Journal of Archaeological Science 39 (2012) 3052–3070

Contents lists available at SciVerse ScienceDirect

Journal of Archaeological Science

journal homepage: http://www.elsevier.com/locate/jas

Late medieval copper alloying practices: a view from a Parisian workshop of the 14th century AD

David Bourgarit [a,*], Nicolas Thomas [b,c]

[a] Centre de recherche et de Restauration des Musées de France (C2RMF), Palais du Louvre, Porte des Lions, 14 Quai François Mitterrand, 75001 Paris, France
[b] Institut National de Recherches Archéologiques Préventives (INRAP) UMR 8589 CNRS-Université Paris I Panthéon-Sorbonne, France
[c] Laboratoire de médiévistique occidentale de Paris (LAMOP), UMR 8589 CNRS-Université Paris I Panthéon-Sorbonne, France

ARTICLE INFO

Article history:
Received 11 November 2011
Received in revised form
28 March 2012
Accepted 6 April 2012

Keywords:
Late medieval
14th century
Western Europe
Copper alloy
Brass
Paris
Workshop
Archaeometallurgy
Analysis
PIXE

ABSTRACT

161 late medieval copper-based day-to-day items have been analysed, mostly consisting of small artefacts such as dress fittings. The items were all recently excavated from a 14th century AD metallurgical workshop located in Paris. Eight well-defined copper alloys have been identified that refer to various constraints, the most important one being economics. According to the model proposed, most of the alloys were obtained by dilution of a fresh brass master alloy by scrap metal containing small amounts of zinc, tin and lead. Pure lead was added separately in relatively large quantities, with a limit of 6 wt% Pb marking the boundary between leaded and unleaded alloys. It has been found that the less the cost of the artefact, the more the fresh brass is diluted. For the medium-size castings such as cast vessels, alloys containing large quantities of lead or alloys rich in antimony were used. Such complex alloying strategy pertains more to a small industrial-like plant organisation rather than to craftsman activity, as further supported by a variety of archaeological and historical evidence.

1. Introduction

Medieval copper metallurgy in Western Europe has long been studied at an analytical level through the sole perspective of museum collections, thus concentrating mostly on ecclesiastical ornaments (Werner, 1982; Oddy et al., 1986; De Ruette, 1996), or specific items such as statuary (Riederer, 1980, 1983, 1985; Laub, 1993; Hachenberg, 2006), aquamaniles, funeral tabs, cannons, bells or monumental castings (Cameron, 1974; Tylecote, 1976; Giot and Monnier, 1978; Forshell, 1984; Drescher, 1992; Bayley et al., 1993; Neri, 2004; Giannichedda et al., 2005; Dandridge, 2006; Bellendorf, 2007). Though very valuable, the information supplied by these analytical studies has only been concerned with a minor part of medieval copper production, while omitting all aspects of the production of day-to-day domestic items. This trend was first reversed in the British Isles in the 1980's when, for the first time, a series of analyses were carried out on recently excavated and well-dated small day-to-day artefacts such as sheet metal, small castings and wire (Brinklow, 1975; White, 1982; Heyworth, 1991; Blades, 1995), although unfortunately most analyses have not yet been published. One shall also mention the large contribution in the 1980's by Coventry University on the analysis of North-West European medium-size castings, such as vessels, candleholders or steelyards from museum and private collections, partly published (Brownsword, 2004), as well as the analysis of a few Saxonian items (Zientek, 1996). In France, we have had to wait for the rescue excavations of 2003 on the site of the Hôtel de Mongelas, located in the centre of Paris (Thomas, 2006, 2009; Thomas et al., 2008). In this particular case, an exceptionally well-preserved bronze workshop was revealed, which had been producing primarily day-to-day items: small objects such as dress accessories, household and furniture fittings (Fig. 1), in addition to larger items such as vessels. This discovery provided the starting point for a large interdisciplinary research project involving archaeologists and historians, as well as several branches of archaeometry including ceramic refractory study and metallurgy (Thomas and Bourgarit, 2006; Katona et al., 2007; Thomas et al., 2008; Thomas, 2009).

* Corresponding author.
E-mail address: david.bourgarit@culture.gouv.fr (D. Bourgarit).

0305-4403/$ – see front matter © 2012 Elsevier Ltd. All rights reserved.
doi:10.1016/j.jas.2012.04.009

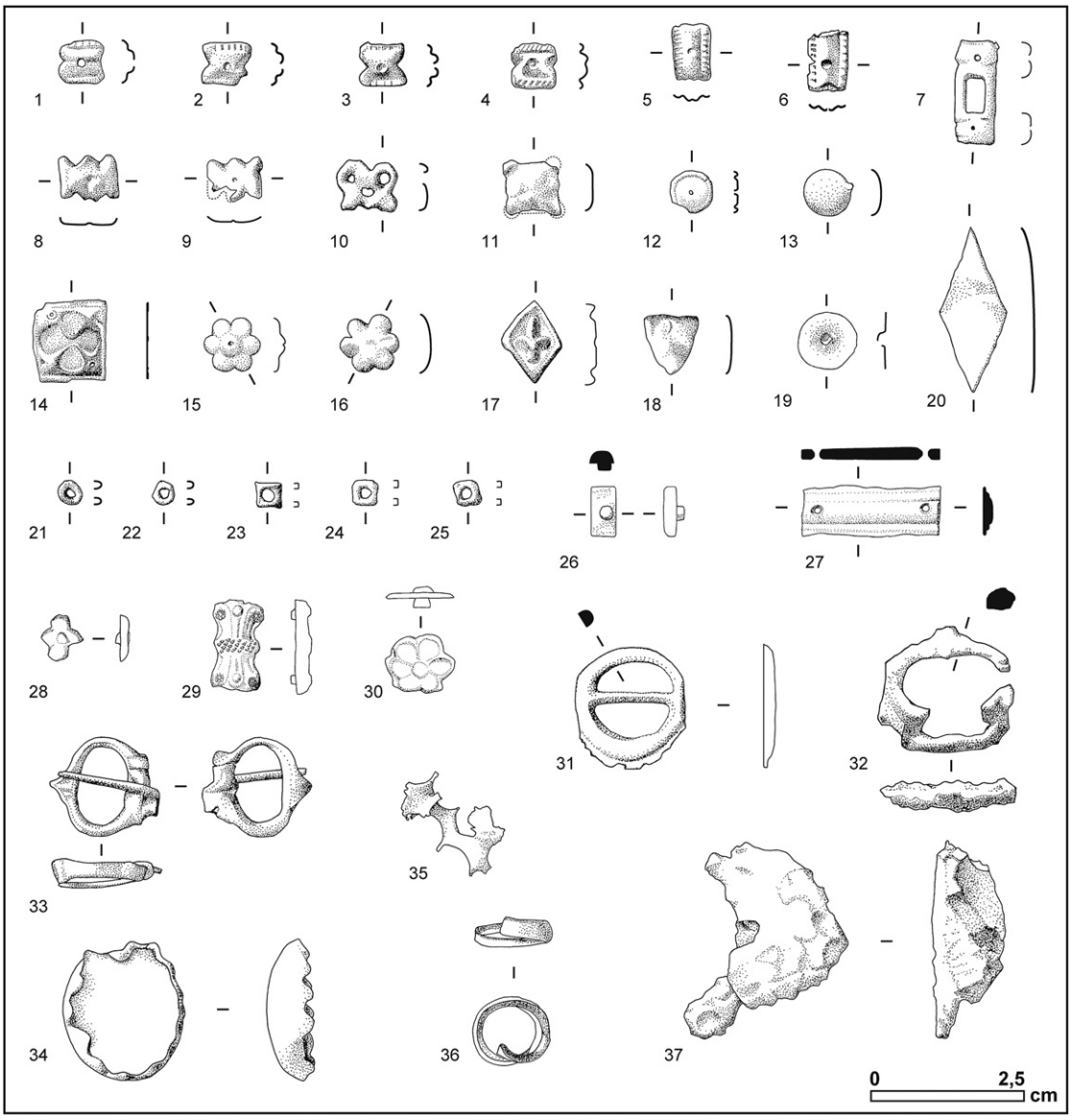

Fig. 1. Selection of copper-based day-to-day items found at the 14th century bronze workshop of Hôtel de Mongelas, Paris. These are mainly dress accessories (#1–25 and 35–36 are sheets, #26–34 are small castings) except #34 (probably a pommel), #35–36 (sheet waste), and #37 (casting waste). Caution, the inventory numbers are specific to this figure and do not correspond to those of the catalogue.

At the site of Hôtel de Mongelas, written records as well as archaeological documentation allow for a precise dating of the metallurgical production between 1325 and 1350. The workshop was located outside of the former inner walls of Paris on a surprisingly large area for this period, the acreage estimated at approximately 750 m^2 (Thomas, 2009: 919–922). As shown by archaeological and historical evidence, the workshop was organised more as a small industrial plant rather than as a craftsman shop (Thomas, 2009: 917–953; Thomas and Bourgarit, 2006; Thomas et al., 2008). Taking the opportunity of such an exceptional archaeological context, elemental analysis of the metal artefacts has been carried out in an attempt to investigate the alloying practices. Two aspects have been focused on. First, the existence of well-defined types of alloys with specific applications has been questioned. Second, the metal supply system within the workshop has been investigated with a particular emphasis on the alloying techniques.

2. Materials and methods

A representative sampling method was undertaken for the elemental analysis, leading to the definition of four main categories, namely small castings, medium-size castings, wire, and sheet metal (Table 1). Small castings and sheet items are mainly dress accessories. Medium-size castings are primarily vessels, see discussion in Section 3.1.These four categories correspond to the three different fabrication methods that have been identified: casting, hammering and wire production.

Due to the small size of a majority of the artefacts and to the difficulty of sampling, surface elemental analysis was carried out by μ-beam Particle Induced X-ray Emission (PIXE) on the AGLAE accelerator facility at the Centre de Recherche et de Restauration des Musées de France (Dran et al., 2000). This method enables large series to be investigated, and is more sensitive than the other technique that was available for this study, that is energy dispersive