

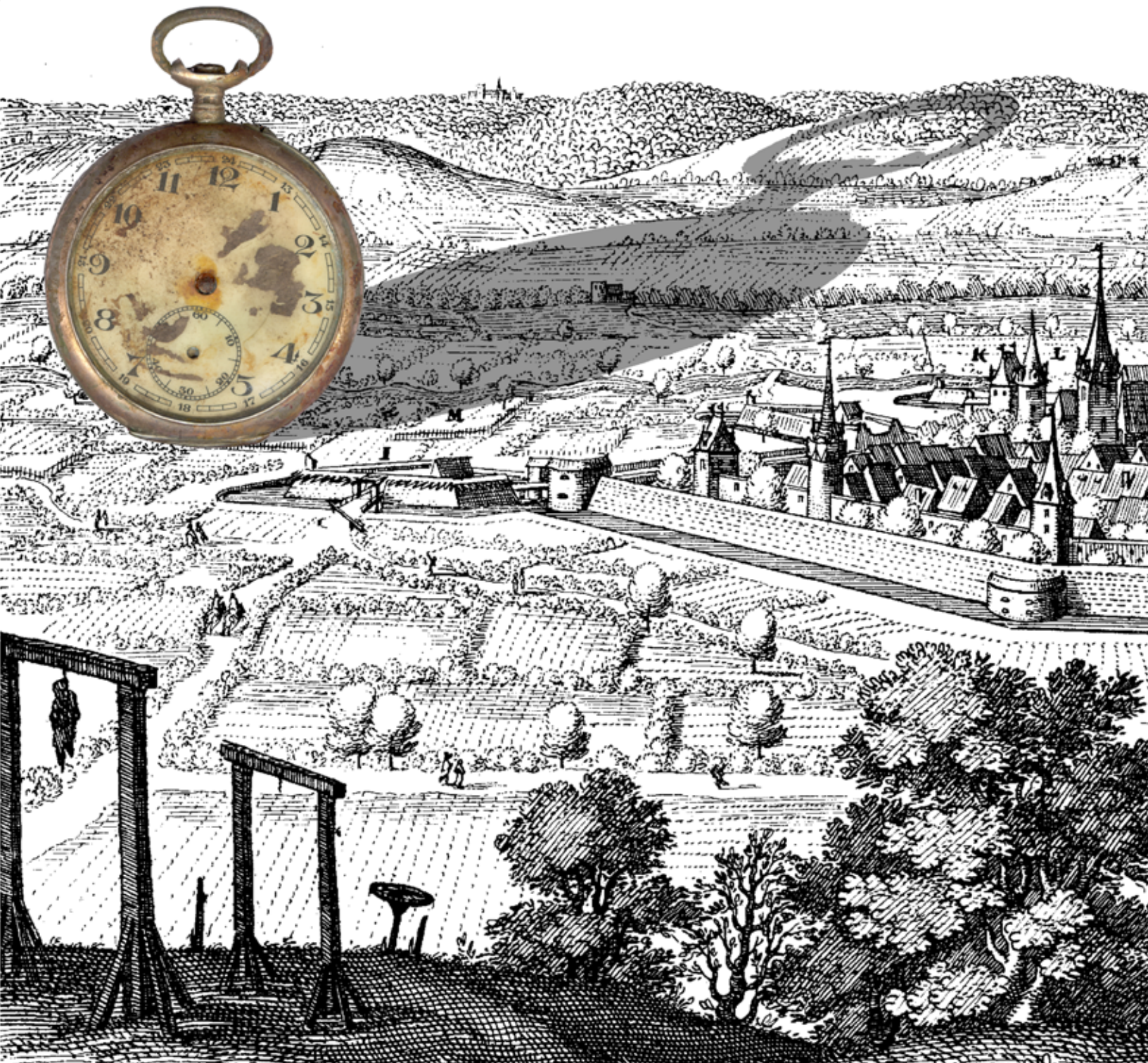
SPECIAL PUBLICATION NUMBER 10



Historical Archaeology in Central Europe

NATASCHA MEHLER

Editor



Historical Archaeology in Central Europe

(FULL COLOR EDITION)

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**SPECIAL PUBLICATION NUMBER 10,
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BACK COVER IMAGE: *The chimneys of Krupp Steel Works in Essen, Germany* (courtesy of Stadtbildstelle Essen, ca. 1890. Exact date unknown).

Dedicated to Paul Courtney

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Craftsmen's Pottery Kilns in Belgium, The Netherlands, Germany, Austria, and Switzerland

ABSTRACT

The topic of the paper focuses on the history of non-industrial ceramic technology in the German-speaking parts of Europe, in Belgium, and in the Netherlands on the basis of excavated pottery kilns. Kilns are the most important part of the pottery production process. In Europe two basic kiln types have been identified archaeologically: updraft kilns and crossdraft kilns. These basic types can be further differentiated on the basis of their ground plans and various construction details. Vertical and horizontal kilns coexisted for a long time. Vertical updraft kilns with circular ground plans for the production of earthenware remained in use alongside crossdraft kilns into the 14th century in almost all regions of the area investigated. Further development of this kiln type only took place on both sides of the English Channel and led in the end to the well known "bottle kilns" of the English ceramic industries. Horizontal crossdraft kilns could be used for the production of earthenware or stoneware. There are several different types, which had been developed since the 12th or 13th century. One of the latest developments for Rhenish earthenware production was mixed crossdraft/downdraft earthenware kilns of the early 19th century.

INTRODUCTION

Pottery kilns are the most important part of the pottery production process. The way they are built decisively influences the final product and its technological properties. The control of the firing process, the steering of an oxidized or reduced kiln atmosphere, and the possibility of reaching the top temperatures necessary for the production of stoneware or porcelain is dependent upon developments and technological progress in kiln construction. The following essay begins with the late medieval foundations of kiln technology in order to better understand the kiln

types found between the 15th and 20th centuries (for references and extended bibliography see Heege 2007).

Archaeological finds of kilns occur relatively frequently in the areas investigated (Germany, Belgium, the Netherlands, Austria, and Switzerland; kilns from France, England, or the Mediterranean/Arabic world were not included in the project). A database of 316 datable pottery kilns from the 15th to the 20th centuries was compiled between January 2005 and March 2007. The largest number of kilns—245 examples—was found in Germany (Figure 1).

KILN TYPES

Two basic types of kilns were identified archaeologically:

- Updraft kilns. These are characterized by a horizontal separation of superimposed furnace and firing chamber through a raised kiln floor, designed as domed or open-top kilns (Figure 2).
- Crossdraft kilns. The essential criterion of this type is the more or less horizontal or upward sloping arrangement of the furnace and firing chamber, which are placed on one level, one behind the other. They may be separated by a

pronounced step, mostly combined with a fire grate of brick or clay columns, or vertically separated by a latticework of bricks. The separating element acts as an openwork fire-protection wall or a fireguard. The kiln draft is diagonal to almost horizontal and includes vents in the kiln vaulting or at the rear of the kiln. An exhaust vent or chimney is not absolutely necessary, but when present ensures an optimum draft (Figure 3).

These basic types can be further differentiated on the basis of their ground plans and various construction

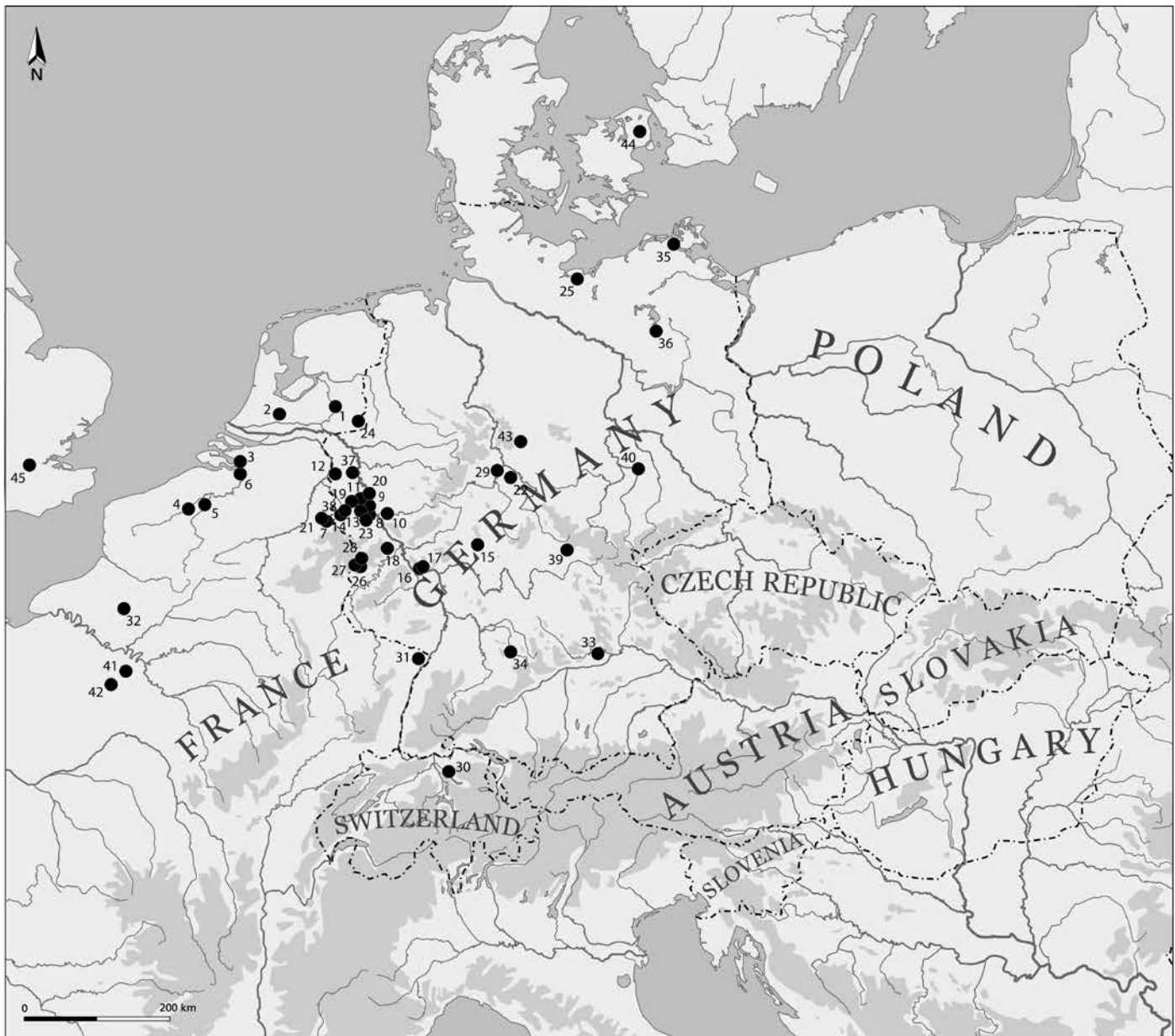


Figure 1. Map with sites mentioned in the text (in Germany, unless otherwise noted): (1) Deventer, the Netherlands; (2) Utrecht, the Netherlands; (3) Bergen op Zoom, the Netherlands; (4) Kortrijk, Belgium; (5) Oudenaarde, Belgium; (6) Antwerp, Belgium; (7) Raeren, Belgium; (8) Badorf; (9) Pingsdorf; (10) Siegburg; (11) Hürth; (12) Brüggen; (13) Brühl; (14) Langerwehe; (15) Aulendiebach; (16) Aulhausen; (17) Marienthal; (18) Mayen; (19) Frechen; (20) Cologne; (21) Aachen; (22) Großalmerode; (23) Bornheim-Sechtem; (24) Vreden; (25) Grenzhausen; (26) Binsfeld; (27) Herforst; (28) Bruch; (29) Möncheberg; (30) Zürich, Switzerland; (31) Oberbetschdorf, France; (32) Beauvais, France; (33) Sandersdorf; (34) Wildenhäusle; (35) Stralsund; (36) Rheinsberg; (37) Neuss; (38) Bedburg; (39) Coburg; (40) Leipzig; (41) Saint-Maurice-Montcourconne, France; (42) Rionville-sous Dourdan, France; (43) Fredelsloh; (44) Fraum Lillevang, Denmark; and (45) Woolwich, Great Britain (Map provided courtesy of the Department of Prehistory and Medieval Archaeology, University of Vienna, Austria).

Figure 2. (right, top) Reconstruction of a vertical updraft majolica kiln with a rectangular ground plan; the furnace and superimposed firing chamber are separated by a raised kiln floor ("Piccolpasso type"). This example is in Deventer, the Netherlands, Klooster noord, and its production period was 1624-1637 (Lubberding et al. 1985:32).

Figure 3. (right, bottom) Ground plan (Grundriss), longitudinal section (Längsschnitt), and cross section (Querschnitt) of crossdraft kiln with furnace (Feuerraum) and firing chamber (Brennraum) positioned one behind the other. Other features depicted are the fire observation hole (Fenster), the kiln door (Türe), the vertical fire grate (Ständer), the chimney (Kamin), and the domed kiln floor (Gewölbe) with clay (Lehm) supports. This example is in Wildenhäusle, Baden-Württemberg, Germany (Stachel 1983:figure 9).

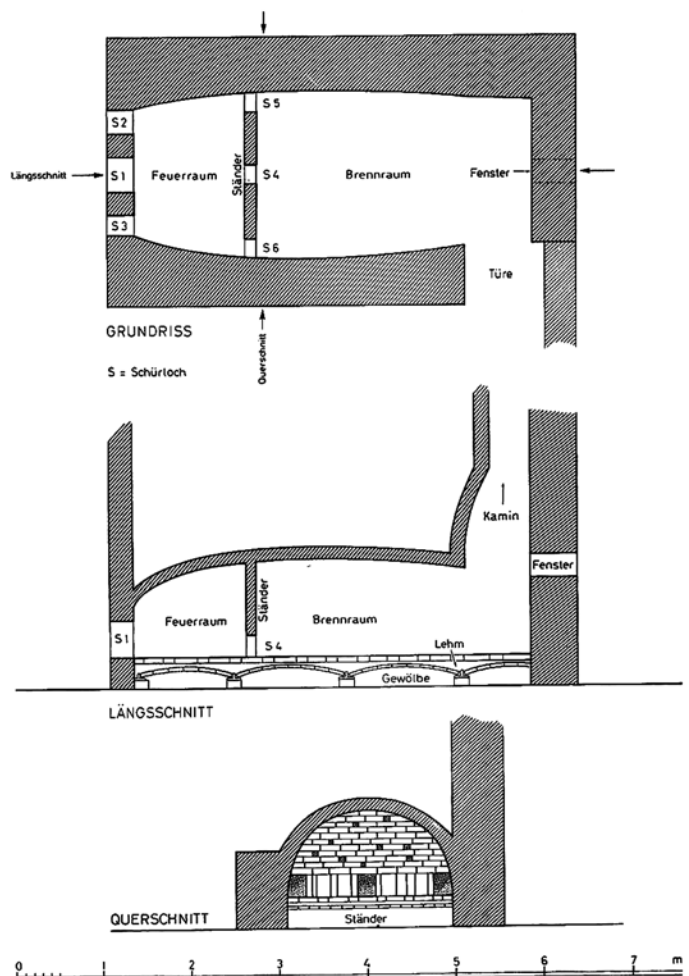
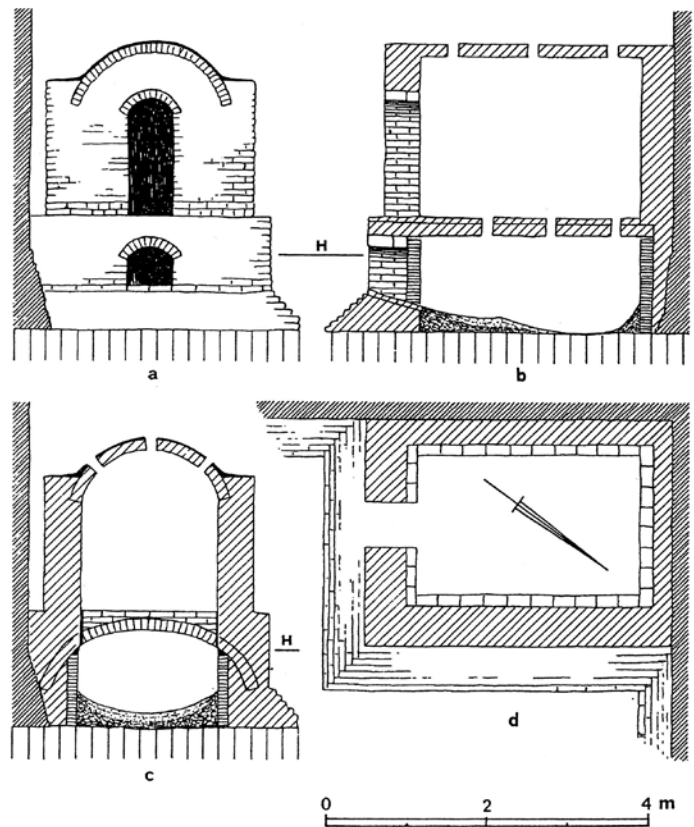
details, which vary according to the type of ware to be produced (i.e., earthenware, stoneware, majolica/faïence, or porcelain). There are two groups of updraft kilns with either circular or rectangular ground plans, both of which have roots in the Roman period. Updraft kilns with rectangular ground plans are typical kiln types in the production of majolica and faïence. In Switzerland, Austria, and southern Germany they were used for earthenware production as well.

As far as crossdraft kilns are concerned, late medieval specimens with fireguards form the basis of two continuing lines of development: Rhineland oval stoneware kilns with sunken furnaces and crossdraft earthenware and stoneware kilns with elongated oval ground plans. The latter type is widespread in Lower Saxony, Saxony, Thuringia, and Bavaria. Two further types of crossdraft earthenware kilns with rectangular ground plans were developed in the 18th century.

Updraft Kilns

Vertical Updraft Kilns with Circular Ground Plans

Vertical updraft kilns with circular ground plans and vertical flues from the Celtic and Roman (later Frankish or Roman) areas of German-speaking central Europe (as well as in Italy and southern France) were the starting point in the further development of kilns. To what extent Islamic kiln building influenced French or Italian kiln traditions is unclear. Updraft kilns of this basic type, with structural variations over time, remained in use alongside crossdraft kilns into the 14th century in almost all regions of the area investigated. The later examples were built in brick, and the Dutch and Belgian findings from Utrecht (the Netherlands) as well as Kortrijk and Oudenaarde (Belgium) are particularly



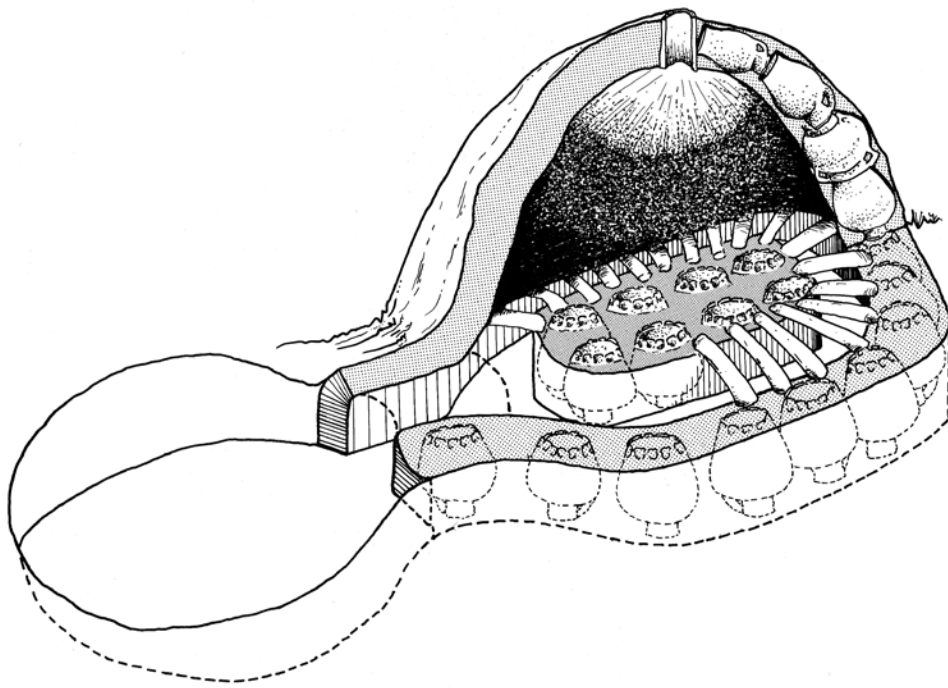


Figure 4. Reconstruction of a vertical updraft kiln with circular ground plan and a raised kiln floor consisting of a central pillar and movable fire bars. The kiln superstructure is a permanent dome made of crocks. This example is in Oudenaarde-Pamele, Belgium, kiln D, and it dates to the second half of the 14th century (De Groote 1993:figure 21).

noteworthy for their good archaeological preservation (Figure 4) (De Groote 1993).

Despite the continuous presence of pottery in the archaeological record, there is a gap of more than 200 years between these kilns and the younger vertical updraft kilns as typified by excavated examples from Bergen op Zoom (the Netherlands) and Arras in north-eastern France. A technological relationship is nevertheless likely. The younger updraft kilns of “Bergen op Zoom-type” (Figure 5), which occur in the 17th and 18th centuries, were made from bricks with double opposed flues (twin stoke holes) and a raised oven floor made of a central pillar and movable fire bars (Groeneweg 1992). On both sides of the English Channel this type of kiln seems to have combined twin stoke holes with elements from stoneware-kiln technology (movable fire bars) and from early industrial cylindrical updraft kilns, although it is not clear where the invention of the early round updraft kiln took place. Knowledge of the described kiln construction technology reached North America in the late 17th century (Noël Hume 2001:30).

Vertical Updraft Kilns with Rectangular Ground Plan (“Piccolpasso Type”)

Vertical updraft kilns with a rectangular ground plan can also be traced back to Roman-Mediterranean

roots (Italy, Spain, southern France). Corresponding to the well-known construction drawings from the Piccolpasso manuscript of 1558 (Figure 6) (Lightbown and Caiger-Smith 1980), kilns of this construction type were initially introduced north of the Alps by Italian majolica potters by 1500 at the latest (see Figure 2). With small modifications in its construction, this kiln type became the technological foundation of all European faïence manufacture (even in England and France). This type, with adaptations to the flue (i.e., grate and air supply) was also adopted by European porcelain manufacturers as glow or bisque firing kilns. The rapid and seemingly technologically unproblematic acceptance

of this type of kiln may have also been influenced by the fact that, in Utrecht and Switzerland for instance, similar kilns with raised floors on transverse arches, in which roof tiles and glazed floor slabs were made, had already existed in the 14th and 15th centuries.

Vertical updraft kilns with rectangular ground plans, but with a frontal stoke-hole and later with a second smoke dome, are found regularly in Switzerland as “standard kilns” from the mid-16th century onwards (Figure 7). They were used for the manufacture of faïence ceramics and faïence stove-tiles, and for the production of simple glazed earthenware. A few examples, based on technology transfer by wandering journeymen in the 19th and 20th centuries, subsequently spread (as earthenware kilns) to southern Germany and South Tyrol and East Tyrol in Austria.

Crossdraft Kilns

The second group of kilns is that of the horizontal crossdraft kilns (see Figure 3). Until now, the medieval development of the horizontal kiln type could only be hypothesized. One possible starting point of their development may have been the “prehistoric looking” single chamber kilns of the 8th-10th centuries in France, for example in Saint-Maurice-Montcouronne

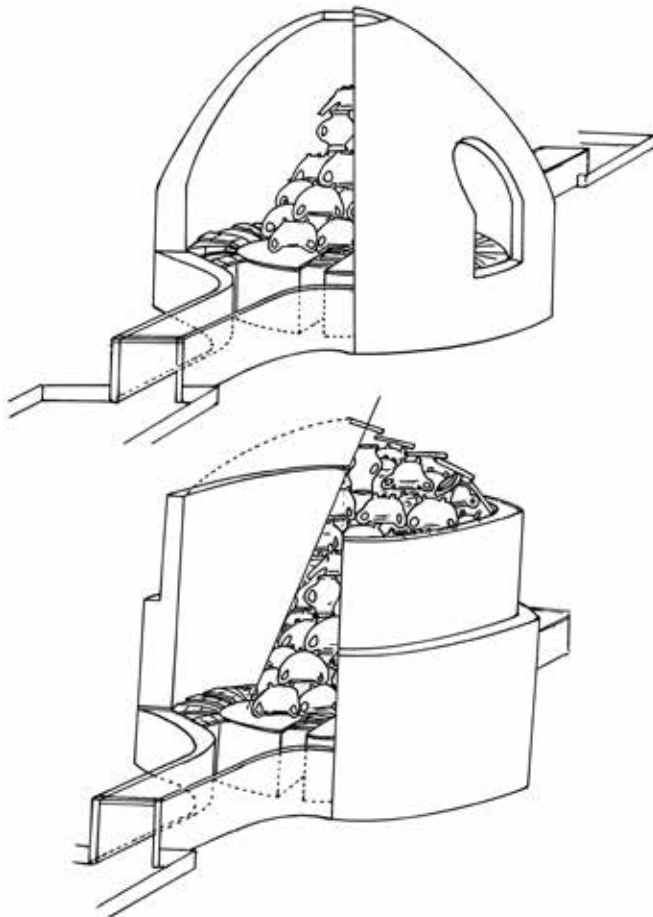


Figure 5. Vertical updraft kiln made from bricks, with double opposed flues and a raised kiln floor consisting of a central pillar and movable fire bars. This example is from Bergen op Zoom, the Netherlands, Steenberg workshop, with production dates before 1765. Below the photograph of the kiln, drawings show alternate reconstructions as a domed (middle) and open-top (bottom) kiln (Groeneweg 1992:figures 78, 80-81).



Figure 6. Vertical updraft kiln with a rectangular ground plan for Majolica production in Italy, from Cipriano Piccolpasso's *The Three Books of the Potter's Art*, 1558 (Lightbown and Caiger-Smith 1980:book 1, folio 35r, figure 100).



Figure 7. Vertical updraft kiln with a rectangular ground plan, 16th century. The kiln base with stoke hole and combustion chamber are shown; the raised kiln floor and the firing chamber are not preserved. This example is in Zürich, Switzerland, Augustinergasse 46 (Heege 2007:284, figure 8).

or Rionville-sous Dourdan (Bourgeau 1987; Goustard 2002). A separating element between the furnace and firing chamber was perhaps developed in a second stage, from the 11th and 12th centuries onwards. This consisted of individual or multiple clay or crock columns. These distributed the flames (by acting as fire grates or flame separators), supported the transition between the furnace area and the kiln dome, and prevented the shifting of the kiln load. In Rhineland and northern Germany, kilns of this type became the starting point for the subsequent development of stoneware kilns.

There has been no verified occurrence of this type of kiln in Belgium or the Netherlands, nor is it known in southern Germany (Bavaria, Baden-Württemberg). Instead, it is known in the Rhineland and in the Rhineland-Palatinate in the 12th and 13th centuries. Further development can be followed relatively well until the 14th century. An increasingly lower setting of the furnace in combination with a sloping or vertical positioning of the transition point from the furnace to the firing chamber, a sloping firing chamber floor, and a massive fire grate of thick, mainly horizontally braced clay columns can be observed. Such kilns are known from North Rhine-Westphalia, Germany: at Badorf, Pingsdorf, Siegburg-Galgenberg and Siegburg-Aulgasse, Hürth-Fischenich, and Brüggen-Elmpt. At first, from the 13th century onwards, open flue-like structures in the middle or at the edge of the firing chamber floor were also developed (Ulbert 2004) in order to ensure a better circulation of the heating gases under the kiln load (the best example is a kiln in Brühl, Germany, Figure 8). Only with the most recent find of this kiln type in Langerwehe, Germany (ca. 1400), have fixed, built-on flue covers, so-called “immovable fire bars,” been verified (Figure 9). Kilns with sunken furnaces and fire grates were also known in the 13th and 14th centuries in Germany in the Hesse region north of the Rhine (Aulendiebach, Aulhausen, and Marienthal), as well as in Rhineland-Palatinate (Mayen and the Westerwald).

Sunken Crossdraft Stoneware Kilns with Oval Ground Plan and a Sunken Stoking-Pit, Vaulting Supporting the Kiln Floor (“Frechen Type”)

At the present time we can only speculate that the kiln type described above was further developed into the sunken oval stoneware kiln (“Frechen type”) during the following 100 years, since late 14th – and 15th-century kiln finds in the Rhineland are scarce. Kiln construction materials changed at the same time, up to the first



Figure 8. Horizontal crossdraft kiln with a vertical fire grate of clay columns as a dividing element between the stoking pit (background) and the firing chamber (foreground), a low-lying furnace, and a sloping firing chamber floor. Open flue-like structures were additionally placed in the middle or at the periphery of the firing-chamber floor, in order to provide for better distribution of the heating gases under the kiln load. This example is in Brühl, North Rhine-Westphalia, Germany, Franziskanerhof kiln 256, and it dates to the second half of the 13th century (Ulbert 2004:figure 159).

half of the 16th century (brick or fire-resistant argillite replaced domes of clay wickerwork or domed crocks). This kiln type has a sunken furnace and a horizontal or slightly sloping firing chamber floor, which was formed by “fire bars” that covered the three flues below (Figure 10). Based on construction drawings, it has been shown that in Frechen, Germany, this kiln type was built and operated virtually unchanged into the late 19th century (Koch 1998). Only then did recognizable changes in stoneware kilns take place, primarily the building of additional chimneys.



Figure 9. (left) Horizontal crossdraft kiln with elongated ground-plan, low-lying furnace, and upright vertical step as the rear part of a sunken furnace. The remains of a vertical fire grate and a firing chamber with three flues and permanent built-on flue covers (so-called "immovable fire bars") can be seen. This example is in Langerwehe, North Rhine-Westphalia, Germany, Hauptstraße 78, kiln 1, and it dates to the second half of the 14th century (Heege 2007:79, figure 130).

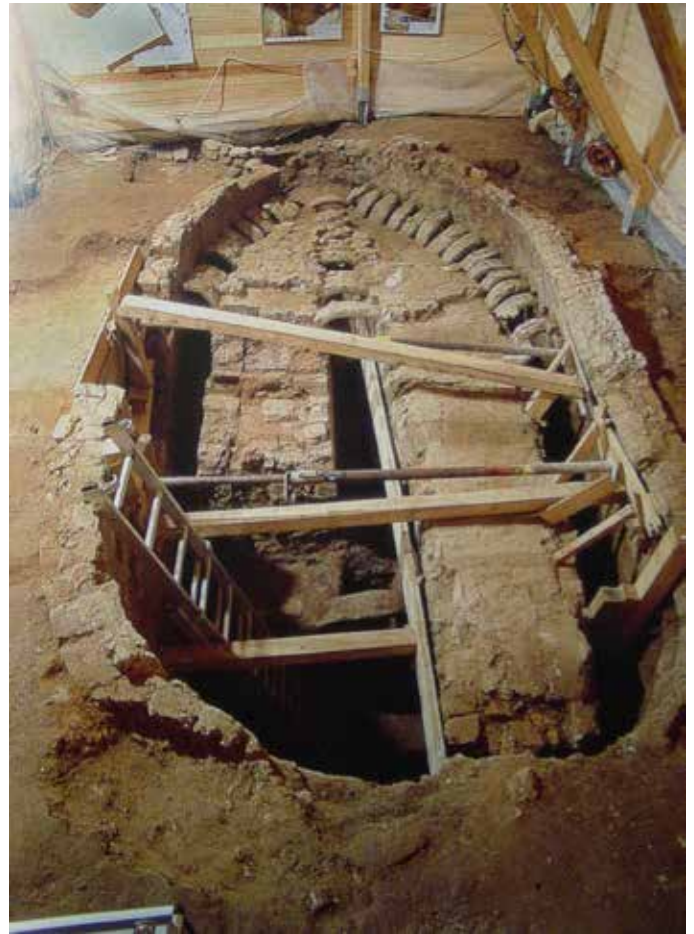


Figure 10. (right) Sunken crossdraft stoneware kiln with oval ground plan and a sunken stoking pit with vaulting under the kiln floor and a slightly sloping firing chamber floor formed by "fire bars" that covered the three flues below. This Frechen-type kiln is from Frechen, North Rhine-Westphalia, Germany, Franzstraße/Mühlenbach, kiln 1, and it dates to ca. 1600 (Koch 1998:figure 131).

Based on recent excavations, it has become clear that in the second half of the 16th century kilns for earthenware production in Frechen (and perhaps in the rest of Rhineland), hardly differed from stoneware kilns. They were somewhat more elongated and probably had a chimney at the end of the firing chamber.

Identical stoneware and earthenware kilns from the late 15th and early 16th centuries are also known from Cologne, Germany. To the west, the distribution of this type of kiln reached as far as Langerwehe and the Aachen (Germany) and Raeren (Belgium) region. This is not surprising considering the typological kiln forerunner in Langerwehe (see above, Figure 9). To the east of the Rhineland, this type of kiln spread in Germany via Bornheim-Sechtem at least as far as Siegburg. Thanks to migrating Frechen potters, this kiln type reached the Westphalian stoneware centers at Vreden/Stadtlohn

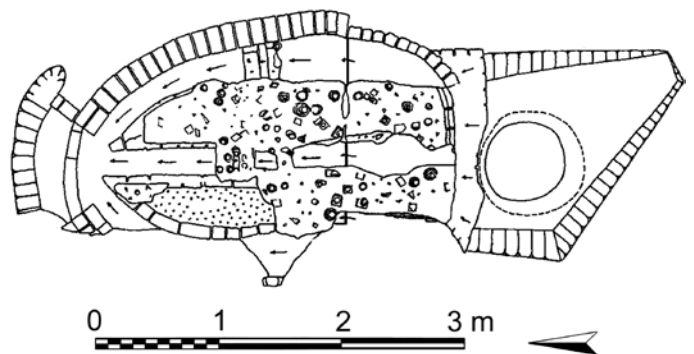


Figure 11. Sunken crossdraft stoneware kiln with oval ground plan and a sunken semi-circular stoking pit with vaulting under the kiln floor, Frechen type. This example is from Woolwich, Great Britain, near London, and dates from 1640 to ca. 1660 (Pryor and Blockley 1973:figure 4).

and also England, where the mid-17th-century kiln from Woolwich is the only known example (Pryor and Blockley 1973) (Figure 11).

Crossdraft Stoneware Kilns, Built in a Sloping Position above Ground with a Rectangular Ground Plan ("Westerwald Type")

The technological connection between stoneware kilns from Frechen and those in the area where the Westerwald potters later dispersed is unfortunately unclear, since there have been no relevant excavations in the Westerwald. In the light of the Rhenish bases of kiln technology in Rhineland-Palatinate and the immigration of potters from Raeren (Belgium) and Siegburg (Germany) in the second half of the 16th century, kilns with sunken furnaces such as those in Frechen or Raeren are likely in the Westerwald from the 16th to 18th centuries.

Due to the inclination of the slope, however, they had to be constructed differently, and the ground plan was changed to the well-known elongated rectangular shape. Development could just as well have originated in the pottery region of Raeren, for example, where stoneware kilns have been found, originally with oval ground plans and then in the 19th century with rectangular ground plans.

The oldest verified example of a stoneware kiln with a rectangular ground plan, a sunken furnace, and only two flues comes from Sandersdorf in Bavaria (construction plan dated 1831). The construction principle occurring here could, however, be older (kiln find from Grenzau bei Grenzhäusen, Germany). This kiln construction type (Figure 12) was also used until the late 19th century in all the migration and influence areas of the Westerwald potters, above all in the southern Eifel area (Binsfeld, Herforst, and Bruch, Germany), in Raeren (Belgium), in Oberbetschdorf in Alsace (France), and around Beauvais in northern France (Brongniart 1877). The kilns of the stoneware potters Crolus and Remmey, who emigrated from the Westerwald to Manhattan in 1718 and 1731, respectively, were used there until ca. 1831 and were probably similar (Baaden 1994:3).

The Westerwald stoneware kilns appear to have switched to coal and to firing with a horizontal grill

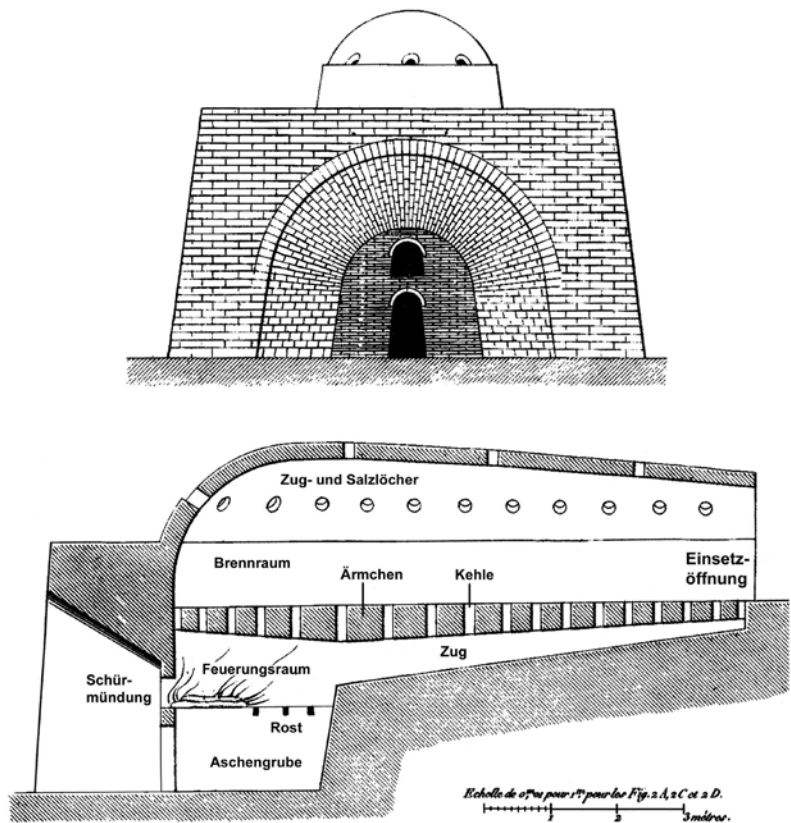


Figure 12. Crossdraft stoneware kiln with a rectangular ground plan, one sunken furnace, and two flues, Westerwald type. Features shown are the stoke hole (Schürmündung); the combustion chamber (Feuerungsraum); the hearth (Rost), which was built with iron fire bars or bricks as a horizontal separation between the underlying ashpit and the combustion chamber; the ashpit (Aschengrube); the flue channel (Zug); the immovable fire bar (Ärmchen), which covered the flue; the space between the flue covers (Kehle); the firing chamber (Brennraum), the kiln door (Einsetzöffnung); and vents (Zug- und Salzlöcher) for draft-control or salting of the stoneware kiln. This example is in Voisinlieu near Beauvais, France (Brongniart 1877:table 38, figure 2).

as early as the first half of the 19th century, leading to construction changes. Kilns with one furnace per flue were constructed a little later. Stoneware kilns with three furnaces and three flues were constructed (even in the Westphalian stoneware centers) possibly in the late 19th century, but certainly before World War I. After a switch to two flues per furnace and the introduction of movable “fire bars,” technological development ceased shortly before World War II. After ca. 1970–1980 all firing of this type of stoneware kiln stopped, due to rapid changes in the methods of preserving food (refrigerators). Stoneware of Westerwald-type was no longer a mass-product and is almost completely out of use today. The last “experimental” firings took place in Höhr-Grenzhäusen, Westerwald, in 2004 in one of the last existing kilns of this type (Figure 13).



Figure 13. Interior of a 50-cubic-meter, Westerwald-type crossdraft stoneware kiln with a rectangular ground plan, three exterior stoking pits, six flues (two flues per furnace), and a firing chamber floor formed of movable "fire bars." The kiln load is partially placed for firing. This example is from Höhr-Grenzhausen, Germany, Bergstr. 3, 2004 (Heege 2007:33, figure 43).



Figure 14. Horizontal crossdraft kiln with a vertical fire grate of clay columns, stoking pit (excavated) in the foreground, and combustion chamber behind the fire grate. This example is from Rheinsberg, Brandenburg, Germany, and dates to the 13th century (Heege 2007:97, figure 162).

Horizontal Crossdraft Kilns with a Vertical Fire Grate of Pottery or Crock-Columns as a Dividing Element Between Stoking Pit and Firing Chamber: Northwest and Northeast Germany

A further line of technological development began in the 13th century with the horizontal crossdraft kilns with clay or crock columns from the federal states of Hamburg, Mecklenburg, Brandenburg, Saxony-Anhalt, Thuringia, Saxony, Lower Saxony, and (north) Hesse. These kilns had a sloping or almost horizontal firing chamber that was separated from the stoking pit by a variably sloping pronounced step with a fire grate of crock or clay columns (Figure 14). They predominantly date to the late 12th to mid-14th centuries, as is also true of comparable findings from Denmark.

The further technological development of this type of kiln can be seen in southern Lower Saxony, North Hesse,

Saxony, and Denmark. The relevant kilns (for example from Fredelsloh, Leipzig, and Farum Lillevang) date to the late 13th or early 14th centuries (Liebgott 2001; Lönne 2007; Ronnefeldt 2007). The pronounced sloping step with crock or clay columns was further developed into an upright vertical step, on top of which a vertical fire grate sometimes stood. The form, construction type, and size of this fire grate are, however, currently unknown. It cannot be ruled out that a first row of rigidly fixed built-in vessels functioned as a fire grate and was subsequently disposed of as wasters. These kilns are characterized by elongated, slightly bulging ground plans.



Figure 15. Horizontal crossdraft kiln with elongated, slightly bulging ground plan and upright vertical step as the rear part of a sunken furnace. Traces of a vertical partition wall or fire grate built of bricks can be seen on top of the sunken furnace. This example is in Leipzig, Saxony, Germany, Grimmaische Vorstadt, kiln VII, and dates to the 16th century (Heege 2007:figure 171, 101).

Horizontal Crossdraft Earthenware and Stoneware Kilns with a Vertical Fire Grate and an Elongated Oval Ground Plan ("Kassel-Type")

From the late 15th century until the 17th century evidence for the appearance of kilns is limited to a few regionally, widely separated kilns in northern Germany, North Hesse, Saxony, and Bavaria. These kilns appear as a brick version of the above-mentioned older kilns (Figure 15). They have an elongated oval ground plan, a sunken brick-built furnace, and probably a vertical partition wall or fire grate between it and the horizontal firing chamber. Contrary to the stone – and earthenware kilns from Frechen and Cologne (see Figure 10), they do not have sunken flues. Whether there was a chimney, necessary for a genuinely horizontal flue, is not known.

The probable line of development led in the 18th century to kiln types with a deeply sunken furnace, a vertical partition wall, a horizontal or near-horizontal firing chamber floor, a chimney, and an oval to spindle-shaped ground plan. These tended to be called

"Kassel-type kilns" from the second half of the 19th century onwards. The name was taken from the "Kasseler Flamm-Ziegelofen," used for bricks, roof tiles, and pipes, developed in 1827 in Möncheberg near Kassel, Germany, but only published in 1855 (Wiegand 2000). The development of this type of brick kiln demonstrates the technological interaction between traditional earthenware pottery, stoneware, faïence, and porcelain production and the brick industry in the early 19th century.

When historical news items, reports and excavation finds, construction drawings, and still-standing kilns or remains thereof from the German states of Lower Saxony, Hesse, Brandenburg, Saxony, Thuringia, and Bavaria are taken together, an independent southern Lower Saxony-northern Hessian-central German-eastern Bavarian kiln region can be posited, which spans the period from the 16th to the 20th centuries. Kilns with a pointed to elongated oval ground plan (Figure 16) in which stoneware and earthenware could both be manufactured, sometimes even in one and the same firing, were built in this area.

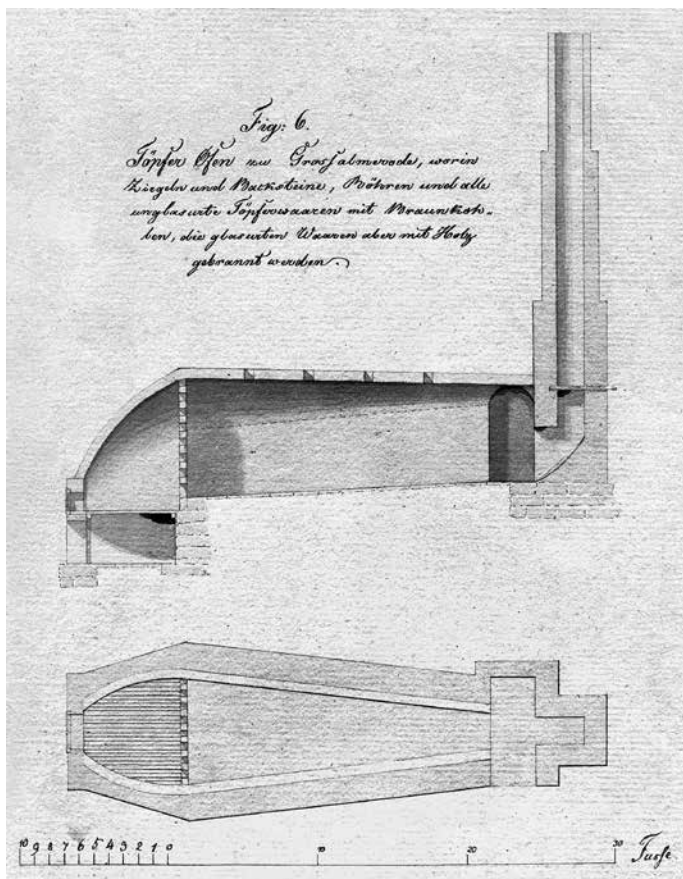


Figure 16. (left) Horizontal crossdraft stone- or earthenware kiln with a deeply sunken furnace, a vertical partition wall, a horizontal or near-horizontal firing-chamber floor, a chimney, and an oval to spindle-shaped ground plan: "Kasseler Ofen." The inscription reads: "Pottery kiln from Großalmerode for the production of bricks, roof tiles, drain pipes and unglazed earthenwares by means of brown coal, the glazed earthenwares will be fired with wood." This example is from Großalmerode, Hessen, Germany, and dates to 1851 (Wiegand 2000:37).

Figure 17. (bottom) Mixed crossdraft /downdraft earthenware kiln with a raised kiln floor on a double vault. This example is from Frechen, North Rhine-Westphalia, Germany, Alte Straße 67-73 (Heege 2007:418, Figure 6).



Horizontal Crossdraft Earthenware Kilns with a Vertical Fire-Grate and a Rectangular Ground Plan

In contrast to the kiln group just described, horizontal crossdraft kilns with a rectangular ground plan and chimney and variable furnaces (sunken or on the same level as the firing chamber, with or without a hearth) and firing chambers (with or without temporarily installed flues, firing-chamber floor mostly level or slightly sloping, firing chamber interior occasionally slightly tapered) seem to occur considerably more frequently (see Figure 3). They are evenly scattered between the North Sea and the Alps, and are the “classic” 18th – to 20th-century earthenware kiln. They are usually referred to as “Kassel kilns.” In the second half of the 19th century, they are also encountered as firing and glazing or reduction/smoking kilns for roof tiles and bricks. There is currently no evidence of kilns of this type from Belgium, Switzerland, and Austria. In the Netherlands, they are only known in the area bordering on Germany.

How this type of kiln developed technologically until the first evidence for it in the late 18th century has not yet been clearly established. What is certain, on the basis of the oldest dates, is that it is not a successor, but instead a forerunner of the “Kasseler Flamm-Ziegelofen” (brick kiln). The two oldest examples of a horizontal crossdraft kiln with a rectangular ground plan functioning as an earthenware kiln come from Stralsund (built 1784) and Neuss (planning application dated 1786), Germany. They also existed until the middle of the 20th century,

CONCLUSIONS

All known kiln types are a functional adaptation of the thermodynamic and physical properties of fire. Amongst other things, this led to the independent emergence of similar or identical ceramic firing methods and kiln types in Latin America, Asia, and Europe (vertical and horizontal kilns). As regards the various peculiarities of the kilns dealt with here, the spread of specific kiln types can also be traced back to cultural contacts and technology transfer.

Kiln types provide evidence of technology transfer by migrant potters and their still-existing contacts to home. One example of this, oval stoneware kilns of the Frechen pattern, can be seen in Westphalia, Germany, and in Woolwich, England. It is noteworthy that this kiln type was not adopted by English potters later on. Evidence of technology transfer can be seen as well with the rectangular stoneware kilns in the

however, in Schleswig-Holstein, Mecklenburg-Western Pomerania, Lower Saxony, North Rhine-Westphalia and the eastern part of the Netherlands, Hesse, Thuringia, Rhineland-Palatinate, Bavaria, Baden-Württemberg, and Alsace (France). The development of wood-fired earthenware kilns came to an end in the 20th century with this type of kiln. In the still-existing potteries, they were at first either converted to gas – or oil-firing at the end of World War II, or replaced by smaller electric kilns.

Mixed Crossdraft/Downdraft Earthenware Kilns

One last kiln type remains to be described, based on excavation finds and historical construction drawings from Frechen, Bedburg, Siegburg, and Coburg, Germany. This is a crossdraft kiln with a chimney and horizontal grate of bricks or iron, a vertical partition wall, and, as a characteristic feature, a raised kiln floor supported by a double arch (Figure 17). The chimney guaranteed an optimum diagonal or downdraft. Since the two supporting arches were open to the stoking pit, the flames were distributed under the kiln load, and were also extracted through the partition wall and the kiln floor. The oldest example of this type of kiln is known from Frechen and dates to ca. 1800. Comparable finds from faïence and porcelain manufacture can be taken as a firm indication of the basis on which this very specific kiln type was developed in the Rhineland.

emigration area of the Westerwald potters, or of the oldest vertical majolica kiln brought by Italian potters to Antwerp, Belgium.

Kiln types also provide evidence of technology transfer by adoption (which could well be in the way of espionage). Examples here are the spread of vertical majolica and faïence kilns in the Netherlands and the rest of northwestern Europe, which are used by Dutch and, later on, German faïence potters.

Kiln types additionally provide proof of technology transfer by adoption without, however, taking on the original specific production methods or product range for the type of kiln concerned. Examples of this type are the “Italian” vertical majolica kilns in Switzerland and their further development, which were primarily used in normal earthenware and stove-tile production.

With regard to the date of technological “innovations,” we can conclude that the tendency was toward relatively long and continuous lines of development, during the course of which several different kiln types existed coincidentally. Vertical and horizontal kilns coexisted for a long time.

On the other hand, kiln types that had reached a mature state were erected and used for centuries virtually unchanged. Good examples of this are the horizontal, oval, sunken stoneware kilns from the Rhineland and the vertical kilns with a rectangular ground plan of the “Piccolpasso” type. In the first case, the technological

foundations were developed between the 12th and 14th centuries, and in the latter as early as the Roman period. The same seems to have been the case for the horizontal earthenware and stoneware kilns with an elongated oval ground plan from the Lower Saxony-Saxony-Bavaria region in Germany. Their development started in the 12th century and essentially seems to have ended around 1500 in a perfect technological state. In comparison, horizontal kilns with a rectangular ground plan and horizontal kilns with a firing chamber floor on a double arch only seem to have been developed from the 18th century onwards.

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