



Research article

Archaeomagnetic investigation of a Roman glass workshop in Goch-Asperden, Germany



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ABSTRACT

A Roman glass workshop situated near the German–Dutch border in the vicinity of the modern village of Goch-Asperden has been investigated archaeomagnetically. Archaeological evidence including potsherds, coins and fragments of glass vessels suggests that the workshop was in use from shortly before 400 CE to the first third of the 5th century CE, though from archaeological point of view the period of operation cannot have covered more than a few years. The archaeomagnetic directions of the two superimposed glass furnaces are well defined while a feature of burnt sand gave relatively scattered directions. The mean direction of the upper furnace agrees well with that of the burnt sand but the results from the lower furnace are significantly different. This difference is likely to be due to a tilting of the lower furnace because of the sandy foundation. Archaeointensities obtained from classical Thellier and multiple-specimen paleointensity domain-state corrected experiments are in good agreement between methods as well as between the furnaces. This supports the hypothesis for contemporaneity of the furnaces. Archaeomagnetic dating evidence is in good agreement with the archaeological age indicators but is not able to refine it further. The well dated and reliable archaeomagnetic full vector contributes to the archaeomagnetic database of Europe.

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1. Introduction

Archaeomagnetic in situ sampling of a baked, archaeological structure can provide an archaeomagnetic direction and intensity. Such data can be used to indicate the dating of the last firing, when compared with the archaeomagnetic secular variation calibration curve of the region (e.g. Pavón-Carrasco et al., 2009; Schnepf and Lanos, 2005). This can support archaeological dating akin to the use of ceramic chronologies, or small finds such as coins or types of glass vessels. On the other hand, if archaeological dating is well constrained such data can be used to refine the world wide archaeomagnetic database, which is important for increasing our understanding of the geomagnetic field.

The growing worldwide archaeomagnetic database (e.g. Brown et al., 2015) provides a compilation of such data published up until 2014. A search of this database indicates that the number of archaeomagnetic directions and intensities for Germany and its hinterland (6–15°E and 47–55°N) during the Roman epoch (about 0 to 500 CE) is surprisingly small. Only 42 entries can be found, which

represent 37 declinations, 38 inclinations and only 5 intensities. No result provides the full archaeomagnetic vector, but there is one from Belgium (Ech-Chakrouni et al., 2013) not included in the database. The geographical distribution of these data is concentrated to the west of Germany and some places in central and eastern Germany. All intensity data come from the southern part of this area and cover the time interval 150 to 500 CE. If the area is extended in longitude by 5° to the west many more directions (91) appear, mainly from France, Belgium and The Netherlands, but there are only 4 more intensities from France, of which only one is accompanied by inclination data.

The investigated features described in this paper are glass furnaces, which have been found close to a Roman *burgus* in Germany. The occupation period of the *burgus* and the glass workshop is well defined by archaeological evidence. The aim of this study is to provide archaeomagnetic dating of the glass furnaces, test the contemporaneity of the structures and augment the German archaeomagnetic database with new results.

2. Archaeological features and dating

In Late Antiquity a *burgus* and a glass workshop existed near the German–Dutch border in the vicinity of the modern village of Goch-Asperden (Fig. 1a). The *burgus* lay on a fluvial terrace north of the

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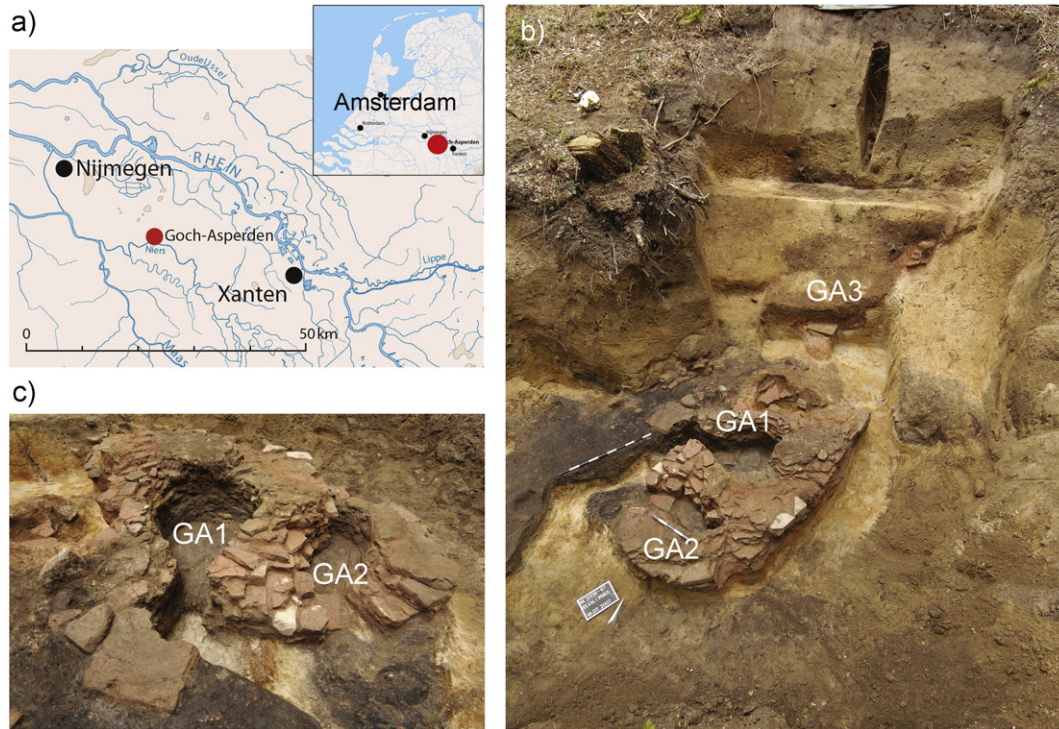


Fig. 1. a) The site of Goch-Asperden in the Lower Rhine Region, Germany. b) The entire structure of the glass workshop was built into the slope, in front of it the two furnaces in view from the south. c) View from the west of the two furnaces with the blackened working levels seen in the foreground.

river Niers near a suggested road-crossing (Hinz and Hömberg, 1968). A few metres below the *burgus*, on the estuarine plain of the river, the glass workshop was situated (Fig. 1b). It was excavated in 2006 and 2007 by the LVR – State Service for Archaeological Heritage (LVR – Amt für Bodendenkmalpflege im Rheinland, Brüggler 2011, 2016). Two glass furnaces were uncovered, the younger one partly overlying the older one (Fig. 1c). Both were made of tiles, and to a lesser extent natural stone and loam. To the west of the furnaces, a black layer containing charcoal and other debris from glass-working was interpreted as the working level of furnace GA1. The older furnace (number GA2) had a similar layer associated with it, also to the west of the furnace. Around the furnaces, postholes were documented, which most likely belonged to a shelter. To the north of the furnaces, a terrace was built into the natural slope and lined with loam and stone. This structure was – at some point – fired, so that the loam and the surrounding sand were burnt red (Fig. 1b, GA 3).

The *burgus* was dated to the last third of the 4th and beginning of the 5th century CE by coin evidence, while roller-stamped Argonne ceramics suggest occupation had begun around 340 CE and ended around 420/30 CE. Furthermore, three dendrochronological samples from a jetty or river bank revetment were dated to 360, 361 and 363 (all samples within a range of ± 10 years; Th. Frank, Dendrolab Cologne, cf. Brüggler, 2016). The proposed date of the glass workshop lies within the earlier part of the time span associated with the use of the *burgus* and is derived from the analysis of stratified potsherds (especially roller-stamped Argonne ware) and to a lesser extent,

coins. In addition, stratified and un-stratified fragments of glass vessels provide important dating evidence for the structures and the timescale of production. Thereby, a period from shortly before 400 CE to the first third of the 5th century is proposed as the time span of furnace operation (for details cf. Brüggler, 2016; Rehren and Brüggler, 2015). However, each furnace could probably have only been used for a campaign of seven to eight months without substantial repairs. There are indications of repairs, but of course, the substructures could have been furnished with new cupolas without leaving any archaeological trace. However, the period of operation in all cannot have been more than a few years.

3. Material and methods

Archaeomagnetic sampling of the two glass furnaces and the burnt earth/sand around the terrace feature was carried out during the excavations in 2006 and 2007. The tiles of the furnace walls were taken as oriented blocks while the baked loam surrounding furnace GA1, underlying GA2 and foundational sand GA3 (Fig. 1b) were sampled with the soft core technique (Schnepf et al., 2008), see Table 1, columns 1 to 3). Soft cores were consolidated and cut into cylinders, block samples were sawn into cubes and 278 specimens were obtained.

In order to obtain the characteristic remanent magnetization (ChRM) direction a standard palaeomagnetic treatment was applied, including measurement of natural remanent magnetization (NRM),

Table 1

Archaeomagnetic results of the glass furnaces of the excavation Goch-Asperden (51.705°N, 6.049°E): name, sampled structure, number of independently oriented samples (tile/baked loam or sand), number of demagnetization experiments with alternating field (AF) or thermal (th) demagnetization or obtained from Thellier experiments (Th), number of independent ChRM directions, mean declination, inclination, precision parameter of Fisher (1953) statistics, radius α_{95} of error cone.

Name	Feature	n	AF/th/Th	N	D (°)	I (°)	k	α_{95} (°)
GA1	Furnace I	23 (10/13)	21/22/5	17	354.4	65.5	305	2.0
GA2	Furnace II	19 (12/7)	28/12/2	14	5.2	60.8	264	2.5
GA3	Terrace of burnt sand	10 (0/10)	10/8/0	3	354.7	65.6	91	13.0
Combined direction GA1/GA3		–	–	20	354.5	65.5	255	2.0

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