

Geography of Antimony in Roman and Early Medieval Colorless Glass

This note, provided as an interim and summary report on research made possible by the Rakow Grant for Glass Research, is an indication of what can be achieved from the synthesis of a large amount of geographically recorded glass data. Specifically, it focuses on changing patterns in antimony in colorless glass in Britain between the third and fourth centuries. The assumption is that antimony falls out of use in the third century, and this can be used to track Britain's access to fresh glass and glass trade.

As part of my doctoral dissertation at the University of Oxford, I assembled an extensive database of chemical values of glass. The glass values were taken from previous volumes of the *Journal of Glass Studies*, the *Annales* of the International Association International for the History of Glass (AIHV), Historic England Research Reports (formerly English Heritage Reports and Ancient Monument Laboratory Reports), and authors who were published in these journals.¹ These values were expanded by fresh analyses conducted at the Research Laboratory for Archaeology and the History of Art at the University of Oxford. This database approach was used to better address the nature of glass in Roman and early medieval Britain, particularly patterns of sourcing and recycling.

Creating this database was an extensive undertaking. It has resulted in a collection of more than 2,000 analyses of glasses from sites across England, as well as analyses of more than 1,500 oves glasses from other European sites, principally along

Acknowledgments. This note would not have been possible without the generosity of the Rakow Grant for Glass Research, which was awarded by the Corning Museum of Glass. I am especially grateful to two members of the staff of the Juliette K. and Leonard S. Rakow Research Library there: James A. Galbraith, chief librarian, for all of his assistance, and Gail P. Bardhan, reference and research librarian, whose encyclopedic knowledge of the collection was invaluable. I also thank Peter Bray of the University of Oxford for his collaboration on Roman antimony.

¹. The Rakow Research Library, which contains the world's largest collection of works on glass, was immensely helpful to this study. It provided access to otherwise unavailable out-of-print books and gray literature containing published values of chemically analyzed first- to eighth-century glass, predominantly from western Europe. A complete list of the papers used is available from the author.

the Rhone and Rhine Rivers. The aim of the dissertation is to understand British glass patterns from the first to eighth centuries, specifically the changing reliance or otherwise on recycling in lieu of trade, and so the database is both more extensive and more detailed, specifically containing World Geodetic System coordinates of the findspots of the glasses. The European database, while extensive, is nowhere near as exhaustive or as geographically precise, and it was assembled as a comparative set.²

This large-scale approach, which has yielded very positive results in traditional archaeology³ and scientific analysis of metals,⁴ is also showing promising indications in glass, specifically in terms of geographic relations.⁵ One interesting example of this will be elucidated below to give an indication of the work undertaken.

Antimony is known as a “glassmakers’ soap” because of its oxidative properties. However, in 1961, Sayre and Smith noticed that some glasses from the Syrian coast had been decolorized less by antimony oxide than by manganese oxide.⁶ Many further studies have concluded that, all across the Roman world, antimony was used as a decolorizer and opacifier in glass until the late third century, when it began to appear with, or to be replaced by, manganese.⁷ Because antimony is better than

2. Following the completion of my doctorate, the database will be available online and deposited digitally in the Rakow Library.

3. Daniel Stansbie and Sarah Mallet, “Big, Bad (?) Data: New Approaches to the Study of Food, Identity and Landscape in Early Medieval England,” *Medieval Settlement Research*, no. 30, 2015, pp. 16–24.

4. Peter J. Bray and A. M. Pollard, “A New Interpretative Approach to the Chemistry of Copper-Alloy Objects: Source, Recycling and Technology,” *Antiquity*, v. 86, no. 333, 2012, pp. 853–867; Aurelie Cuénod, Peter Bray, and A. Mark Pollard, “The ‘Tin Problem’ in the Prehistoric Near East: Further Insights from a Study of Chemical Datasets on Copper Alloys from Iran and Mesopotamia,” *Iran*, v. 53, no. 1, 2015, pp. 29–48.

5. Victoria Sainsbury, “When Things Stopped Travelling: Recycling and the Glass Industry in Britain from 1st–7th Centuries,” in *Things That Travelled: Mediterranean Glass in the First Millennium AD*, ed. D. Rosenow and others, London: University College London Press, forthcoming.

6. E. V. Sayre and R. W. Smith, “Compositional Categories of Ancient Glass,” *Science*, v. 133, June 9, 1961, pp. 1824–1826.

7. See, for example, B. Velde and C. Gendron, “Chemical Composition of Some Gallo-Roman Glass Fragments from Central Western France,” *Archaeometry*, v. 22, pt. 2, August 1980, pp. 183–187; P. Mirti, A. Casoli, and L. Appolonia, “Scientific Analysis of Roman Glass from *Augusta Praetoria*,” *Archaeometry*, v. 35, pt. 2, August 1993, pp. 225–240; Ian C. Freestone, “Primary Glass Sources in the Mid First Millennium AD” *Annales de l’Association Internationale pour l’Histoire du Verre*, v. 15, Corning and New York, 2001 (Nottingham, U.K., 2003), pp. 111–115; and C. M. Jackson, “Making Colourless Glass in the Roman Period,” *Archaeometry*, v. 47, pt. 4, November 2005, pp. 763–780.

manganese at removing color from glass, this manganese appears to have been, in many cases, part of the sand rather than a deliberate addition, so this change was probably prompted by something other than a technical choice—although this requires further investigation. When we look at patterns of antimony concentrations within England across many centuries, this point of change can potentially be used to begin to unlock patterns of trade and access.

Within the assembled database, there is a clear aggregation of colorless Roman glasses with antimony slightly above 0.5 weight percent (wt %) in the second and third centuries, perhaps indicating a recipe or an “ideal” composition. However, as we move into the fourth century, we begin to see the change to manganese. It is interesting to note how this change in antimony concentration maps geographically, and how this may be related to the reuse and recycling of glass in smaller systems, such as the frontier province of Britain.

For the sake of brevity, only three maps have been included in this note, but hope they will be sufficient to illustrate the potential of such an approach. The note focuses on the shift from the third to fourth centuries. The maps were assembled on the basis of glasses in reports by authors who originally identified them visually as “colorless,” although this can be problematic because of its subjective nature. The glasses were then geographically separated, using ArcGIS, into “fishnet” rectangles, polygons measuring approximately 25 by 75 kilometers, the extent of which was determined by the geographical limit of the data found. ArcGIS, is a geographic information system, a computer-based database system that can be used to both present and then analyze data with a spatial component.

Map 1 shows the outline of the fishnet used and the density of the analyzed glasses in each polygon, as demonstrated both by color and by a numbered label. This approach, rather than surveying individual excavations or sites, was chosen in an attempt to show the most comparable compositions geographically, instead of according to the density of finds or analysis, but with that information still at hand. The information showing the sites that fall into each fishnet has been retained, so that

each polygon can be assessed both internally and externally. This allows us to consider geographical trends across Britain, without allowing certain large-scale sites to bias the data, and permitting geographically proximate sites to be considered together. Such an approach was also taken in the English Landscape Project.⁸

Maps 2 and 3 use these polygons to demonstrate the split between glasses with less than 0.1 wt % antimony (indicated in red) and those with 0.1 wt % or more (indicated in blue). The category “null” refers to areas where there are no colorless glasses dated to that century. Map 2 encompasses third-century colorless glasses, which Map 3 shows fourth-century colorless glasses.

When we consider the third century (Map 2), it is very clear that the vast majority of glasses fall into the higher group (greater than 0.1 wt % antimony). There is one particular exception: a polygon dominated by glass from the Roman fort of Mancetter, over 40 percent of which falls into the category of less than 0.1 wt % Sb. This is not seen in the second century (which is not presented in this note),⁹ but it marked the start of a trend that continued into the fourth century (Map 3). This implies that these sites in the interior of Britain were recycling glasses containing antimony with another, naturally nearly colorless glass. This could be an indication of careless recycling, or of a watering down of colorless glass of better quality, to make the stock go further. It may also suggest that nonstandard antimony glass was made in the region, but the appearance of elevated copper in some of these glasses supports the former alternative.¹⁰ This implies that these central sites may have had less access to fresh material, which is particularly interesting because Mancetter was an imperial fort. Forts are usually assumed to have had better access to trade than other British sites,¹¹ and this raises interesting questions as to why this fort does not seem to. Is this assumption incorrect? Are military sites better or more reliant on the recycling of glass?

⁸ Chris Green, Chris Gosden, Anwen Cooper, Tyler Franconi, Letty ten Harkel, Zena Kamash, and Andrew Lowerre. "Understanding the Spatial Patterning of English Archaeology: Modelling Mass Data, 1500 BC to AD 1086." *Archaeological Journal* 174, no. 1 (2017): 244-280.

⁹ Sainsbury [note 2].

¹⁰ Sainsbury [note 2].

¹¹ Barri Jones, and David J. Mattingly. *Atlas of Roman Britain*. Oxbow Books Limited, 2002: 175-178

When we move into the fourth century, there is a general shift to a much higher proportion of the assemblage containing antimony levels of less than 0.1 wt % (Map 3). However, the more central part of Roman Britain has the highest percentage of this. While in the third century, there is ‘central’ data from the North of the West Midlands, in this century unfortunately there is only data from further South, the edge of the West Midlands, into the North of the South West. In some areas, the more standard third-century composition of high antimony is seen. This is particularly true in coastal areas, which could be related to trade routes, although such arguments are tentative at present. However, this slow shift of glass compositions, with a clear geographical variance, begins to raise some interesting questions about our ability to trace these trade routes. These patterns are beginning to be analyzed in relation to ancient rivers and roads.

Unfortunately, very little colorless glass dating to the fifth century has been analyzed. There are many reasons for this, including a shift toward a preference for brightly colored glasses. However, and perhaps more detrimentally, there is the problem of dating. In Britain, the identification of fifth-century sites or strata is particularly difficult because of their potential material similarity to fourth-century Roman sites. For example, excavations at Tubney Wood in Oxfordshire uncovered what appeared, on a stylistic basis, to be Roman burials; however, now that these finds have been radiocarbon-dated, they have been classified as belonging to the fifth and sixth centuries.¹² This means that tracing how the transition away from antimony as a decolorizer continues is difficult. However, when we return to a usable density of data, in the sixth century, there is a notable amount of colorless glass containing higher amounts of antimony—which, at this point, would be a production not common outside of Britain for 200 years. This lends credence to the concept of long-term continuous glass recycling, with periodic replenishing of fresh glass.

The compositional change of antimony in glass throughout the first millennium in England is particularly interesting when considered geographically. This has been briefly demonstrated with this case study of the third and fourth

¹². Andrew Simmonds, Hugo Anderson-Whymark, and Andrew Norton, “Excavations at Tubney Wood Quarry, Oxfordshire, 2001–9,” *Oxoniensia*, v. 76, 2011, pp. 105–172.

centuries, and it raises interesting questions about the trade and recycling of glass in England at this time. The place of recycling and the longevity of glass types, as well as how they fall across England, could answer much broader questions about Britain's access to Late and Post-Roman trade. As well as this, it is interesting to consider how different parts of England had and used this access.

Victoria A. Sainsbury

Research Laboratory for Archeology and the History of Art

University of Oxford

Oxford, England, United Kingdom

victoria.sainsbury@arch.ox.ac.uk

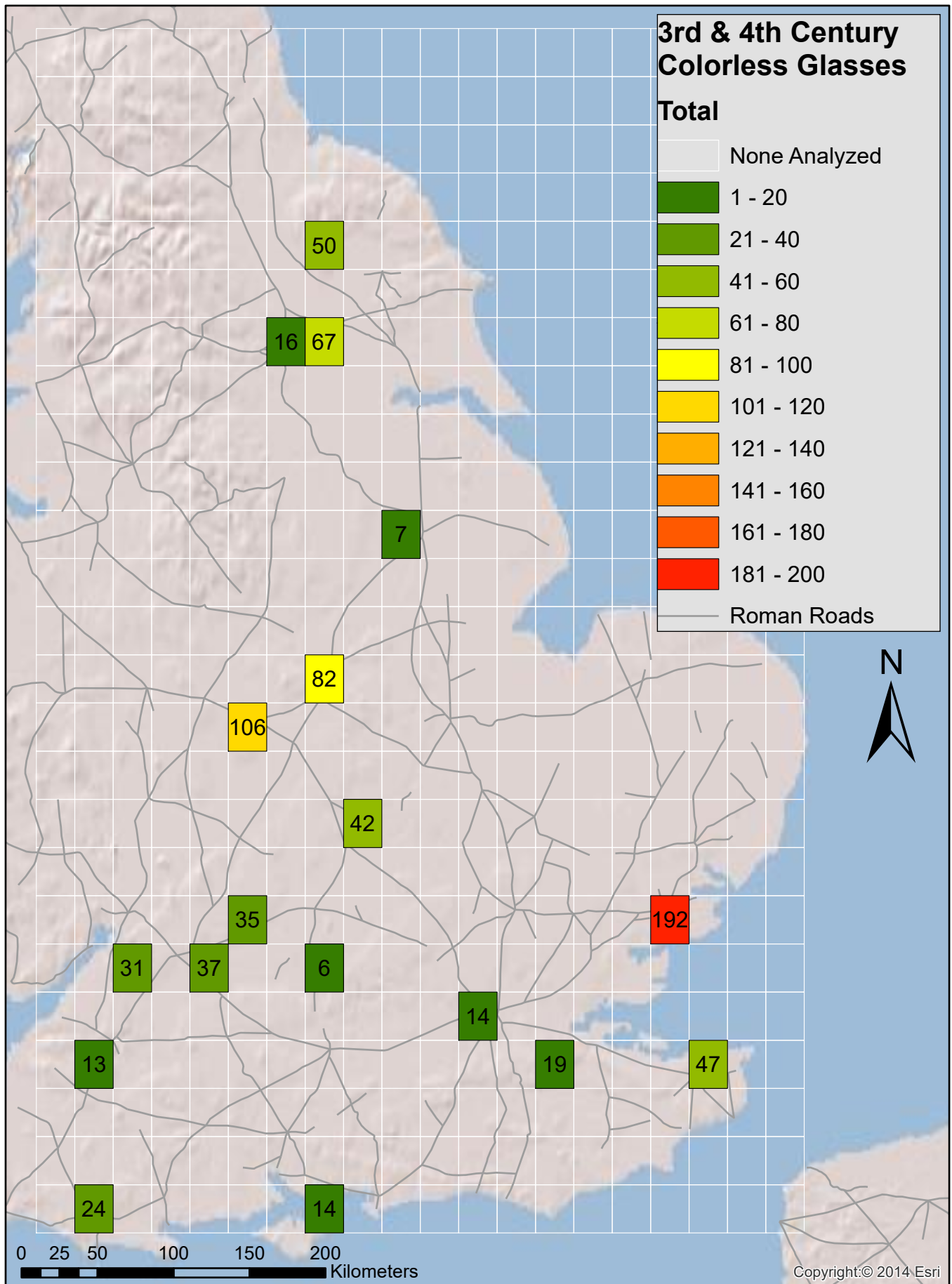
FIGURE CAPTIONS

MAP 1. Density of third- and fourth-century colorless Roman glasses, as separated by the fishnet described in the text. The color scale and the number label refer to the quantity of glasses analyzed.

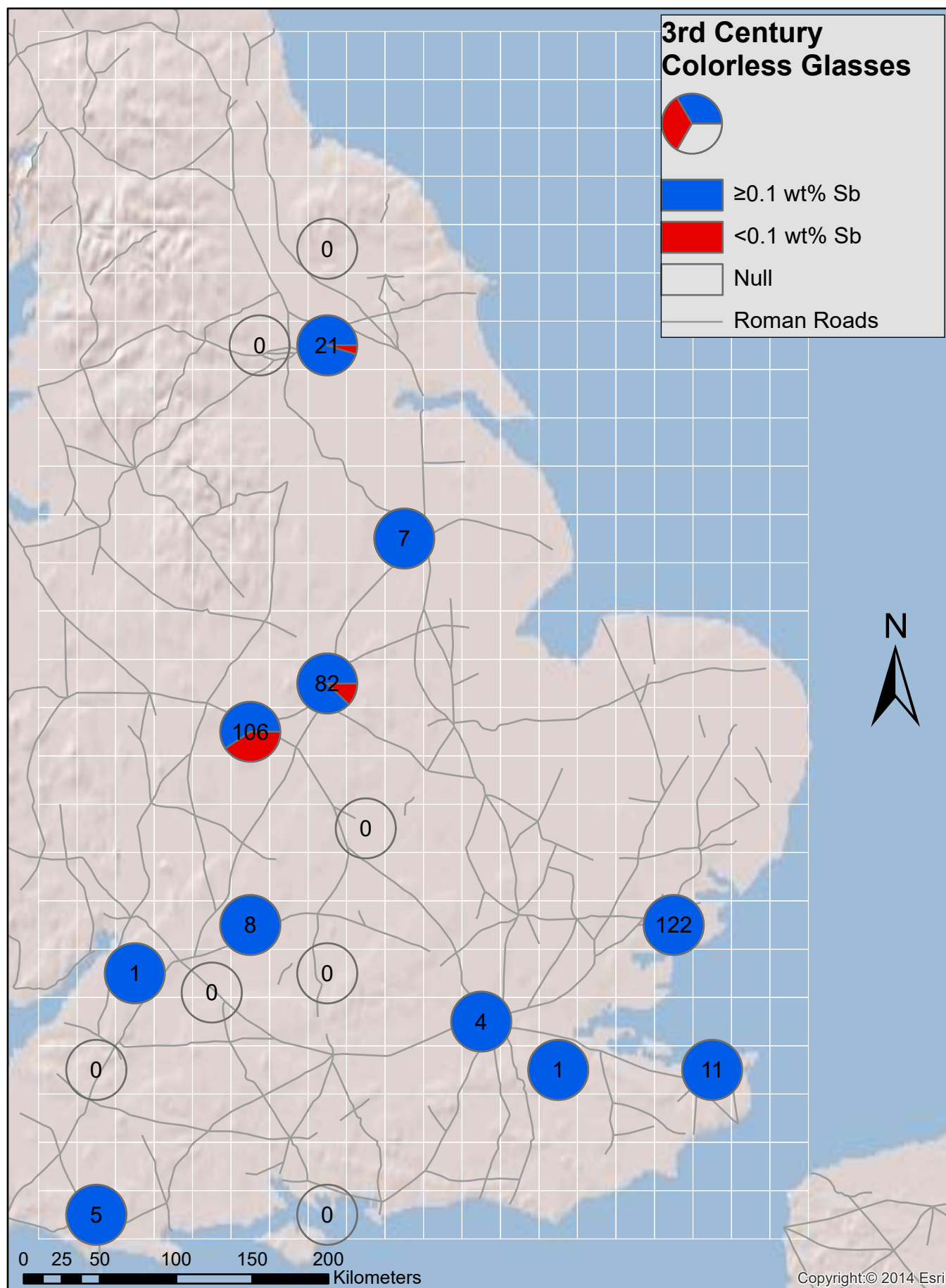
MAP 2. Colorless Roman glasses from the third century, with pie charts indicating the percentage of glasses with less than (red) or greater than or equal to (blue) 0.1 wt % antimony. The empty pie charts indicate areas where no glass was found dating to that century, but instead to the fourth century. The numerical label indicates the actual number of glasses in the polygon.

MAP 3. Colorless Roman glasses from the fourth century, with pie charts indicating the percentage of glasses with less than (red) or greater than or equal to (blue) 0.1 wt % antimony. The empty pie charts indicate areas where no glass was found dating to that century, but instead to the third century. The numerical label indicates the actual number of glasses in the polygon.

Map 1



Map 2



Map 3

