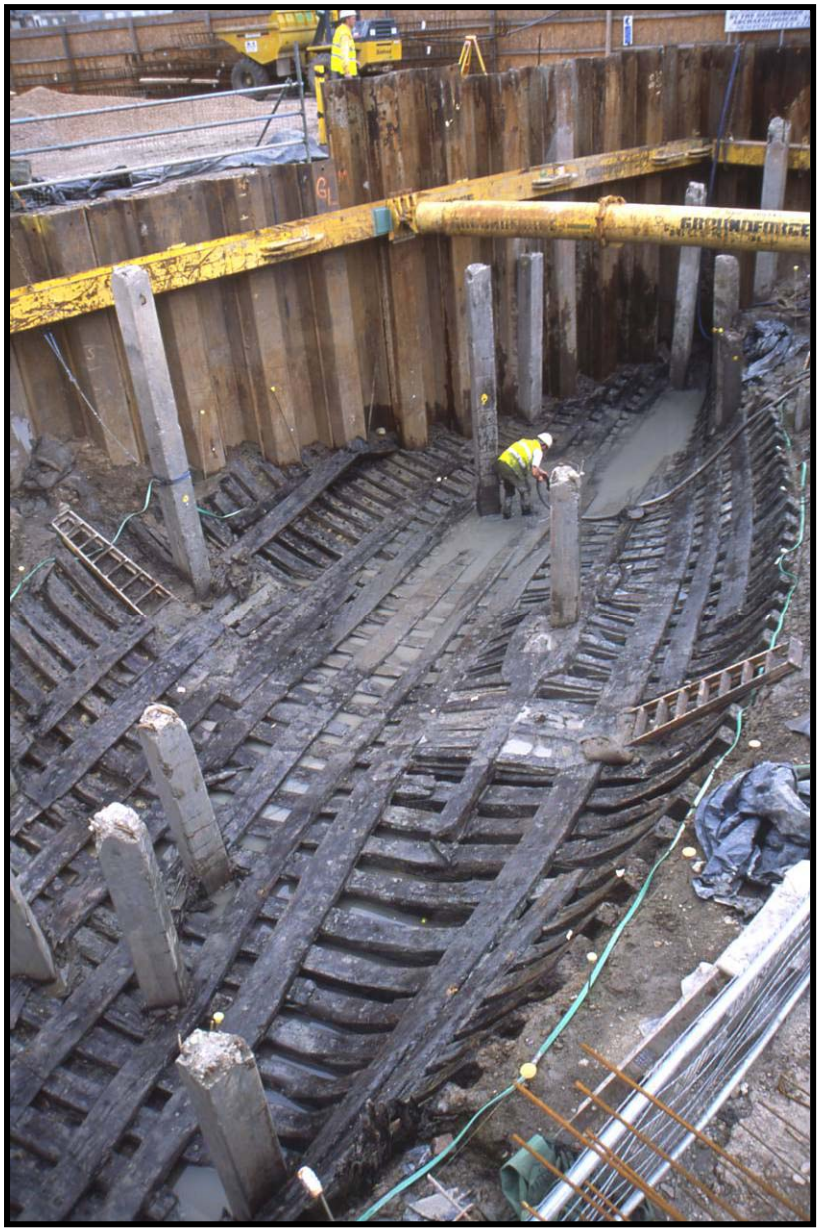
# Newport Medieval Ship Project

# Specialist Report: GLASS



Site number: GGAT 467
Site location: NGR: ST 31286 88169 Kingsway, Newport, South Wales, UK.

Newport CITY COUNCIL
CYNGOR DINAS Casnewydd

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# The Newport Ship Project

## Introduction

In 2002, during the construction of the Riverfront Theatre, on the banks of the River Usk in Newport, South Wales, an archaeological find of great significance was unearthed. In the summer of that year, while undertaking the excavations for the theatre's orchestra pit, the well-preserved remains of a 15th century clinker built merchant vessel were discovered.

The site, which was surrounded by a cofferdam, was being monitored by the Glamorgan Gwent Archaeological Trust at the time of discovery. The ship lay in what is locally known as a pill or small inlet, with its stern closest to the river and its bow facing into the inlet. The timbers were covered in thick alluvial mud, which created an ideal anaerobic environment for successful preservation. Seventeen strakes of planking remained on the port side and thirty-five on the starboard side of the ship. The vessel was approximately 30m in length.

A silver French coin was found purposely inserted into the keel of the vessel, dating the ship to after May 1447. Dendrochronological research has shown the hull planking to be from the Basque country and after 1449 in date.

After a much publicised 'Save Our Ship' campaign, it was decided that the ship would not be recorded and discarded but excavated with the aim to conserve. The riders, stringers, braces, mast step, frames and overlapping clinker planks and keel were dismantled one by one and lifted. Almost 2000 ship components as well as hundreds of artefacts were excavated.

This report examines and lists the glass remains recovered during the Newport Medieval Ship excavation.

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# REPORT ON THE COMPOSITION OF A SANDGLASS FROM THE NEWPORT MEDIEVAL SHIP

(Requested by Newport City Museum and Heritage Service)

*Several fragments of glass from the Newport medieval ship, believed to be part of a sandglass, were analysed in the scanning electron microscope. Chemical analysis has revealed that the glass is all from the same object, and is of a 'potash' compositional type typical of that produced in Britain, northern Europe and the northwestern Iberian Peninsula between the fourteenth and sixteenth centuries.*

## INTRODUCTION

Several fragments of glass from the Newport medieval ship were provided for analysis. They are assumed to be part of a sandglass or running glass used on board the ship in the late-fifteenth century (Trett 2010). The aim was to confirm a medieval date, with a further hope to determining the type of glass and its provenance.

## METHODS

Small samples were taken, mounted in epoxy resin and polished. They were coated with a thin layer of carbon and examined in the scanning electron microscope (CamScan Maxim). The chemical compositions of the samples were determined using an Oxford Instruments INCA energy-dispersive x-ray analyser (EDXA) attached to the SEM. Relative analytical accuracy is believed better than ±2% for silica, and ±5% for other elements present in concentrations greater than 10%, but greater for elements present in lower concentrations. Detection limits were 0.2% for most of the components analysed, 0.3% for lead and tin and 0.7% for antimony, due to high levels of calcium in the glass matrix. Results were taken from an average of five analyses, and were normalised to 100% to improve precision and comparability.

Table 1 – Average composition of the Newport Ship hourglass alongside those of contemporary English medieval potash glasses.

| *Oxide (wt%)*[1] | *Sample* | | |
|---|---|---|---|
| | Newport Ship[2] | Little Birches[3] | Blunden's Wood[4] |
| *No. anals.* | *1* | *54* | *20* |
| $Na_2O$ | 1.9 | 2.3 | 2.5 |
| $MgO$ | 6.9 | 7.2 | 6.7 |
| $Al_2O_3$ | 0.8 | 1.5 | 0.9 |
| $SiO_2$ | 57.3 | 56.8 | 58.4 |
| $P_2O_5$ | 2.8 | 3.4 | 2.0 |
| $SO_3$ | 0.2 | 0.2 | n.a. |
| $Cl$ | 0.7 | n.a. | 0.5 |
| $K_2O$ | 11.4 | 11.7 | 11.3 |
| $CaO$ | 15.6 | 14.6 | 13.1 |
| $TiO_2$ | 0.1 | 0.2 | 0.1 |
| $MnO$ | 1.2 | 1.5 | 1.1 |
| $Fe_2O_3$ | 0.4 | 0.6 | 0.7 |
| $Sb_2O_5$ | <0.7 | n.a. | 0.8 |
| $BaO$ | 0.2 | n.a. | n.a. |

[1]Results normalised to 100%. n.a. = not analysed. Cobalt oxide (CoO), copper oxide (CuO), zinc oxide (ZnO), tin oxide ($SnO_2$) and lead oxide (PbO) were analysed for but not detected.

[2]Newport Ship sandglass, late-fifteenth century context. Average of five analyses. New data (this report).

[3]Potash glass from Little Birches, Staffordshire. Mid-sixteenth century (Mortimer 1997).

[4]Potash glass from Blunden's Wood, Surrey. Early-fourteenth century (Meek 2011).

[5]The green substrate of a red-layered window glass fragment from *Las Huelgas Monastery*, Burgos, Spain. Twelfth-fourteenth century (Ortega-Felui *et al.* 2011).

## RESULTS

Oxide compositions for the glass analysed is presented in Table 1, col. 1. This is an average of five analyses.

All of the fragments of glass analysed are of exactly the same composition, indicating that they are indeed from the same object. The glass is of a type rich in potash (11.4 %) and lime (15.6 %), but low in soda (1.9 %), with a moderate amount of magnesia (6.9 %). This is consistent with glass of the so-called 'potash', 'wood ash', 'plant ash' or 'forest' glass type. It was produced using a two-ingredient recipe consisting of quartz-rich sand, or quartz pebbles, and the ashes of wood or terrestrial plants (as indicated by 2.8 % phosphate). Iron is present as a minor element (0.4 %), and is responsible for the green tint of the glass. The glass also contains 1.2 % manganese and 0.8 % alumina.

## DISCUSSION

The glass is typical of the potash compositional type, typical of northern European medieval glass produced using plant ash and sand. Potash glass was in use in northern Europe from about the 9$^{th}$ century AD, when it replaced glass based on a mineral source of soda (Tite *et al.* 2006). The high potash and low soda levels, together with a high amount of phosphate, indicate that the source of alkali was obtained by burning woodland trees and plants. This represents a distinctly northern European medieval glassmaking tradition; in southern European medieval glass the alkali source used was typically rich in soda, having been instead derived from halophytic and marine plants (Jackson and Smedley 2004; Meek 2011; Smedley and Jackson 2002).

As mentioned, the glass is distinctively northern European. Its composition is particularly consistent with glass produced in Britain between the fourteenth and the mid-sixteenth centuries, (Table 1 cols. 2-3), which corresponds well with the late-fifteenth century date ascribed to the ship. An Iberian origin is also possible, but a lack of work on medieval glass from this region, particularly vessel glass, means that comparison is difficult. Glass produced in the southern regions of the Iberian Peninsula was produced using a soda-rich alkali source similar to that employed elsewhere in southern Europe, whereas in the northern regions it was produced using wood-ash in the northern European tradition (Ortega-Felui *et al.* 2011).

As can be seen, the Newport Ship glass has a number of similarities with a fragment of medieval window glass from northern Spain (Table 1, col. 4); notably the distinctly similar potash and magnesia contents. Its composition is, however, atypical for the majority of medieval glass analysed from Germany and France. German potash glass

produced after the eleventh century generally contains much higher levels of lime and slightly lower levels of soda (Wedepohl 1997), whereas French vessel glass of the potash type typically contains similar potash levels but less than one percent soda (Barrera and Velde 1989), in contrast to nearly two percent here. It should, however, be noted that French medieval window glass of the potash type is compositionally similar in many respects.

Given that the composition of the ash used in medieval glassmaking is determined by a number of factors, including the habitat of the plants used, the specific parts of the plant employed, and the ashing method (*e.g.* Jackson *et al.* 2005; Smedley *et al.* 1998; Tite *et al.* 2006), it is not possible to speculate as to which plant species was used in this particular glass. Historical sources, such as the twelfth century treatise by Theophilus, commonly cite beech as the preferred source of ash, but the ashes of other plants including oak and bracken were also used (Jackson *et al.* 2005; Smedley and Jackson 2002).

Colourless glass was difficult to produce because of impurities introduced with the raw materials (Freestone 1993), and low levels of iron and alumina here suggest the use of a relatively pure silica source. Nonetheless, the small amount of iron present produces the slight green colouration visible, which usually results from the use of a reducing furnace atmosphere (easily obtained in a wood fired furnace) (Stern and Gerber 2004). Manganese was sometimes added as a decolourant to counteract the effects of this, but its presence here is unlikely to represent a deliberate addition as wood ash usually contains it in high levels (Sanderson and Hunter 1981; Stern and Gerber 2004).

The high levels of lime and potash present significantly decrease the durability of this glass type, meaning that it is particularly prone to corrosion by water, which has resulted in the thick opaque white weathering layer visible (Cox and Ford 1993; Smedley *et al.* 1998).

## CONCLUSIONS

The fragments of glass analysed are all from the same object. They are of a ‘potash’ compositional type, with major elements suggesting that they were produced in northern Europe from the ashes of woodland trees or plants. The glass is typical of that produced between the fourteenth and sixteenth centuries, and it is therefore almost certainly contemporary with the ship. However, due to the compositional variability of this glass type, and a lack of published data on glass of this period from both Britain and elsewhere in Europe, it is not possible at present to further hypothesise as to the plant species employed in its manufacture or confirm the specific region in which it was produced. However, its composition would seem to indicate

that it is likely to have been produced in Britain, although an Iberian origin cannot be ruled out until medieval potash-glass from the region has been more extensively studied.

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REFERENCES

Cox, G. A. and Ford, B. A. (1993) 'The long-term corrosion of glass by groundwater', *Journal of Materials Science*, 28, 5637-5647.

Freestone, I. C. (1993) 'Theophilus and the composition of medieval glass', in Vandiver, P. B., Druzik, J. R., Wheeler, G. S., and Freestone, I. C. (*eds.*) *Materials Issues in Art and Archaeology III*, 739-746. *Pittsburgh, Pennsylvania: Materials Research Society Symposium Proceedings, Volume 267*.

Jackson, C. M., Booth, C. A. and Smedley, J. W. (2005) 'Glass by Design? Raw Materials, Recipes and Compositional Data', *Archaeometry*, 47(4), 781-795.

Jackson, C. M. and Smedley, J. W. (2004) 'Medieval and Post-Medieval Glass Technology: Melting Characteristics of Some Glasses Melted from Vegetable Ash and Sand Mixtures', *Glass Technology*, 45(1), 36–42.

Meek, A. (2011) *The Chemical and Isotopic Analysis of English Forest Glass*. Unpublished PhD thesis, University of Nottingham.

Mortimer, C. (1997) 'Analysis of the glass', in Welch, C. 'Glassmaking in Wolseley, Staffordshire', *Post-Medieval Archaeology* 31, 1-60.

Ortega-Feliu, I., Gómez-Tubío, B., Respaldiza, M. A. and Capel, F. (2011) 'Red layered medieval stained glass window characterization by means of micro-PIXE technique', *Nuclear Instruments and Methods in Physics Research B*, 269, 2378-2382.

Sanderson, D. C. W. and Hunter, J. R. (1981) 'Compositional Variability in Vegetable Ash', *Science and Archaeology*, 23, 27-30.

Smedley, J. W. and Jackson, C. M. (2002) 'Medieval and Post-Medieval Glass Technology: Batch Measuring Practices', *Glass Technology*, 43(1), 22-27.

Smedley, J. W., Jackson, C. M. and Booth, C. A. (1998) 'Back to the Roots: The Raw Materials, Glass Recipes, and Glassmaking Practices of Theophilus', in McCray, P. and Kingery, W. (*eds.*), *The Prehistory and History of Glassmaking Technology*, 145-165. Westerville, OH: The American Ceramic Society.

Stern, W. B. and Gerber, Y. (2004) 'Potassium-calcium glass: new data and experiments', *Archaeometry*, 46, 137-156.

Tite, M. S., Shortland, A., Maniatis, Y., Kavoussanaki, D. and Harris, S. A. (2006) 'The Composition of the Soda-Rich and Alkali Plant Ashes used in the Production of Glass', *Journal of Archaeological Science*, 33, 1284-1292.

Trett, B. (*ed.*) (2010) *Newport Medieval Ship: A Guide*. Newport: the Friends of the Newport Ship.

Wedepohl, K. H. (1997) ‘Chemical composition of glass from excavations in West Germany’, *Glastechnische Berichte*, 70, 246-255.