle, echoing the work of the Chinese potters. Although lustre and other overglazed ceramics were made again, both the pots

*Associate Professor of Archaeometry and Conservation.

0305–4403/02/$-see front matter

and techniques became widely diffused (Frierman, 1970; Perez-Arantegui, 1995).

In this work, various types of Islamic glazes that were excavated from Jordan were chemically analysed in order to reconstruct their manufacturing technology. The contribution of Islamic glaze makers to the inherited glazing techniques was specially emphasized.

Materials and Methods

Archaeological context of the samples

In the period between 1990–1993 major excavation works were conducted by a joint team from the Institute of Archaeology and Anthropology/Yarmouk University and the Department of Antiquities of Jordan at the archaeological site of Dohaleh/northern Jordan. The site is situated in a fertile area 25 km to the southeast of the city of Irbid (Figure 1). The excavation works unearthed large quantities of artefacts and architectural remains. The foundations and structural remains of a mosque, a Byzantine church and large numbers of houses were uncovered. Also a large Islamic cemetery was discovered. Large quantities of various styles of pottery, glass, coins and metal objects were also unearthed from the site, especially from the cemetery. The archaeological evidence extracted from the remnant structures in addition to the stylistic and typological studies of pottery and coins strongly suggest that the site was continuously occupied from the early Roman period to the Ottoman (Sari, 1991, 1992*a*).

A great deal of ceramic materials, including a number of vessels, in addition to large amounts of pottery shards were uncovered from the residential area of the site. Various styles of Roman, Byzantine and Islamic pottery were identified. The most abundant among these styles is the Islamic painted pottery. The largest proportion of this pottery was dated to the Ayyubid/Mamluk period based on the morphology and decorative styles. In addition to the painted pottery a relatively small amount of glazed pottery shards were uncovered from the same level. The glazed shards were attributed to the Ayyubid/Mamluk period based on their archaeological context and the associated materials, mainly coins (Sari, 1992*b*).

Samples

Unfortunately, when Islamic glazed ceramics are studied, only a few objects are available for analysis because glazed fragments are scarce at archaeological sites. Taking into account this limitation, 17 glazed shards of different glaze types were selected for this study. The selected shards were derived in most cases from recognizable objects such as jugs, jars, and bowls. The shards were selected to represent the different styles of glazes found at the site. Three major styles were identified, these are:

1—Coloured monochrome-glazed shards. This type of glaze is characterized by having a transparent glaze layer on a slipped coarse earthenware. The glazes have turquoise and blue as their most common colours. The shards show incised decoration under the glaze layer. Seven shards of this type were selected for the chemical analysis.

2—Underglaze painted shards. In these glazes the design was executed directly on the body fabric using a mixture of unfused coloured minerals. The decoration was painted either in black or blue. The paint layer was sealed *in situ* by a coating of translucent glaze mainly of green colour. Six shards from this type were selected for the chemical analysis.

3—Blue in-glaze decorated shards. These glazes are characterized by their opaque white background with an overlaying blue decoration. The decorations consist mainly of geometric motifs. Four shards from this type were selected for the chemical analysis.

Analytical techniques

The chemical compositions of the glaze samples were determined by energy dispersive x-ray fluorescence analysis. Calibration was done using a variety of synthetic and natural mineral standards. The glaze compositions were determined by averaging results of at least five spot analyses at random points of the glaze surface.

Body samples were examined by standard petrographic methods, using polarizing light microscope and a point counter. Chemical analysis of the body samples was done using atomic absorption spectrometry.

Results and Discussion

Classification of the glazes

Glazes may be described and classified in many ways; for example, by their maturing temperature, their principal modifier or flux and the wares on which they may be used (Rice, 1987: 90; Hodges, 1976). The most informative of these classification systems is the one that is based on principal modifier which is the one that will be used in this study.

The glazes under study can be classified with reference to their principal modifiers into three distinct groups; these are: (1) the alkaline glazes (Table 1), (2) the high lead glazes (Table 2), (3) the lead–alkali glazes (Table 4). For each type the chemical composition, raw materials used manufacturing technology will be discussed.

Chemical composition and manufacturing technologies

1—Alkaline glazes. All the glazes in this group are of the coloured monochrome. The glazes are characterized by having significant amounts (average %