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Composition and state of alteration of 18th-century glass finds found at the Cistercian nunnery of Clairefontaine, Belgium

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ABSTRACT

A hundred 18th-century glass fragments were recovered at the Clairefontaine monastery in the Belgian province of Luxembourg. They were analysed by a combination of SEM-EDX and LA-ICP-MS in order to determine their major composition as well as their trace element signature. Multivariate statistical methods such as hierarchical clustering and principal component analysis were used to divide the glass fragments into four main groups: potassium-rich glass, sodium-rich glass, potassium/lime-rich glass and high-lime-low-alkali glass. Within every group, not only a similarity in composition is observed, but also in colour, morphology and deterioration patterns. Potash glass fragments are the most abundant and show extensive deterioration; two classes of potash glass were identified: one similar to certain Central European glass compositions, while the other one, characterised by large variations in potash: lime ratio, may be attributed to local (regional) glass production.

1. Introduction

1.1. Aim and context

Archaeological excavations at the Cistercian nunnery of Clairefontaine, Belgium have revealed an assemblage of 18th-century glass vessels. These were mainly utilitarian objects used for storage, drinking or dining. The assemblage is dominated by storage bottles of various kinds and by conical beakers, a particular type of 18th-century drinking ware. A set of 100 glass samples from Clairefontaine was analysed by means of two techniques: scanning electron microscopy with energy dispersive X-ray analysis (SEM-EDX, for obtaining the major and minor element composition) and laser ablation inductively coupled mass spectrometry (LA-ICP-MS, for trace element determination).

The aim of the study is twofold. First of all, the compositional analyses are used to provide insight in the chemical composition of the glass finds; they provide information on a period of (vessel glass) history not extensively studied up to now. The results are compared with the glass compositions found in England and Central Europe in the same period (Ashurst, 1970). Secondly, in view of the fact that a large part of the glass assemblage consists of non-durable glass, the compositional results have been used to assess whether the different alteration states of the glass are related to technological variation/evolution or to post-depositional processes.

1.1.1. The dawn of industrial glass

The study of 18th-century glass from archaeological contexts is still in an early stage. On the basis of mainly visual aspects such as shape and decoration, 18th-century vessel glass in the Low Countries may be classified as either 'Bohemian', English' or 'local' products, yet this has proven to be a rather subjective approach (Henkes and Laan, 1986). In fact, unlike for the study of 16th and 17th-century vessel glass (e.g., Janssens et al., 1998), only seldom the chemical composition of 18th-century finds are taken in account (Van der Linden et al., 2005).

In the course of the 17–18th century, the historical context to which these glass finds belong, witnessed several technological innovations in the European glass industry. At the beginning of the 17th century, English glassmakers started to fire their ovens with coal. Higher and more stable temperatures could be obtained which allowed them to produce high quality products on a larger scale. Examples are the large and robust wine bottles in coloured potash glass that were exported to Europe and North America (Jones, 2010). As a general trend, glassmakers settled near/in towns and urban centres (Henkes, 1994). New recipes for

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colourless crystal glass were developed in England and Central Europe and products of these areas took over the market of luxury glass. As such, traditional luxury products such as the soda-lime *Façon de Venise* glass became replaced by new kinds of crystal-like glasses. Since the early 17th century, continental and English glassmakers experimented with the addition of lead to soda and potash glass. It was the English glassmaker George Ravenscroft who optimised the production process for *English lead glass* and patented it (Hengen, 1989). At the same time, in Bohemia, glassmakers developed another type of potassium-rich glass. Through the addition of lime, a shiny and resistant glass could be produced (Petrova and Olivié, 1990; Hötl, 1995). Just as the English lead glass, the Bohemian vessels were characterised by a soft paste that was very suitable for decoration by wheel engraving. Both the English and the Bohemian types of glass became increasingly popular from the end of the 17th century onwards (Hötl, 1995). In a first stage, mainly finished products were exported. However, there are several indications that the glassmaking technology itself was diffused only a little later. By the end of 17th century also on the continent, coal as source of energy became increasingly important (Cabart, 2011), while historical sources testify that several glassmakers in the Low Countries experimented with English and Bohemian recipes to produce highly decorated crystal clear glass *à la façon d'Angleterre* and *à la façon de Bohème* (Charleston, 1958). This appears to have been done with varying success: most of them struggled with the stability of the glass, which made their products much more prone to deterioration and crizzling (Francis, 2000; Watts and Tait, 2007).

1.2. The Clairefontaine nunnery and the archaeological excavation

The Cistercian nunnery of Clairefontaine was founded around 1247 by the famous Luxembourgian Countess Ermesinde and her son Henry V. For around one hundred years, the abbey would serve as the dynastic burial ground of the House of Luxembourg–Limbourg which, before its decline in the 15th century, played an important role in European politics, especially during the 14th century. Members received not only the ducal rank but also acquired the royal crown of Bohemia and delivered no less than four emperors of the Holy Roman Empire (Margue, 2003). As a *lieu de mémoire* of this powerful and influential dynasty, the Clairefontaine monastery maintained its prestigious character until its suppression by the French in 1796 (Goffinet, 1877). Supported by the Luxembourgian and European feudal elite, the community in Clairefontaine – largely populated with their wealthy daughters – lived a glorious history, reflecting in a continuously transforming architectural setting. After the dissolution, the abbey was razed to the ground and only the 18th-century farm and mill are still standing today (Herremans and Coomans, 2013).

In 1997, on the occasion of the 750th anniversary of the founding of the abbey, large-scale archaeological excavations began within the framework of a European research project. Fieldwork was directed by the late J. De Meulemeester, funded by the Direction de l'Archéologie du Service public de Wallonie. Eleven annual campaigns revealed the almost complete architectural layout of the abbey. In the field campaigns of 2003–2004, a cess-pit in the north wing of the cloister was fully excavated. The structure was erected in the second half of the 17th or the first half of the 18th century and was built over the Durbach, a narrow stream that flows south of the monastic complex. The filling of the cess-pit comprised, next to a great number of animal bones, large numbers of glass and ceramic vessels all dating to the last three quarters of the 18th century.

1.3. The analysed glass finds

The glass finds were sampled mainly based on visual aspects such as colour, shape and visible alteration type of the vessels. As much as possible, the complete range of glass fragments was sampled, taking into account the quantitative proportions of the context. Examples of the analysed glass typologies can be found in Fig. 1. Samples were taken from both the permanently waterlogged layers and from the layers that were covered on a regular basis by the fluctuating water level. A significant part of the samples consisted of coloured glass dated to the 18th century. Most of the fragments were part of green thick-wall wine bottles and green or blue thin-walled storage vessels of all kinds such as square bottles, jars and phials. The major part of the samples consisted of colourless glass with a large number of highly decorated 'Bohemian' or at least 'Bohemian-styled' conical beakers. Most of them are plain beakers with wheel engraved decorations typical for the first half of the 18th century. The few facetted and mould-blown beakers in the context can be dated to the second half of the 18th century. Other drinking and table ware from the same period such as salt cellars, shot glasses, jugs, goblets and cups were present in smaller numbers. A few coloured goblets were present among the finds. A more complete description of the finds, including drawings and the context for each object type, can be found in Herremans et al. (in press).

The entire assemblage shows a high degree of corrosion. Five types of weathering were recognised after a visual examination of the finds, varying from heavy crizzling to the formation of a white opaque patina (Fig. 1). In general, both the thick- and thin-walled green (in the web version) glass was heavily iridised and stained; some of these showed thick crusts, with or without relicts of the original glass remaining (Fig. 1E, F) (Koob, 2006; Schreiner, 1991; Newton and Davison, 1997; Kunicki-Goldfinger, 2002, 2008). The blue (in the web version) glass (Fig. 1D) and a significant part of the colourless glass has a non-weathered appearance (Fig. 1B), while an equally important fraction has a notable opaque white patina on the surface (Fig. 1A). The cloudy appearance of the surface indicates the presence of alkali and an initial stage of crizzling. A certain amount of the colourless samples is heavily crizzled: the cracking has progressed and in many cases spalling had occurred, leading to small chips or flakes detaching themselves from the surface (Fig. 1C). Several of these heavily altered fragments are discoloured, turning the transparent glass body into a pinkish–brownish opaque material (Kunicki-Goldfinger, 2002, 2003, 2008).

Based on its colour, the glass fragments could be divided into two main groups: on the one hand the coloured vessels, mainly consisting of green thick-walled wine bottles and of green, blue or white thin-walled storage bottles of various kinds and on the other hand the colourless vessels, mainly consisting of conical beakers and other drinking vessels and of table ware such as cups, jugs, salt cellars and goblets.

2. Experimental

The set of 100 glass samples was quantitatively analysed with Scanning Electron Microscope-Energy Dispersive X-ray spectroscopy (SEM-EDX, major and minor element composition) and Laser Ablation – Inductively Coupled Plasma – Mass Spectrometry (LA-ICP-MS, trace elements). SEM-EDX was used for initial quantification of the major elements. This was done to determine the concentration of an internal standard element (Ca) for the LA-ICP-MS quantification. This provides a more robust quantification compared to sum normalisation (Bertini et al., 2013). Small glass samples (a few mm^2 in size) were removed from the archaeological finds and embedded into acrylic resin. The resin blocks were