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Natron as a flux in the early vitreous materials industry: sources, beginnings and reasons for decline

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Abstract

Natron deposits, the best known of which being those at Wadi Natrun in Egypt, have been used as the flux in the production of vitreous materials from the early 4th millennium BC onwards. In the present paper, the history of the use of natron as a flux is traced from its beginnings in the glaze of Badarian steatite beads, through its use in glass production starting in the 1st millennium BC, until its apparent shortage during the 7th to 9th centuries AD, and its subsequent replacement by plant ash during the 9th century AD. Documentary evidence for possible natron sources in Egypt, including the Wadi Natrun, and around the eastern Mediterranean is summarised, and the results of recent fieldwork at the Wadi Natrun and at al-Barnuj in the Western Nile Delta are presented. The possible reasons for the apparent shortage of natron from 7th to 9th centuries AD and its subsequent replacement by plant ash as the flux used in glass production during the 9th century AD are then considered. These include the possibility that, because of the massive scale of glass production, the demand for natron exceeded its supply; the possible effect of climatic changes; and the potentially disruptive role of political events in the Wadi Natrun–Delta region.

Keywords: Natron; Egypt; Wadi Natrun; Al-Barnuj; Steatite; Faience; Glass; Badarian; Bronze Age; Roman; Byzantine; Islamic; Chemical analyses; Political disruption; Documentary evidence

1. Introduction

Evaporitic deposits containing sodium carbonate and sodium bicarbonate have been exploited as a source of alkali for millennia. In an archaeological context such deposits are normally referred to as *natron*. Strictly speaking, however, natron is the mineral name for the sodium carbonate 10-hydrate, whereas the dominant carbonate in these deposits is frequently the sodium carbonate bicarbonate 2-hydrate, *trona*. Natron deposits has been widely used from the early 4th millennium BC onwards as the flux in the production of vitreous materials (glazed stones, faience and glass) as well as for a variety of other purposes, including for mummification, in soap production and as a medicine. Perhaps the best known natron deposits to be exploited in antiquity are those at Wadi Natrun on the edge of the Western Desert of Egypt, some 100 km northwest of Cairo.

It was first observed by Sayre and Smith [47], and has since become generally accepted, that ancient soda-lime–silica glasses may be divided into two principal categories. They found that Roman glass typically contained less than 1.5% of each of magnesium and potassium oxides, while Bronze Age, Islamic and Venetian glass typically contained in excess of 1.5%. This subdivision into ‘‘low magnesia’’ and ‘‘high magnesia’’ glasses has since become generally accepted and there is a consensus that ‘‘low magnesia’’ glasses represent those made using natron as the source of the soda flux, while ‘‘high magnesia’’ glasses represent those made using plant ash [e.g. 24,35]. Thus, these two fundamental glass types can be readily distinguished on the basis of their chemical compositions, the

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high potash and magnesia contents of plant ash-based glasses contrasting with the low potash and magnesia contents of natron-based glasses.

The aim of the present paper is to provide an overview of the history of the use of natron in the production of vitreous materials from the early 4th millennium BC through to the 9th century AD, to identify the possible sources of natron, other than Wadi Natrun, used in antiquity, and to explain why natron was replaced by plant ash as the flux used in glass production during the 9th century AD. In both the identification of possible natron sources and in considering the potentially disruptive role of political events in the Wadi Natrun–Delta region in explaining the reasons for the replacement of natron by plant ash, documentary evidence has been extensively used and has made an important contribution. In the context of possible natron sources, the documentary evidence has been supplemented by the results of our recent fieldwork both at the Wadi Natrun and at al-Barnuj in the Western Nile Delta in Egypt.

2. History of natron as a flux in early vitreous materials

2.1. Introduction and early use

The first vitreous materials were glazed stones, mainly quartz and steatite (i.e. fine textured talc—$Mg_3Si_4O_{10}\cdot(OH)_2$), and faience which consists of a ground quartz or quartz sand body coated with a glaze. These vitreous materials were being used in the Near East and Egypt from the 4th millennium BC onwards to produce small objects such as beads, scarabs, seals and amulets. In contrast, it was not until about 1500 BC that significant quantities of glass, including glass vessels, began to be produced.

The number of glaze analyses for steatite and faience dating to the period prior to the beginning of glass production are severely limited. The very few that are available for the Middle Kingdom and Second Intermediate Periods in Egypt (2055–1550 BC) have high potash contents [56,57], indicating that plant ash was the source of the soda flux used. In contrast, the glazes of two steatite beads from Egypt dating to the Badarian Period (early 4th millennium BC) have very low potash contents ($<0.5\%$ K_2O) [56], suggesting that natron was the source of the flux. In this case, the high magnesia content of the glaze, resulting in a high concentration of recrystallised forsterite, further suggests that the glaze could have been produced by applying a mixture of natron and a copper compound to the surface of the bead prior to firing.

The great majority of published analyses of late Bronze Age glass, dating to the middle of the second millennium BC, are of the plant ash type, with high magnesia and potash. There is very limited evidence for the use of natron as a glass making flux at this time. However, the cobalt-blue glass of New Kingdom Egypt is characterised by low potash, commonly less than one percent, but typical plant ash levels of magnesia, and this has generated considerable discussion. It is generally accepted that the cobalt was derived from the alum deposits of the Western Desert oases which, in addition to minor cobalt and high alumina, also contain significant levels of magnesia. Thus it was suggested [52] that the high magnesia level in the cobalt blue glasses reflected the addition of alum, and that both the magnesia and the potash levels of the base glass were low, so that the source of soda was natron rather than plant ash. Rehren [43] has argued that the peculiar compositional characteristics of New Kingdom cobalt blue glass may be the result of the use of plant ash of a distinctive composition. More recently, Tite and Shortland [57] have re-appraised these data, and conclude that the natron in these glasses was contributed through the addition of the colorant in the form of a cobalt-bearing alkali-quartz frit, but that plant ash was also added to the glass as a flux. Thus, in spite of its early use as a flux in the glaze applied to Badarian steatite beads, there is no conclusive evidence from the second millennium BC for the use of natron as the main flux in glass.

The introduction of natron as a flux becomes apparent from around the beginning of the first millennium BC. Schlick-Nolte and Werthmann [50] have recently reported glass vessels from the tomb of Nesikhons in Egypt dated to the 10th century BC that are low in potash, magnesia and lime, indicating that the soda was derived from natron. The lime content of plant ash appears high in virtually all analysed examples, so that the low concentration in the Nesikhons glass is conclusive in this respect, indicating that the glassmakers at this time mixed natron directly with a low-lime silica source (crushed quartz or relatively pure sand). The consequence of this is that these glasses are very unstable and have survived only under the exceptionally cool and dry conditions of the tomb of Nesikhons. Further evidence for the use of natron early in the first millennium B.C. comes from 8–9th century Nimrud, Iraq, where blue glasses coloured by cobalt alum average 0.5% K_2O, and contain as little as 1% CaO [44]. Beads from the same period, made of similar cobalt blue glass, have also been recorded by Gratuze and Picon [21] from France and the raw glass for these was presumably obtained from Egyptian or Near Eastern sources. These glasses are preserved due to the high alumina and magnesia contents introduced with the cobalt; weakly coloured glass and coloured glass where the colorant does not contain a stabilising oxide are likely to have weathered away. Thus detailed evidence for the emergence of natron glass in the late second to early first millennia BC is unlikely to be forthcoming. Most of the glass produced in this period is likely to have been lost because of the failure of the glassmakers to recognise that particular types of sand (rich in lime) were needed to stabilise the glass [44].

2.2. The growth and decline of the use of natron

From the early first millennium BC, the use of natron as a glass flux spread through the Mediterranean and Levantine regions, and certainly by the fifth century BC it was the flux used west of the Euphrates in the great majority of glass. To the East, however, an early observation from the work of Sayre and Smith [53] still holds true. Here, plant ash continued to be used as a flux, and natron does not appear to have displaced it for any significant period of production. This adherence to a plant ash glass formulation in Mesopotamia, Iran and Central Asia is