Töpferöfen – Pottery kilns – Fours de potiers

A study of pottery kilns from early medieval to modern times (6th to 20th centuries) in Belgium, the Netherlands, Germany, Austria and Switzerland

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Introduction – Critical assessment of sources

As shown by the overall statistics, archaeological findings of kilns from between the 6th and 20th centuries occur relatively frequently in the areas investigated (D, B, NL, A, CH). At the time that recording was concluded in March 2007, proof of 1055 kilns had been established through literature sources and the questioning of archaeological institutions and specialized colleagues. Neither clay pipe, porcelain and circular updraught kilns, nor brick kilns have been taken into consideration here. Considering the quality of the excavation documentation, the preservation of the kilns and their regional or chronological distribution, various research shortfalls become clear. Only a few kilns are fully maintained above ground or documented in the form of historical plan documents. Most kilns were unearthed and documented during the course of archaeological excavations. Since WW2, in the region investigated, over 100 kilns per decade are involved.

The number of proven kilns varies as a function of the surface area of the country investigated, which is why the abundance of kilns in Germany is not surprising. However, if the distribution over the individual German and Austrian Federal States, Swiss cantons, Belgian regions and Dutch provinces is examined, considerable differences come to light (Abb. 1, Abb. = figure). The reasons for regional differences can be found, partially at least, in the specific research and job priorities of the various archaeological institutes or other specialist disciplines (e.g. European ethnology, architectural monument care).

Land	5.–6. Jh.	5.–7. Jh.	6.–7. Jh.	7. Jh.	7.–8. Jh.	7.–9. Jh.	8. Jh.	8.–9. Jh.	8.–10. Jh.	9. Jh.	9.–10. Jh.	10. Jh.	10.–11. Jh.	10.–12. Jh.	10.–13. Jh.	11. Jh.	11.–12. Jh.	11.–13. Jh.	12. Jh.	12.–13. Jh.	13. Jh.	13.–14. Jh.	14. Jh.	14.–15. Jh.	15. Jh.	15.–16. Jh.	16. Jh.	16.–17. Jh.	17. Jh.	17.–18. Jh.	18. Jh.	18.–19. Jh.
A	1												1										1	2	3							
B	4		1	1	1			2			1					6	3	7	2	2	1	4	8		1	1	1		1			
CH				6	2		2	1																1			2		1	1	4	6
NL			4											1			1		3	1		1	6				1	1	2	2	2	1
Gesamt	**5**	**-**	**5**	**7**	**3**	**-**	**2**	**3**	**-**	**-**	**1**	**-**	**1**	**1**	**-**	**6**	**4**	**7**	**5**	**3**	**1**	**5**	**15**	**3**	**4**	**1**	**4**	**1**	**4**	**3**	**6**	**7**

Bundesland	5.–6. Jh.	5.–7. Jh.	6.–7. Jh.	7. Jh.	7.–8. Jh.	7.–9. Jh.	8. Jh.	8.–9. Jh.	8.–10. Jh.	9. Jh.	9.–10. Jh.	10. Jh.	10.–11. Jh.	10.–12. Jh.	10.–13. Jh.	11. Jh.	11.–12. Jh.	11.–13. Jh.	12. Jh.	12.–13. Jh.	13. Jh.	13.–14. Jh.	14. Jh.	14.–15. Jh.	15. Jh.	15.–16. Jh.	16. Jh.	16.–17. Jh.	17. Jh.	17.–18. Jh.	18. Jh.	18.–19. Jh.
Schleswig-Holstein																					1								1	1		
Hamburg																						2										
Bremen																																2
Mecklenburg-Vorp.																					3	6	1		1						1	
Brandenburg																				2	3	2	1									
Sachsen																				1		3	5	4	4		1				1	
Thüringen																			1		1	3	1	1				1				
Sachsen-Anhalt																				1	2					1						
Niedersachsen																			4	1	15	5					2	1			2	
NRW (Westfalen)			1																	1		1									2	
Hessen								1												2		26	4	2			1					1
NRW (Rheinland)	1			1			2	21		8	2	2	8		2	2	8	2	7	12	10	3	3		3	6	11	10	3	1	1	7
Rheinland-Pfalz	2	1	2		1	1	1	4					3				1		1		2		2								1	
Baden-Württemberg	3		1	2	2				1		1								1		5	1		1								4
Bayern	3		1																		2	1	2	1	3	1			1		3	
Gesamt	**9**	**1**	**5**	**3**	**3**	**1**	**3**	**26**	**1**	**8**	**3**	**2**	**11**	**-**	**2**	**2**	**9**	**2**	**14**	**20**	**44**	**53**	**19**	**9**	**11**	**8**	**15**	**12**	**5**	**2**	**11**	**14**

Abb. 1 Number of proven kilns per period and country or individual German Federal States.

The quality and completeness of published excavation documentation leaves something to be desired in all the countries investigated. Numerous kilns are only documented in preliminary reports or individual photos and by textual mentions or descriptions. Complete series of drawn or photographed longitudinal and cross-section profiles are the exception. More importantly, longitudinal kiln profiles, which should also include the stoking pit, are, for the most part, missing. The longitudinal profile is, however, of particular importance for the typological classification and functional interpretation of kilns. In many cases, the bases for dating individual kilns are not given, or the accompanying find material not presented. The susceptibility of kilns to be typologically evaluated, moreover, depends on their preservation. Based on this fact, type classification was impossible for over 400 kilns, i.e. for about 40% of all those mentioned in the literature.

In all the countries considered, there are considerable gaps in the chronological distribution of kiln findings (see Abb. 1). Chronological problem horizons include virtually all of the 10th to 11th centuries as well as the late 14th to early 16th centuries. There is also a shortage of excavation finds in the 18th and 19th centuries. This is, however, somewhat counterbalanced by plans from the building files or scientific measurements of the historical construction. The 6th to 8th centuries and the late 12th to early 14th centuries tend to have been well investigated. The existing chronological gaps hamper the drawing up of continuous technological development trends or, in some cases, make it impossible. They also have the result that little more than speculation is possible with regard to the question of reciprocal technological influences. In order to improve understanding,

in particular with regard to early west European influences (horizontal kilns), a critical inspection of the (northern) French kiln findings would really be required, which was not possible within the framework of this study.

Generally speaking, for the large potters' centres or pottery regions, there is usually proof of the existence of numerous kilns. However, there does not necessarily have to be strong correlation between the large number of previously existing workshops and a comparable number of excavations or documented above-ground kilns (e.g. Brunssum-Schinveld NL, Siegburg, North Rhine-Westphalia D, Westerwald, Rhineland-Palatinate D, Saxon stoneware centres D, Kröning in Bavaria D, etc.).

From the archaeological proven kiln structures, two basic types emerge:

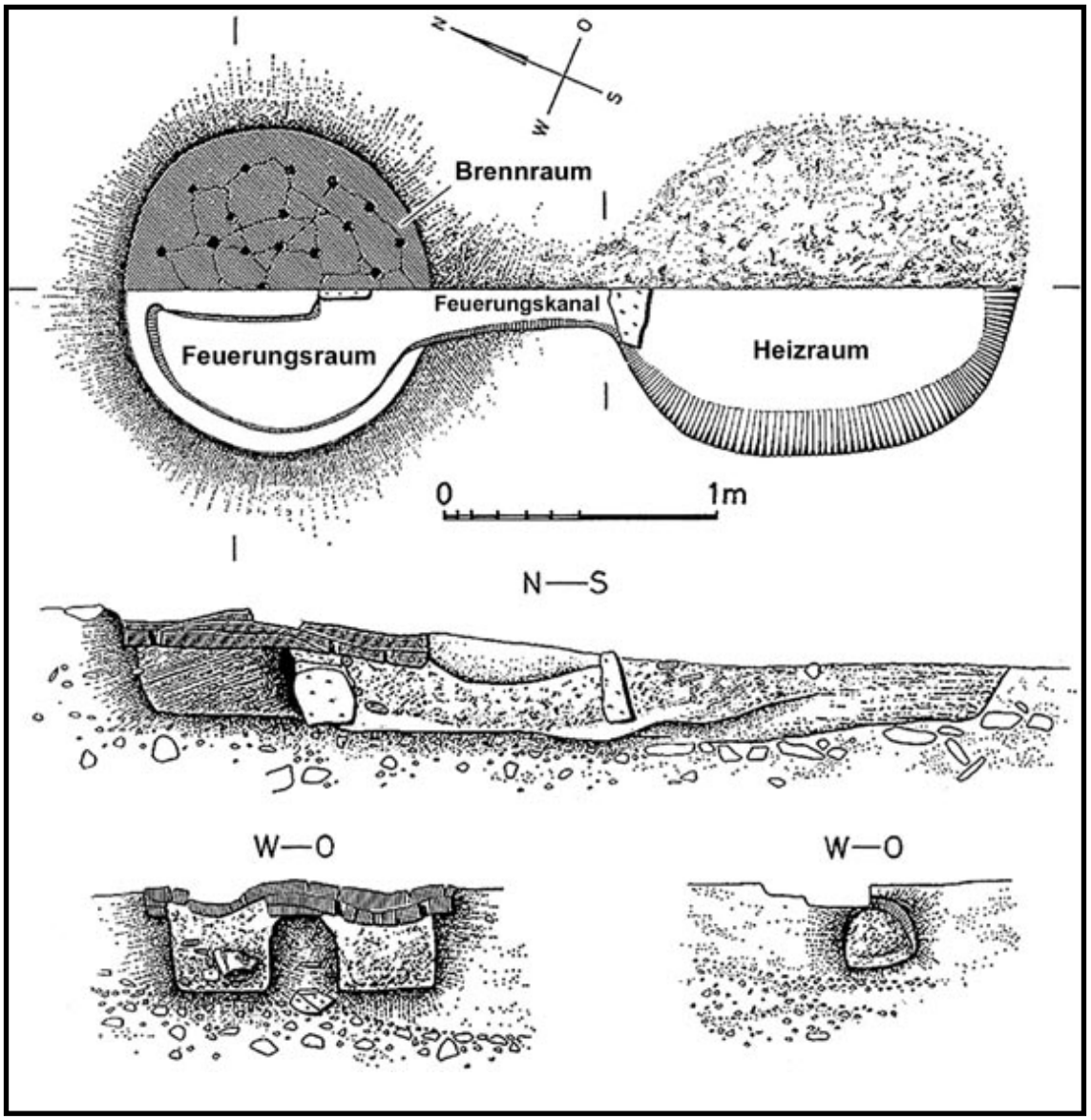

Abb. 2 Updraught kilns with horizontal separation of superimposed fireplace and firing chamber by a raised kiln floor, Wülfingen am Kocher, Baden-Württemberg D, kiln 1722 (Fehring 1969, Fig. 5).

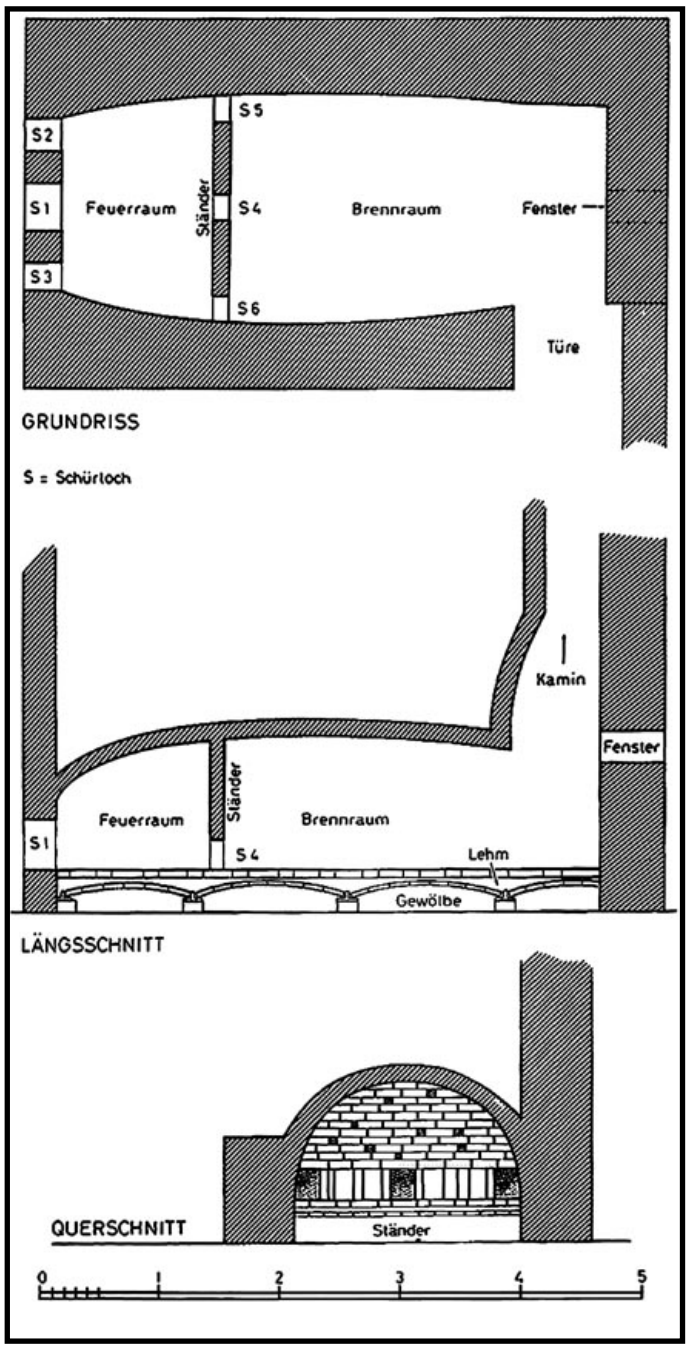

Abb. 3 Cross-draught kilns with a vertical separation of fireplace and firing chamber, disposed one behind the other. Wildenhäusle, Baden-Württemberg D (Stachel 1983, Abb. 9).

1. Updraught kilns with horizontal separation of superimposed fireplace and firing chamber by a raised kiln floor, designed as domed or open-top kilns (Abb. 2).

2. Cross-draught kilns with a vertical separation of sloping fireplace and firing chamber, disposed one behind the other. The separation acts as an openwork fire-protection wall or a fireguard of crock or clay columns. The draught system assumes correspondingly arranged extractor holes in the kiln vault or at the rear of the kiln close to the base. A chimney or exhaust vent is not absolutely necessary, but, however, provides optimum draught (Abb. 3).

These basic types can be further differentiated on the basis of their ground plans and various construction details. With updraught kilns, there are two groups with round and rectangular ground plans, both of which go back to Roman roots. For cross-draught kilns, two different lines of development can be recognized. On the one hand, updraught kilns with raised kiln floors were further developed into cross-draught kilns with spoon-shaped firing floors. On the other hand, cutting back the interior kiln design led to single-chamber cross-draught kilns or cross-draught kilns with fireguards. These form the basis for the two continuing lines of development of the Rhineland oval stoneware kilns with under-built fireplace and the cross-draught earthenware and stoneware kilns with elongated oval ground plans. These latter are widespread in Lower Saxony, Saxony, Thuringia and Bavaria.

1. Vertical updraught kilns

1.1 Vertical updraught kilns with circular ground plans

The vertical updraught kilns with circular ground plans and vertical flues of the 5th/6th centuries were the starting point for the development of kilns in the Middle Ages (Abb. 4). Contrary to old research opinions, in the former Celtic and Roman, later Frankish or Romance areas of Central Europe (above all in Italy, Southern France and Spain), no break in continuity of kiln technology between Roman and early-to-high medieval times could be discerned. In the north-western European, Germanic ("Saxon") area and also in the easterly adjoining Slavic settlement area how-

ever, no verified proof of vertical kilns can be found before the middle of the 12th century. The question of Germanic participation in the technological continuity, apart from the Frankish settlement area in Rhineland, clearly does not arise.

Updraught kilns, with structural variations in details and, in the end, built from bricks, still remained in use alongside cross-draught kilns into the 14th century in almost all regions of the area investigated. Dutch and Belgian findings from Utrecht NL as well as Kortrijk and Oudenaarde B (Abb. 5), and the kilns from Dieburg D (Abb. 6) are especially worth pointing out. In the northern German and northern European regions without the relevant technological continuity (e.g. Denmark), updraught kilns were even built after the middle of the 12th century. This was probably related to the German Ostkolonisation (east colonization) and the extension of trade in the North and Baltic Seas.

Particularly important is the realization that the raised floors in updraught kilns could be designed very differently, so that even plate-like stones and mobile clay objects (rollers, "fire bars") found use (see Abb. 7). Raised floor constructions did not, therefore, need to be constructed immovably. When closing down the kiln, they could be removed, which explains why they are not found by excavators. This has to be taken into account when interpreting and reconstructing comparable kiln finds. A systematic examination of the waster tips belonging to the kilns would, in all probability, greatly add to the number of movable kiln parts. The question as to whether vertical domed kilns or vertical, open-topped kilns are present cannot at present be answered from the archaeological findings. At the end of the day, this question plays no role in the case of oxidizing firing. For greyware-reduction fires, a closed kiln dome would be a more likely assumption.

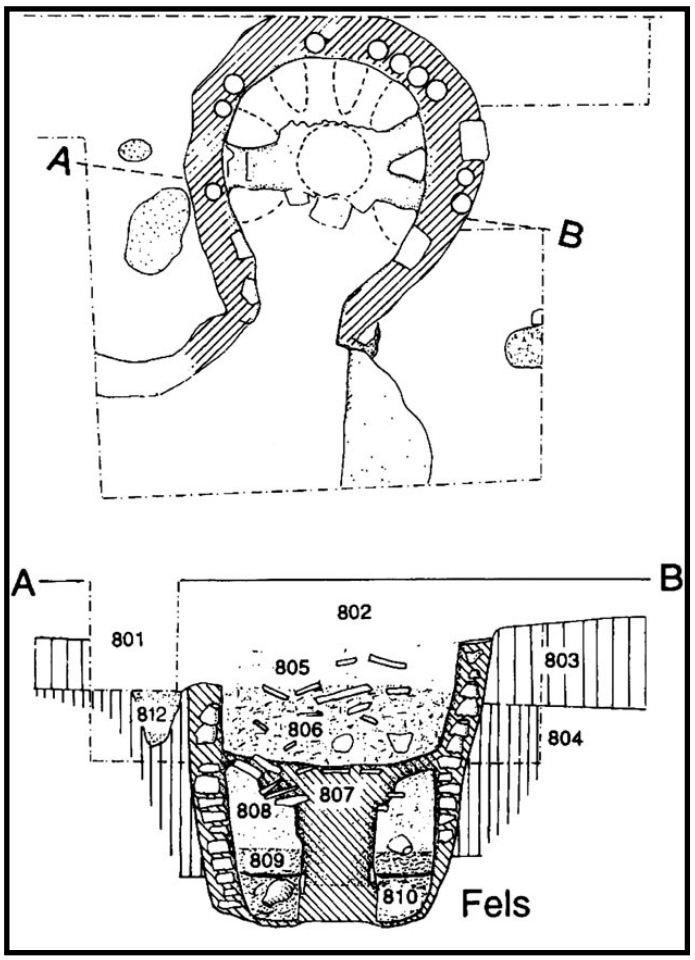

Abb. 4 Vertical updraught kiln with circular ground plan, central pillar and remains of the raised oven floor made of radial placed clay arches. Mayen, Rheinland-Pfalz D, Siegfriedstraße 55, kiln 26, second half of the 5th - 5. – second half of the 6th century (Redknap1999, Abb. 5).

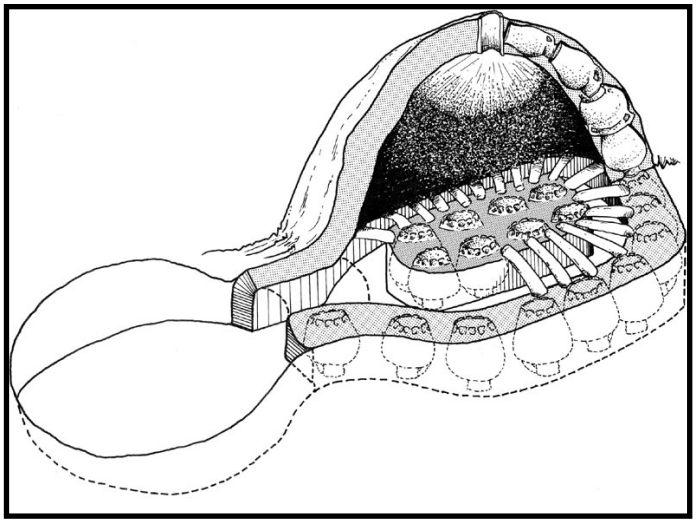

Abb. 5 Reconstruction of a vertical updraught kiln with circular ground plan and a raised oven floor made of a central pillar and movable fire bars. The kiln vault is a permanent dome made of domed crocks. Oudenaarde-Pamele B, kiln D, second half of the 14th century (De Groote 1993, Abb. 21).

1.2 Vertical updraught kilns with rectangular ground plan (Piccolpasso type)

Vertical updraught kilns with a rectangular ground plan can likewise be traced back to Roman-Mediterranean roots (Italy, Spain, southern France). Corresponding to the well-known construction drawings from the Cypriano Piccolpasso manuscript of 1558

Abb. 6 Vertical updraught kiln with circular ground plan, central pillar and remains of the raised oven floor. Dieburg, Hessen D, Fuchsberg kiln 3, 13th/14th century. (Foto Peter Prüssing).

Abb. 7 Vertical updraught kiln with circular ground plan, axial spine wall and a raised oven floor made of removable stone slabs. Therwil, Kanton Basel-Land CH, Baumgartenweg, 8th century. (Tauber 1998, Abb. 6).

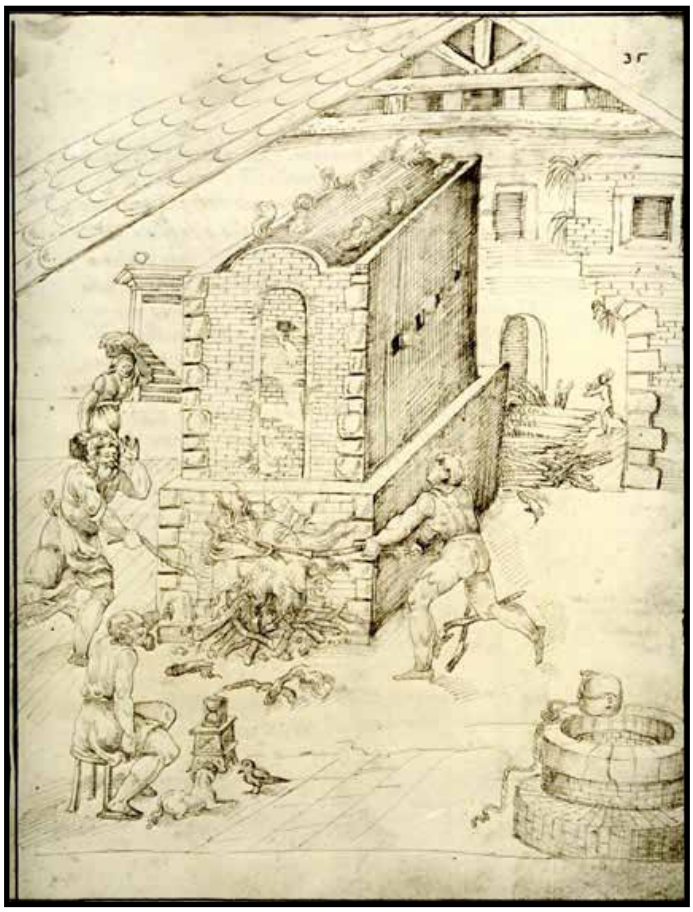

Abb. 8 Vertical updraught kiln with a rectangular ground plan for Majolica productionin Italy. Cipriano Piccolpasso, Li tre libri dell'arte del vasaio, 1558 (Piccolpasso Buch 1, fol. 35r, Abb. 100; Lightbown/Caiger-Smith 1980).

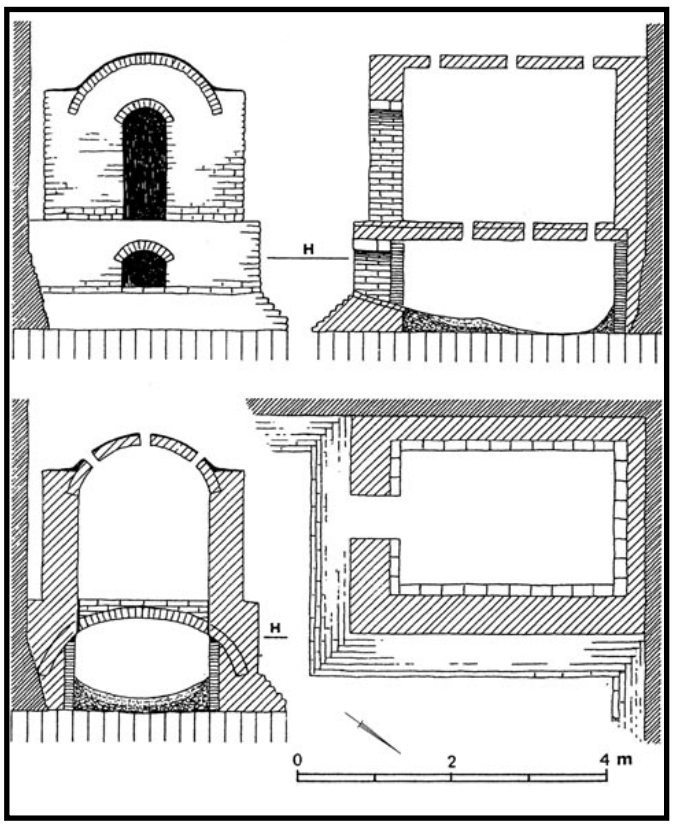

Abb. 9 Vertical updraught majolica-kiln with a rectangular ground plan. Deventer NL, Klooster noord, production 1624–1637 (Lubberding/deBeer/Korf/Bruijn 1985, 32).

Abb. 10 Vertical updraught kiln with a rectangular ground plan. Steffisburg Höchhus, Kanton Bern, CH, first half of the 19th century. (Foto Badri Redha, ADB).

(Abb. 8), kilns of this construction type are referred to below as "Piccolpasso types". They were initially introduced north of the Alps at the latest from around 1500 by Italian majolica potters (Abb. 9). With small construction modifications, this kiln type made up the technical basis for all European faïence manufacturers (even in England and France). As glow or bisque firing kilns, this type, with adaptations to the fuel (grate, air supply), was also taken over by European porcelain manufacturers. The rapid and seemingly technologically unproblematic acceptance of this type of kiln may have also lain in the fact that, for instance, in the Netherlands (Utrecht) and in Switzerland, similar kilns with raised floors on transverse arches already existed in the 14th/15th centuries, and in which roof tiles and glazed floor slabs were made.

Vertical updraught kilns with rectangular ground plans, but with a frontal stoke-hole and later with a second smoke dome, can also regularly be found as "standard kilns" from the middle of the 16th century onwards in Switzerland (Abb. 10). They were used here both for the manufacture of faïence ceramics and faïence stove tiles, as well as for the production of simple glazed earthenware and stove tiles (Abb. 11). A few examples, based on the transfer of technology by wandering journeymen(?) in the 19th/20th centuries (as earthenware kilns), subsequently spread to southern Germany and South and East Tyrol. At that time, in southern Germany at least, other types of kiln were being used. In the 19th/20th centuries, constructional variants existed in Switzerland in connection with the manufacture of conduit, sewage and drainage pipes.

Indeed, in the 14th and 15th centuries already, some rectangular-square section vertical updraught kilns could be found in Hesse (Dieburg D) and in Alsace (Strasbourg F), so that other lines of tradition for this type of construction may have to be reckoned with.

2. Horizontal cross-draught kilns

The second group of kilns is made up of horizontal cross-draught kilns (see Abb. 3). The essential criterion of this type assignation is the more or less horizontal or upward sloping arrangement of the fireplace and firing chamber, which are placed horizontally one behind the other. They could be separated by a pronounced step, mostly combined with a fire grate of crock or clay columns, or a latticework of bricks. The kiln draught was diagonal to almost horizontal. This assumes correspondingly arranged extractor holes in the kiln vault or at the rear of the kiln close to the base. An exhaust vent or chimney is not absolutely necessary, but however ensures an optimum draught.

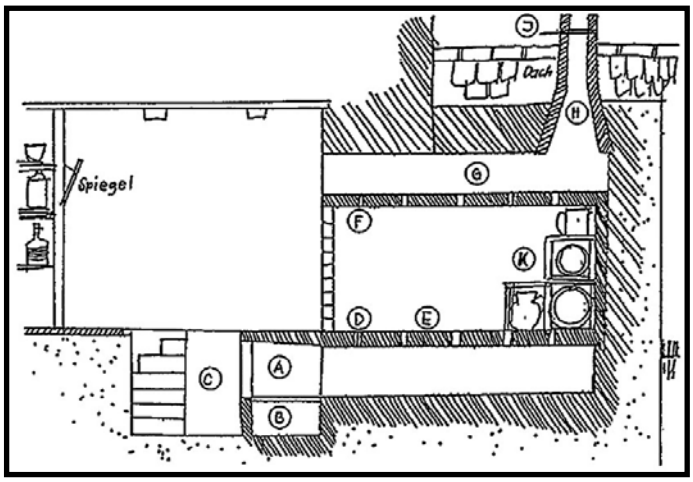

Abb. 11 Sketch of a vertical updraught kiln with a rectangular ground plan, drawn by potter Jakob Gelzer after the original in the workshop where he did his apprenticeship in 1943 (pottery Dietrich at Kiesen, canton Bern CH). A combustion chamber. B ash-pit. C stoking-pit. D flue hole. E suspended floor perforated with circular vents. F dome with exit flues, separating the firing chamber and the smoke exit vault as part of the chimney. G smoke exit vault as part of the chimney. H chimney. I adjustable slide to regulate the draught. K pot stack (Boschetti-Maradi 2006, 42 Abb. 48).

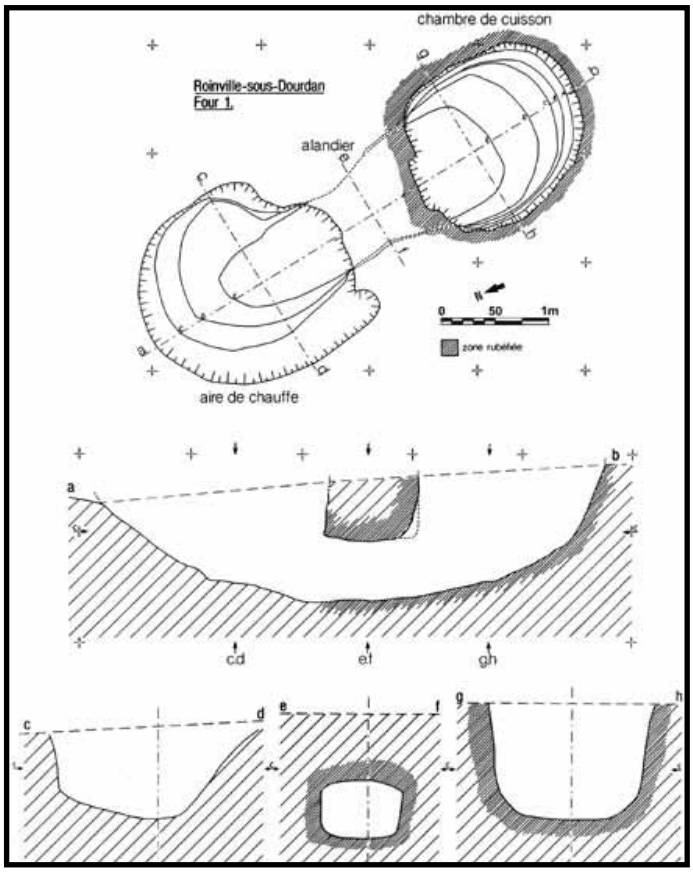

Abb. 12 Cross-draught single-chamber kiln. Rionville-sous-Dourdan F, kiln 1, 10th century (Bourgeau 1987, 83).

Until now, the development of the horizontal kiln type could only be described using hypotheses. If the starting point in the investigation area and the western bordering regions, above all France, is considered, only the vertical kiln type with a circular or slightly oval ground plan in the late-Roman-Merovingian-Carolingian tradition is worthy of consideration as the starting point of a technological development series. The few more recent kiln finds can then be taken as a pointer that there could possibly have been two technologically different, but at least partially contemporaneous, lines of development.

The first development variant in the 8th to 10th centuries led to "prehistoric looking" single chamber kilns by omitting both the split or raised kiln floor as well as the supporting central pillar or axial spine wall. The kiln load was stacked on the bottom of the firing chamber, while the fireplace area was brought forward in the form of a short fire tunnel. If the originally rather circular kiln ground plan is lengthened or enlarged, the kiln floor arranged in a slope and the fireplace area further sunken, one then has a cross-draught single-chamber kiln with a variable slope firing chamber (Abb. 12). Possibly only in a following stage was a separating element between the fireplace and firing chamber then (from the 11th/12th centuries) developed. This consisted of individual or multiple clay or crock columns. These distributed the flames (fire grates, flame separators), supported the transition between the fireplace area and the kiln dome and prevented shifting of the kiln load. In Rhineland, kilns of this type (Abb. 13) formed the starting point for the subsequent development of stoneware kilns (Abb. 14).

Between the 10th and 11th centuries, the second development variant led from vertical round kilns with axial spine walls (see Abb. 2) to vertical elongated oval kilns with axial spine walls and raised floors of mobile or immobile fire bars (e.g. Gesves-Mozet B, Ubach over Worms NL, Eckdorf, Nordrhein-Westfalen D, Abb. 15). If the mobile fire bars are omitted from these kilns, one gets "horizontal kilns with central spoon-shaped firing floors" (Abb. 16), whose surface can vary from flat to rounded. Kilns with spoon-shaped firing floors were not developed further in Belgium and Germany after the 14th century and did not enter into the technology of near-stoneware or stoneware kilns.

Abb. 13 Horizontal cross-draught kiln, fireplace and firing chamber, disposed one behind the other, separated by a vertical fire grate of clay columns. Mayen, Rheinland-Pfalz D, Oben auf dem Glacis kiln 11, spätes 12. bzw. frühes 13. Jh. (rekonstruction made by Redknap 1999, Abb. 3).

2.1 Horizontal cross-draught kilns with spoon-shaped firing floors

On the basis of their construction and geographical distribution, horizontal cross-draught kilns with spoon-shaped firing floors can be subdivided into two groups. The first group comprises northern France, Belgium, Rhineland, Lower Saxony, Saxony-Anhalt, Brandenburg and Northern Bavaria. The second group, in which the spoon-shaped firing floor is always built up of crocks, comprises Southern Bavaria and Austria.

Proof of the existence of horizontal cross-draught kilns with spoon-shaped firing floors of various shapes in the area was examined from the 11th until the early 14th centuries. They are a northern French-Maasland-Rhineland kiln type. North of Paris F, there are isolated discoveries of this type of kiln from the 10th/11th centuries, which are thus the oldest know examples to date. In Belgium, most of the kilns of this type were unearthed in connection with the Maasland ceramic production of the "Andenne" type (late 11th to early 14th centuries). Distribution then also embraced western Flanders (Kortrijk? B) and the southern Netherlands (Brunssum-Schinveld NL) in the 12th and 13th centuries. At the same time as the findings in Brunssum-Schinveld, identical kiln types also appeared in numerous left and right bank pottery locations in North Rhine-Westphalia D (Erkelenz, Katterbach, the town of Bergisch-Gladbach, Langerwehe, Langerwehe-Jüngersdorf, Paffrath, Wildenrath, Witterschlick, see Abb. 16). In comparison, until now, no examples from Mayen or Westerwald, Rhineland-Palatinate D have been found.

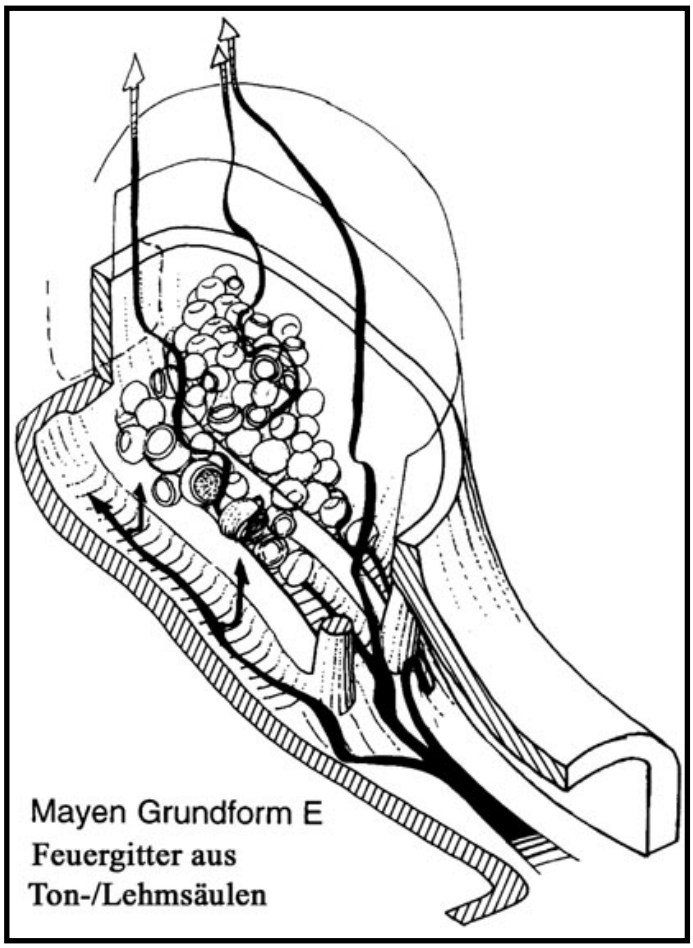

Abb. 14 Horizontal cross-draught kilns with a vertical fire-grate of clay-columns as a dividing element between the stoking pit and the firing chamber, a lower setting of the fireplace and a a sloping firing chamber floor, open flue-like structures at the periphery of the firing-chamber floor. Brühl, Nordrhein-Westfalen D, Tiergartenstraße 1–7, 2. Hälfte 13. Jh. (Ocklenburg 1997, Abb. 118).

With Flemish-Rhineland potters (?), this kiln type reached the Saxon-Germanic-Slavic regions, which were previously without a consequential pottery or kiln tradition (Eastern North Rhine-Westphalia D, Southern Lower Saxony D (Abb. 17), Saxony-Anhalt D, Branderburg D and Denmark), in the 12th and early 13th centuries. This was probably within the context of the initial stages of the Ostkolonisation (east colonization). Astonishing is the further distribution of this type of kiln to the southeast, namely to Lower and Upper Franconia, and Upper Bavaria D, from the middle of the 13th century and into the 14th century.

The medieval kilns in Austria (Amstetten, Hainburg, Mautern, St. Pölten, Tulln), as well as a kiln finding in Bavaria D (Gammelsdorf) are also from the group of kilns associated with spoon-shaped firing floors, but the latter were, however, always constructed from upside down crocks (Abb. 18). These kilns are dated somewhat later than in Rhineland (from the second half of the 13th century) and were possibly still constructed sometime into the 15th century. There are also comparable findings from the 14th century from Mähren. In Austria, because of large chronological gaps, the above-mentioned kilns form a separate group, which follows the old vertical updraught kilns with no recognizable transitions, and in which development or replacement by another kiln type in the modern era has not been clarified.

2.2 Horizontal cross-draught kilns with a vertical fire grate of clay or crock-columns as a dividing element between the stoking pit and the firing chamber

As a basis for the following differentiation of kiln development, the typological starting point forms for further development has to be discussed. For the period of the High and Late Middle Ages, differentiation must be made between the development in Rhineland and Rhineland-Palatinate D, as well as the Hesse region north of the Rhine D, on the one hand, and the development in north-western and north-eastern Germany, northern Hesse as well as Bavaria and Saxony, on the other.

Abb. 15 Vertical elongated oval kilns with axial spine walls and raised floors of immobile fire bars. Gesves-Mozet B, kiln 2 und 3, 11th century. (Duhaut/Plumier 1997, 521).

Abb. 16 Horizontal kiln with central spoon-shaped firing floor. Witterschlick, Gde. Alfter, Nordrhein-Westfalen D, 11th century. (Foto RAB).

Abb. 17 Horizontal kilns with central spoon-shaped firing floor. Einbeck, Niedersachsen D, Negenborner Weg, kiln 4 and 5, second half of the 12th century - 1200 (Foto Andreas Heege).

Abb. 18 Kiln with spoon-shaped firing floor constructed from upside down crocks. Amstetten, Niederösterreich A, 15th century (BundesdenkmalamtWien, Foto Franz Sauer).

Abb. 19 Horizontal cross-draught single-chambered kiln without a separation of fireplace and firing chamber, firing chamber floor with flue-like structures to direct the flame movements. Duisburg, Nordrhein-Westfalen D, Averdunkgelände, 10th century (Foto Duisburg Stadtarchäologie Günther Krause).

2.2.1 Starting points of kiln types

The oldest horizontal cross-draught kiln in Germany was discovered in Duisburg D, and dates from the 10th century (Abb. 19). The possible absence of transitional forms between vertical and horizontal cross-draught kilns in Germany, and the "sudden" appearance of the latter, leads to the conclusion of a transfer of a construction principle rather than the ongoing development of local traditions. In this connection, the finding of horizontal cross-draught kilns of the 8th/9th and 10th centuries from the region around Paris F (Rionville-sous-Dourdan F, Saint-Maurice-Montcourconne F and Sevrey F, see Abb. 12) are of particular importance. As research stands at the moment, the only hypothesis that can therefore be put forward for the time being is that the development of horizontal cross-draught kilns probably took place between the 8th/9th and 10th centuries in the northern or central part of France. It should be noted here that the change in kiln technology was not related to a change in the ceramic wares produced, nor really with the start of stoneware production. A planned increase in temperature was therefore not the trigger for the technological change. The reasons that induced the mainly tradition-bound potters to use a new type of kiln therefore remain completely obscure. Only in a further development stage, again in the north of France, did the construction of a fire grate/flame separator between the fireplace and firing chamber also take place.

One could imagine that similarly simple, horizontal cross-draught kilns also existed in the Cologne-Bonn Vorgebirge (foothills) in the 10th/11th centuries, although definite archaeological proof of this still needs to be provided. Only subsequently, in the 11th-14th centuries, are two distinct lines of development of horizontal cross-draught kilns recognizable in Germany, Belgium and the Netherlands, and for which northern French connections also exist.

2.2.2 Horizontal cross-draught kilns with a vertical fire-grate in the Rhineland

2.2.2.1 Horizontal cross-draught kilns of the late Middle Ages

At the same time as the horizontal cross-draught kiln with a spoon-shaped firing floor, there existed a second type of horizontal kiln with a vertical fire grate of clay or crock columns (Abb. 20). This formed the basis for further kiln technology development in the Rhenish stoneware centres. It consisted of kilns with a sloping, pronounced step between the fireplace and firing chamber, a clearly sloping to almost horizontal firing chamber floor and a more or less permanent fire grate of clay or loam and/or crock columns at the transition point from the fireplace to the firing chamber.

Similar kilns have been documented from findings in northern France and in the area surrounding Paris, which have been dated to the 12th to 15th centuries. Contrary to many of the kilns discussed below, French kilns, however, generally had only one central "pillar" of clay or quarrystone at the transition point from the fireplace to the firing chamber.

Until now, there has been no verified occurrence of this type of kiln existing in Belgium or the Netherlands, neither was it known in southern Germany (Bavaria D, Baden-Württemberg D). On the contrary, it was known in Rhineland (Paffrath D), Mayen D and Kreuzweiler D in Rhineland-Palatinate from the 12th/13th centuries (Abb. 21). Further development can be followed relatively well in Rhineland from the late 12th century until the 14th century. What can be seen is an increasing lower setting of the fireplace in combination with a sloping or vertical positioning of the transition point from the fireplace to the firing chamber, a sloping firing chamber floor and a massive fire grate of thick, mainly sideways-braced clay columns. Such kilns are known in North Rhine-Westphalia D: Badorf, Pingsdorf, Siegburg-Galgenberg and Siegburg-Aulgasse, Hürth-Fischenich, Brüggen-Elmpt (Abb. 22). At first, from the 13th century, open flue-like structures in the middle or at the periphery of the firing-chamber floor were additionally developed, in order to provide better distribution of the heating gases under the kiln load (kilns in Brühl D, Eckdorf D, Pingsdorf D, Xanten D and Maastricht NL; see Abb. 23). Only in the most recent find of this kiln

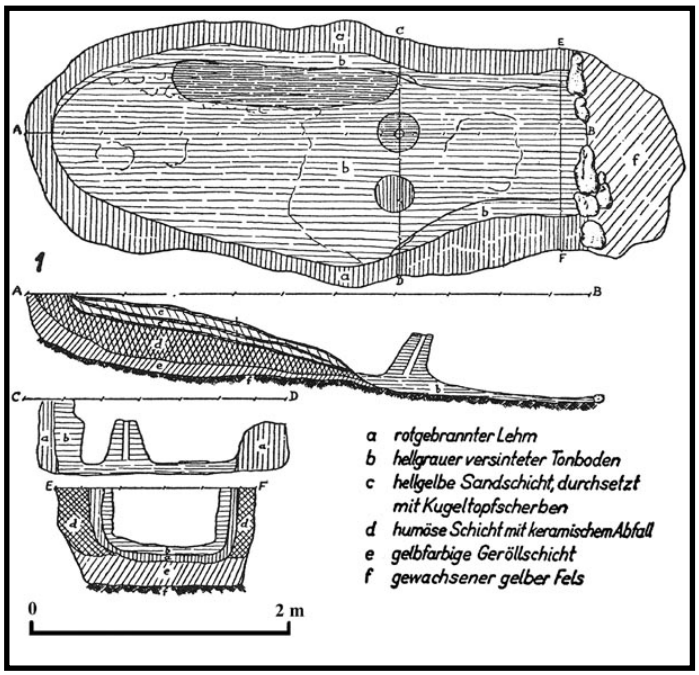

Abb. 20 Horizontal cross-draught kiln with a vertical fire-grate of two clay columns. Paffrath, Stadt Bergisch-Gladbach, Nordrhein-Westfalen D, kiln 1, 12th-13th century (Lung 1955–56, Abb. 3).

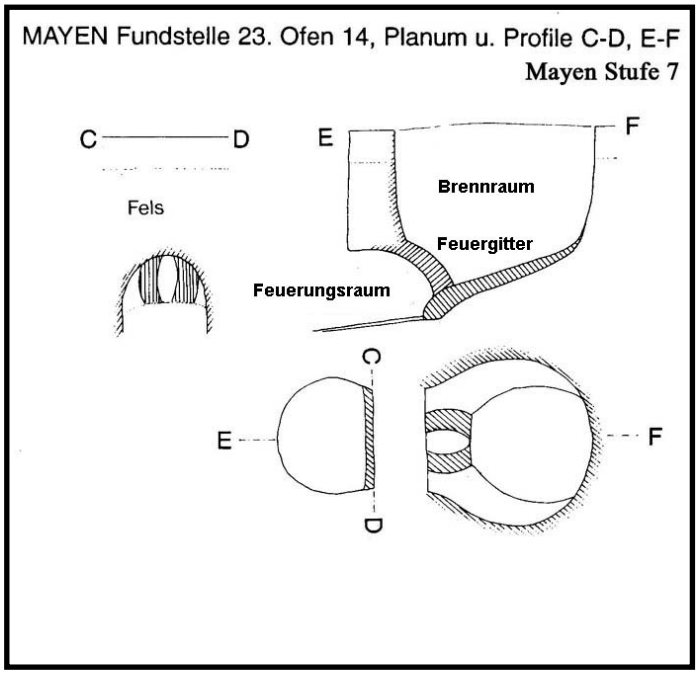

Abb. 21 Horizontal cross-draught kilns with a vertical fire-grate of two clay columns. Mayen, Rheinland-Pfalz D, Siegfriedstr1926, 10th-11th century (Redknap1999_Fdst23_Ofen14).

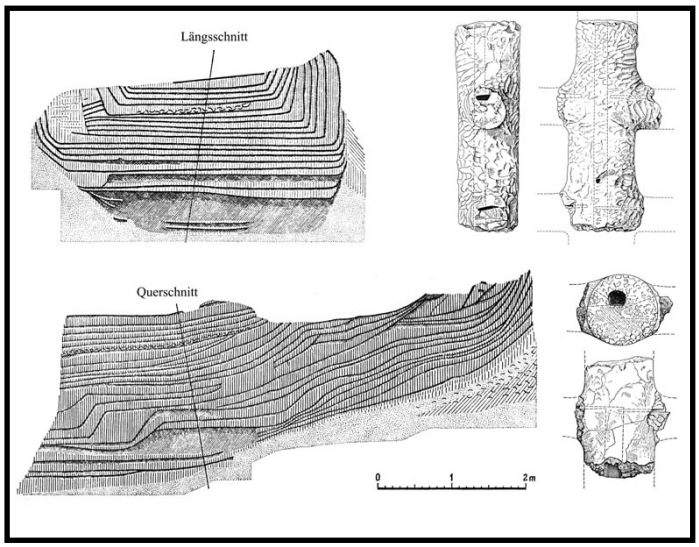

Abb. 22 Complex successions of horizontal cross-draught kilns with an increasing lower setting of the fireplace in combination with a sloping or vertical positioning of the transition point from the fireplace to the firing chamber, a sloping firing chamber floor and a massive fire grate of thick, mainly sideways-braced clay columns. Siegburg, Nordrhein-Westfalen, Aulgasse, kilnstructure 1 und 2, 12th-14th centuries (Beckmann 1964, Abb. 2 und Beckmann 1967, Abb. 42–43).

Abb. 23 Horizontal cross-draught kiln with a vertical fire-grate of clay-columns as a dividing element between the stoking pit and the firing chamber, a lower setting of the fireplace and a a sloping firing chamber floor. Open flue-like structures in the middle or at the periphery of the firing-chamber floor were additionally placed, in order to provide better distribution of the heating gases under the kiln load. Brühl, Nordrhein-Westfalen D, Franziskanerhof kiln 256, second half of the 13th century. (Ulbert 2004, Abb. 159).

Abb. 24 Horizontal cross-draught kiln with elongated ground-plan, a lower setting of the fireplace, upright vertical step, as backpart of a sunken fireplace, on top of which the rest of a vertical fire grate can be seen, firing chamber with three flues and fixed built-on flue covers, so-called "immovable fire bars". Langerwehe, Nordrhein-Westfalen D, Hauptstraße 78, kiln 1, second half of the 14th century (Foto RAB).

type in Langerwehe D (ca. 1400) have fixed built-on flue covers, so-called "immovable fire bars", been verified (Abb. 24). Kilns with sunken fireplaces and fire grates were also encountered in the 13th and 14th centuries in the Hesse region north of the Rhine D (Aulendiebach, Aulhausen and Marienthal), as well as in Rhineland-Palatinate D in Mayen and the Westerwald (Abb. 25).

2.2.2.2 Sunken cross-draught stoneware kilns with oval ground plan and a sunken stoking-pit with vaulting under the kiln floor, Frechen type

Until now, it can only speculated that the kiln reviewed 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 Rhineland D are scarce. Simultaneously, until the first half of the 16th century, kiln construction materials changed (brick or fire-resistant argillite instead of domes of clay basketwork or domed crocks). The mentioned kiln type has a sunken fireplace and a horizontal or slightly sloping firing chamber floor. This was formed by "fire bars" that covered the three flues below (Abb. 26). Based on construction drawings, it has been verified that this kiln type in Frechen was built and operated virtually unchanged into the late 19th century (Abb. 27). Only at that time have recognizable changes in stoneware kilns been established, primarily through the building of additional chimneys.

Based on excavations in the most recent past, it has become clear that kilns for earthenware production in Frechen D (and in the rest of Rhineland?) in the second half of the 16th century hardly differed from stoneware kilns (Abb. 28). They were somewhat more elongated and probably had a chimney at the end of the firing chamber.

Identical stone- and earthenware kilns from the late 15th and early 16th centuries from Cologne are also known. To the west, the distribution of this type of kiln reached as far as Langerwehe and the Aachen/Raeren region. This is not surprising in the face of the typological kiln forerunner in Langerwehe (see above), and the question remains as to whether the development of this type of kiln did not actually take place in this region in the 15th century, befo-

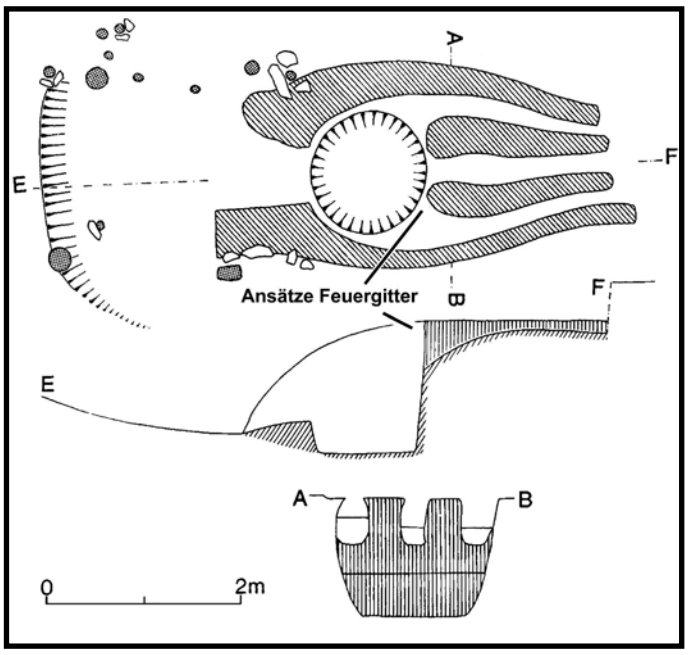

Abb. 25 Horizontal cross-draught kiln with the rest of a vertical firegrate of clay-columns as a dividing element between the stoking pit and the firing chamber, a lower setting of the fireplace and two flues in the firing chamber. Mayen, Rheinland-Pfalz D, Siegfriedstraße 1919, first half of the 14th century (Redknap 1999, Abb. 9, Fdst. 20 kiln 7).

Abb. 26 Sunken cross-draught stoneware kiln with oval ground plan and a sunken stoking-pit with vaulting under the kiln floor, slightly sloping firing chamber floor, that was formed by "fire bars" that covered the three flues below, Frechen type. Frechen, Nordrhein-Westfalen D, Franzstraße/Mühlenbach, kiln 1, around 1600 (Koch 1998, Abb. 131).

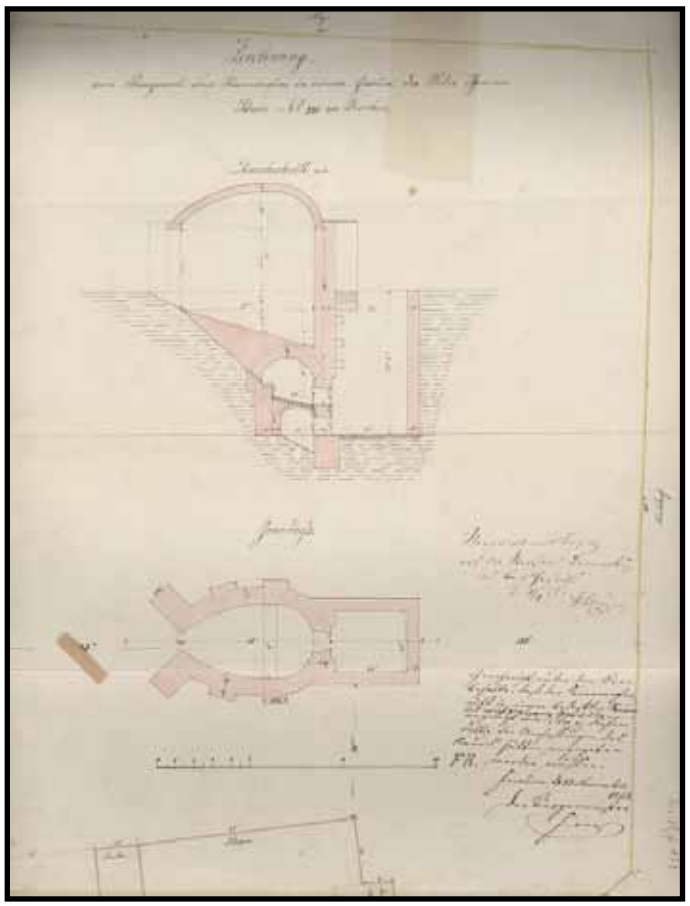

Abb. 27 Sunken cross-draught stoneware kiln with oval ground plan and a sunken stoking-pit with vaulting under the kiln floor, Frechen type. Frechen, Nordrhein-Westfalen D, building applicationfor the stoneware kiln of Peter Thomer, 1868 (Foto Stadtarchiv Frechen, Akte 189 Fol. 173).

Abb. 28 Cross-draught earthenware kiln with a more elongated ground-plan, three flues and a sunken stoking-pit with vaulting under the kiln floor. Frechen, Nordrhein-Westfalen D, Alte Str. 92, kiln Stelle 5, second half of the 16th century (Foto Cornelius Ulbert).

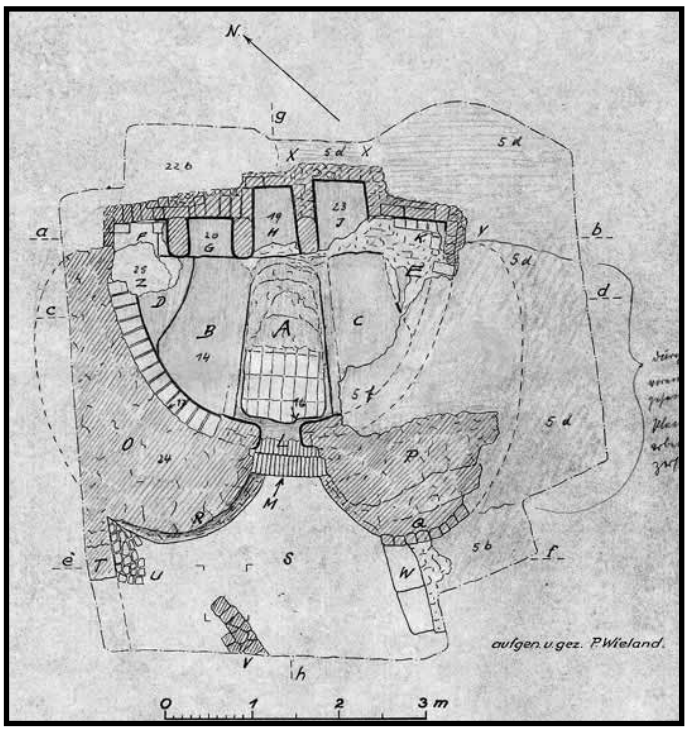

Abb. 29 Cross-draught stoneware kiln with oval ground plan and a sunken stoking-pit with vaulting under the kiln floor. The preserved archaeological remains represent just the sunken stoking-pit and in front of it the working area of the kiln, the firing chamber, originally on higher ground, is destroyed. Siegburg, Nordrhein-Westfalen D, Aulgasse 55, 16th century (Foto RAB).

Abb. 30 Sunken cross-draught stoneware kiln with oval ground plan and a sunken rectangular stoking-pit with vaulting under the kiln floor, Frechen type. To the right side the stoking pit of the kiln is just trenched and not excavated. Vreden, Nordrhein-Westfalen D, Hof Möllering, 18th century (Elling 1994, 122).

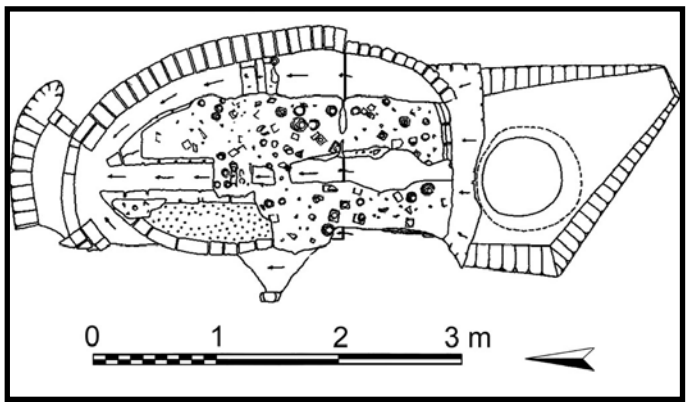

Abb. 31 Sunken cross-draught stoneware kiln with oval ground plan and a sunken semicircular stoking-pit with vaulting under the kiln floor, Frechen type. Woolwich bei London GB, 1640 bis ca. 1660 (Pryor/ Blockley 1973, fig. 4).

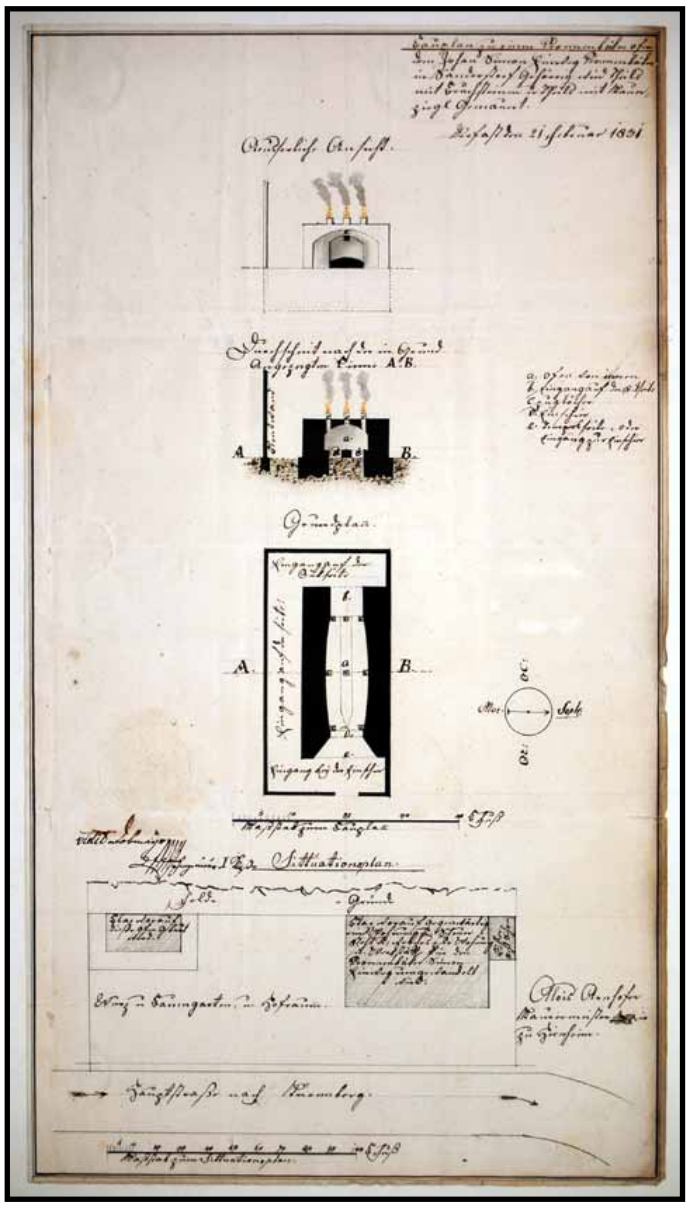

Abb. 32 Cross-draught stoneware kiln, built in a sloping position above ground with a rectangular ground plan and two flues, Westerwald type. Building application Sandersdorf, Bayern D, 1831 (Endres 2000, Abb. 4, StA Amberg, Akte Hofmark Sandersdorf 18, Prod. ad. 23).

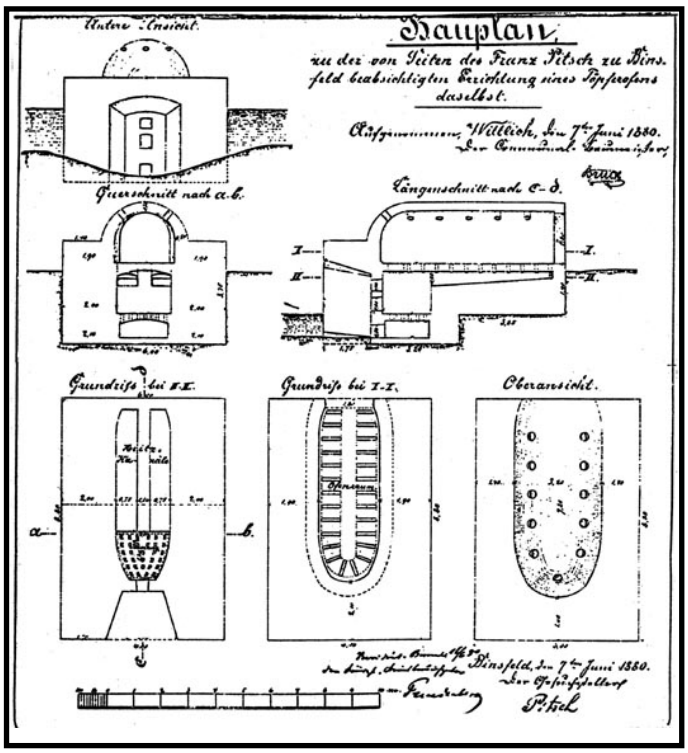

Abb. 33 Cross-draught stoneware kiln, built in a sloping position above ground with a rectangular ground plan, one sunken fireplace and two flues, Westerwald type. Building application Binsfeld, Rheinland-Pfalz D, 1880 (Kerkhoff-Hader 1987, Abb. 17).

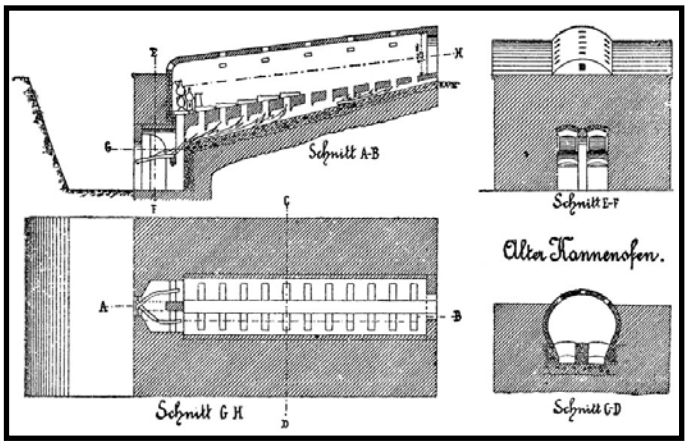

Abb. 34 Cross-draught stoneware kiln with a rectangular ground plan, one sunken fireplace and two flues, Westerwald type. Raeren, Belgium, 1887 (Schiffer 1887, Fig. 2).

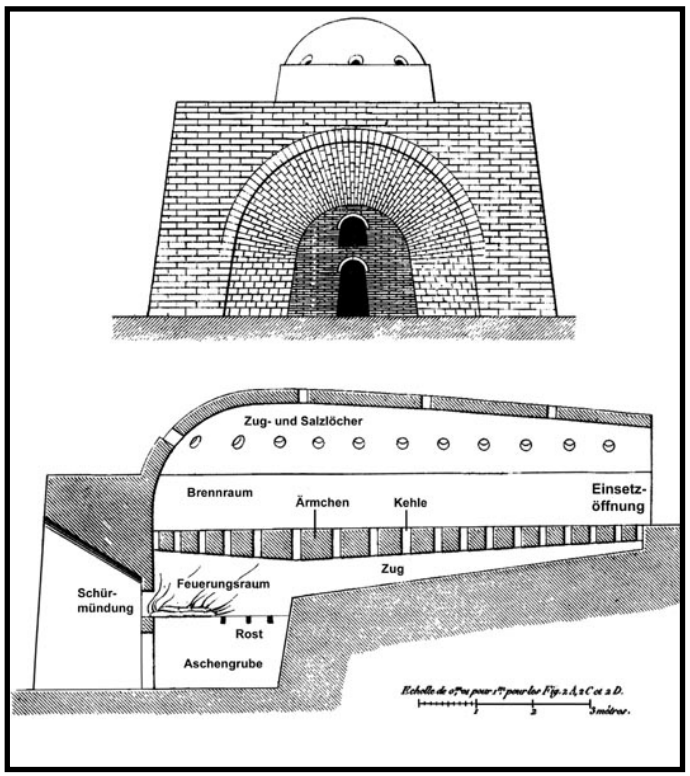

Abb. 35 Cross-draught stoneware kiln with a rectangular ground plan, one sunken fireplace and two flues, Westerwald type. Voisinlieu near Beauvais, France (Brongniart 1877, Taf. 38, Fig. 2).

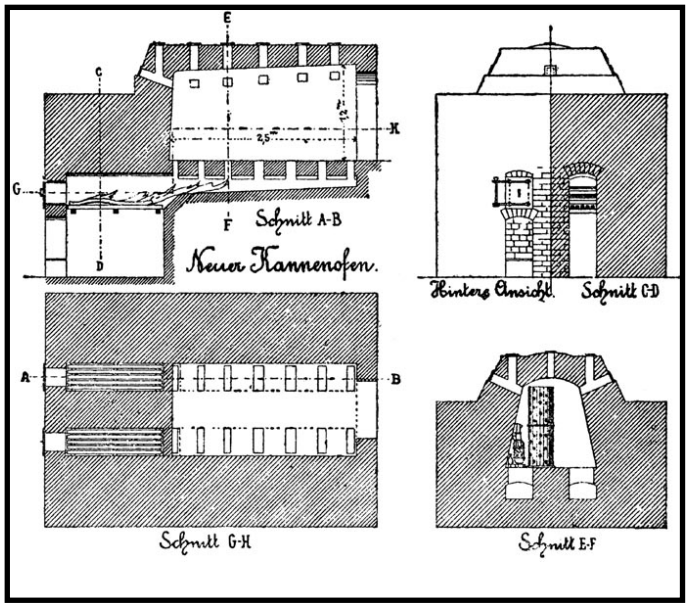

Abb. 36 Cross-draught stoneware kiln with a rectangular ground plan, one exterior stoking-pit per flue, two flues, Westerwald type. Raeren, Belgium, 1887 (Schiffer 1887, Fig. 3).

re the "mature" type of kiln spread to Cologne and Frechen. To the east of Rhineland, this type of kiln spread via Bornheim-Sechtem at least to Siegburg (Abb. 29). Thanks to migrating Frechen potters, this kiln type reached the Westphalian stoneware centres of Vreden/Stadtlohn (Abb. 30) and also to Woolwich in England (Abb. 31).

2.2.2.3 Cross-draught stoneware kilns, built in a sloping position above ground with a rectangular ground plan, Westerwald type

The technological connection between stoneware kilns from Frechen with those in the area where the Westerwald potters later dispersed is unfortunately unclear, since there are no relevant excavations in the Westerwald. Potters' kilns from the Westerwald were stoneware kilns with a rectangular ground plan, mostly erected on a slope above ground. In the light of the Rhenish bases of kiln technology in Rhineland-Palatinate D (Mayen and the Westerwald) and the immigration of potters from Raeren B and Siegburg D in the second half of the 16th century, kilns with sunken fireplaces in the Westerwald from the 16th to 18th centuries, as in Frechen D, Raeren B and Langerwehe D could be envisaged. However, due to the inclination of the slope, they had to be constructed differently and the ground plan was changed to the well-known elongated rectangular shape. However, development could just as well have originated, for example, from the pottery region of Raeren B, where stoneware kilns have been found, originally with oval ground plans and then in the 19th century, with rectangular ground plans.

Until now, the oldest verified example of a stoneware kiln with a rectangular ground plan, a sunken fireplace and only two flues came from Sandersdorf in Bavaria D (construction plan dated 1831, Abb. 32). The construction principle occurring here could, however, be older (kiln find from Grenzau bei Grenzhausen D). This kiln construction was also used until the late 19th century in the actual form in all the migration and influence areas of the Westerwald potters, above all in Südeifel (Binsfeld D, Herforst D, Bruch D, Abb. 33), in Raeren B (Abb. 34), in Oberbetschdorf F in Alsace and in the proximity of Beauvais in northern France (Abb. 35). Already in the first half of the 19th century, the Westerwald D stonewa-

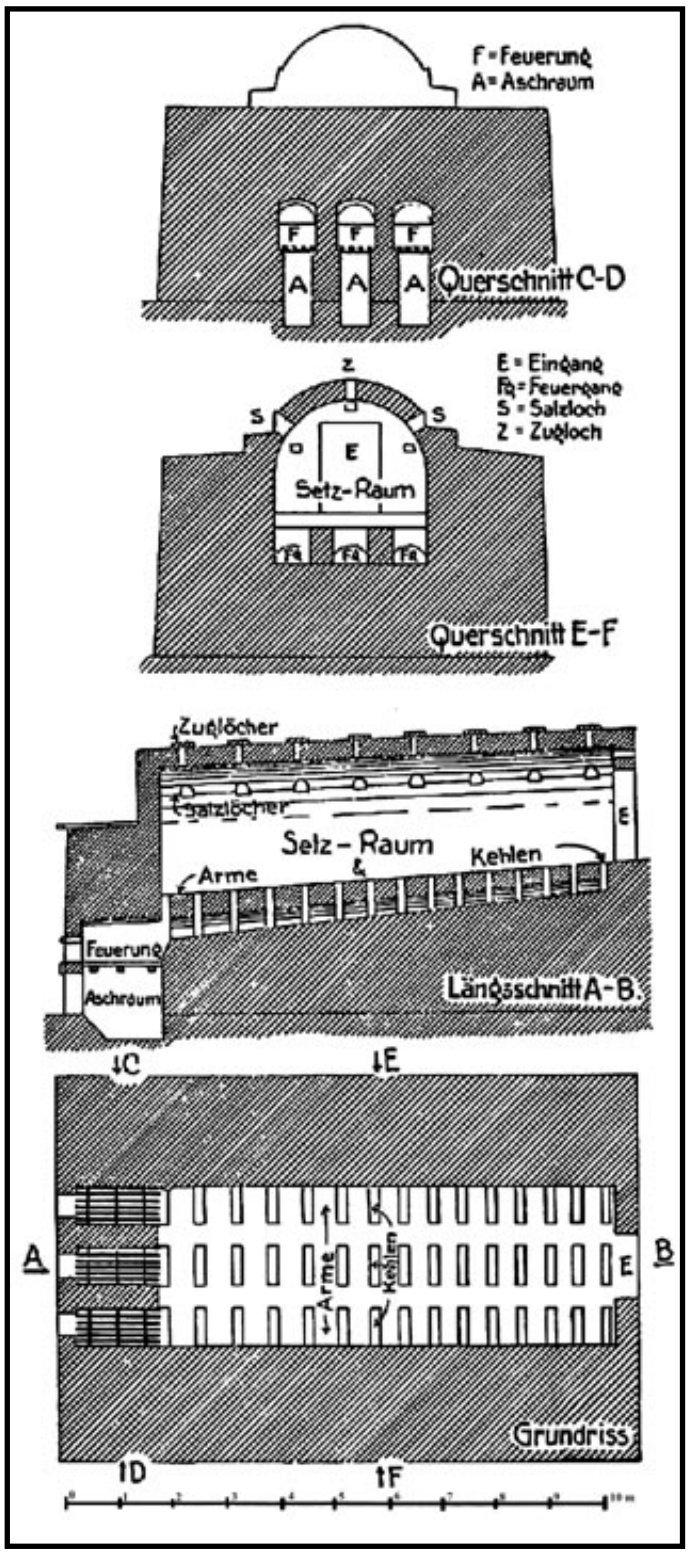

Abb. 37 Cross-draught stoneware kiln with a rectangular ground plan, one exterior stoking-pit per flue, three flues, Westerwald type. Speicher, Rheinland-Pfalz D, 1922 (Löschke 1922, 18).

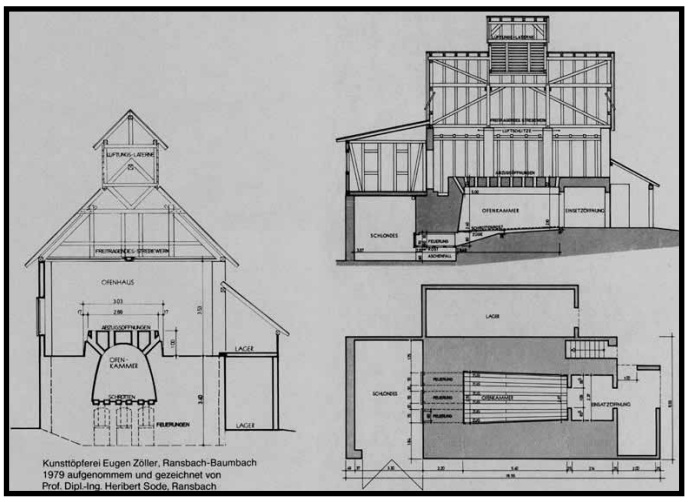

Abb. 38 Cross-draught stoneware kiln "Kellchesofen" with a rectangular ground plan, three exterior stoking-pits, six flues (two flues per fireplace), a firing chamber floor, that was formed by movable "fire bars", Westerwald type. Art-pottery Zöller in Ransbach-Baumbach, Rheinland-Pfalz D 1979. The kiln still existed in 2007 (Lenz 1983, 23 und 24).

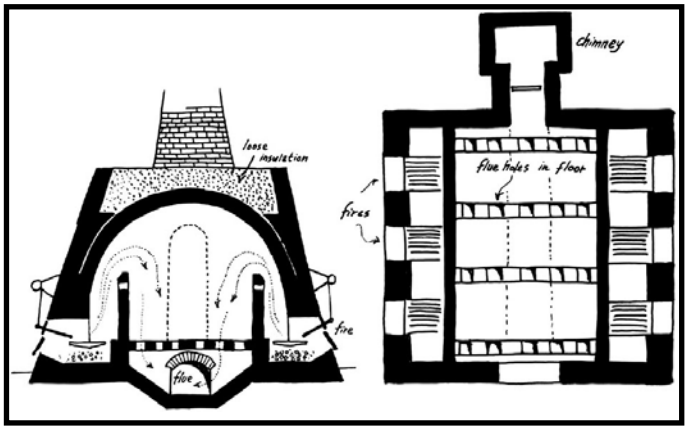

Abb. 39 Rectangular down-draught kiln with fireplaces on the long side of the kiln, so-called "old-German kiln" (Rhodes 1968, Abb. 50).

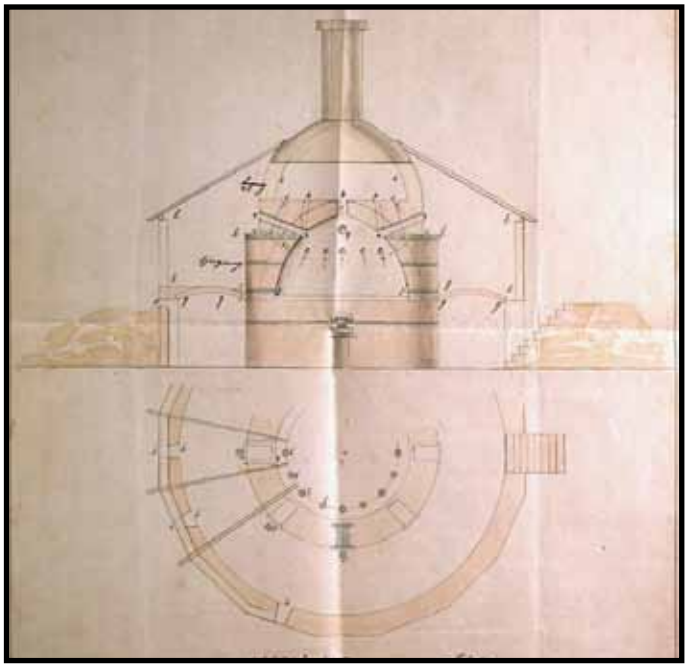

Abb. 40 Round or cylindrical updraught kiln with grate-firing. Projectplan 1870. Kiln of Jacob Wilhelm Zöller II from Grenzhausen, Rheinland-Pfalz D (Hessisches Hauptstaatsarchiv Wiesbaden 211 Nr. 14334).

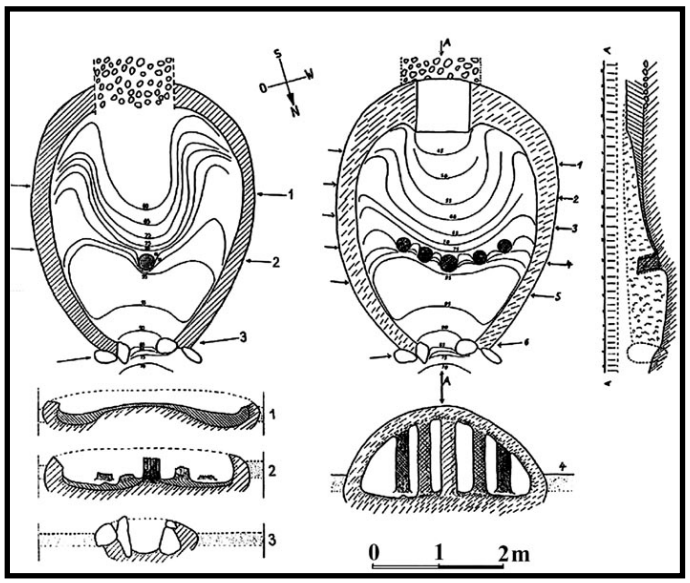

Abb. 41 Horizontal cross-draught kiln with a vertical fire-grate of clay columns. Older and younger phases of the kiln from Dümmer, Mecklenburg-Vorpommern D, first half of the 14th century. (Engel 1951/1952, Abb. 1,2).

Abb. 42 Horizontal cross-draught kiln with a vertical fire-grate of clay columns. Rheinsberg, Brandenburg, 13th century (Foto Johannes Weishaupt).

Abb. 43 Horizontal cross-draught kiln with a vertical fire-grate of clay and crock columns and a base of the kiln superstructure made of roof-tiles. Winterthur, Kanton Zürich CH, Untertor 21–25, um 1400 (Foto Kantonsarchäologie Zürich).

re kilns appear to have switched to hard coal and firing with a horizontal grill, which led to construction changes. A little later, kilns, each with one fireplace per flue, were constructed (Abb. 36). Possibly already in the late 19th century, but certainly before WW1, stoneware kilns with three fireplaces and three flues were then constructed (even in the Westphalian stoneware centres, Abb. 37). With a switch to two flues per fireplace and the introduction of movable "fire bars", technological development ceased shortly before WW2 (Abb. 38).

In conclusion, mention should be made of the simultaneous existence of so-called "old-German kilns" in Höhr-Grenzhausen D and Stadtlohn/Wesphalia D, with fireplaces on the long side of the kiln (Abb. 39). Their technological origin is unclear (England? The Netherlands?). Moreover, there were also round kilns along the lines of English or French(?) models in the German stoneware centres (Abb. 40).

2.2.3 Horizontal cross-draught kilns with a vertical fire grate of clay or crock-columns as a dividing element between the stoking pit and the firing chamber: northwest and northeast Germany

Starting from the horizontal cross-draught kilns with clay or crock columns from the federal states of Hamburg D, Mecklenburg D, Brandenburg D, Sachsen-Anhalt D, Thüringen D, Saxony D and Lower Saxony D, and (North) Hesse D, a further technological line of development took place from the 13th century. These kilns had a sloping or almost horizontal firing chamber which was separated from the stoking pit by a variably sloping pronounced step with a fire grate of crock or clay columns. In a reconstruction, a chimney for these kilns may be questionable on the basis of Danish experiments. The horizontal cross-draught kilns in Mecklenburg-Vorpommern D (Abb. 41), Brandenburg D (Abb. 42) and Hamburg-Boberg D can be predominantly dated to the late 12th to mid 14th centuries. This is also valid for comparable findings from Barmer in Denmark (late 13th century?). To the south and west of the area already described, there are vague indications of kilns of a questionable type from Arnstadt in Thüringen D (14th century) and Eilenburg in Saxony D (14th-15th century?).

In connection with the kilns from Hamburg-Boberg, the kiln from Winterthur CH, Untertor 21-25 (ca. 1400), the base of which was constructed in an identical way, should be mentioned (Abb. 43). Until now, it is the only kiln from the period between 1000 and 1550 in the whole of Switzerland. Since this kiln type is also unknown in the area of southern Germany, it is thought to concern a potter who immigrated from northern or north-western Germany.

Kilns of the type described are also met relatively frequently in Lower Saxony D and North Hesse D: Einbeck, Bengerode bei Fredelsloh, Coppengrave, Duingen and Salzgitter-Gebhardshagen, as well as deserted potteries from the Reinhardswald (Abb. 44) and Marburg areas (Knechtbach bei Michelsberg D, Neuental-Neuenheim D).

The further technical development of this type of kiln can be seen in southern Lower Saxony and North Hesse (Bengerode D, Fredelsloh D, Abb. 45, Reinhardswald D, Marburg area D), Saxony (kiln from Skoplau D) and Denmark (kiln from Farum Lillevang). The kilns considered here date to the late 13th or early 14th centuries and in the case of Skoplau D probably to around 1400. The pronounced sloping step or kiln hump with crock or clay columns was further developed into an upright vertical step, on top of which a vertical fire grate could stand. The form, construction type and massiveness of this fire grate are, however, currently unknown. It cannot be excluded that a first row of fixed in-built vessels functioned as a fire grate and was possibly subsequently disposed of as wasters. These kilns are characterized by elongated, slightly bulging ground plans.

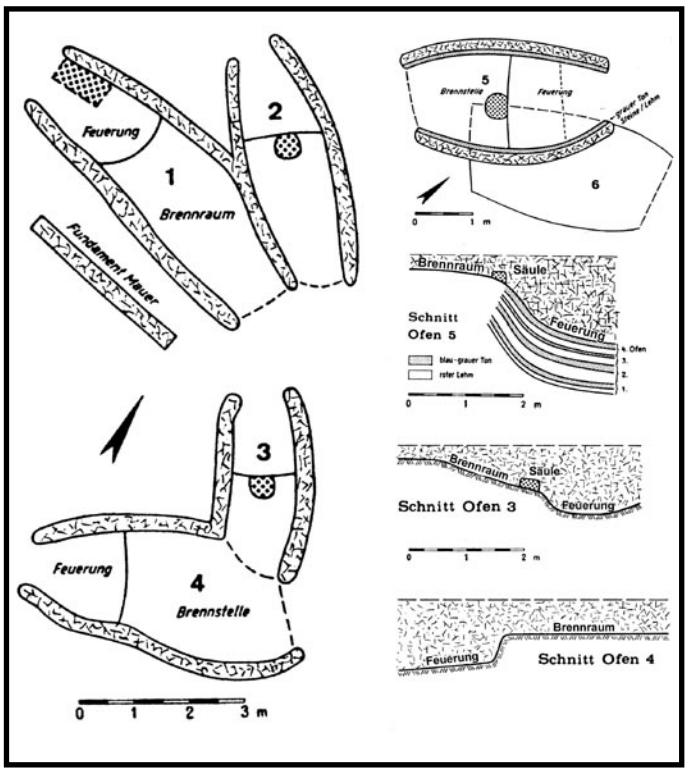

Abb. 44 Horizontal cross-draught kilns with a vertical fire-grate of clay and crock columns and a pronounced sloping or nearly vertical step between the stoking pit and the firing chamber on top of which a vertical fire grate could stand. Reinhardswald, Nordhessen D, kiln waster dumping area A und E an der Fulde bzw. Donne, 13th – 14th century (Desel 1969, 216).

Abb. 45 Horizontal cross-draught kiln with elongated, slightly bulging ground plan, upright vertical step, as backpart of a sunken fireplace, on top of which a vertical partition wall or fire grate could stand. Fredelsloh, Niedersachsen D, Gasse 24, kiln 2, late 13th century (Foto Kreisarchäologie Northeim, Petra Lönne).

Abb. 46 Horizontal cross-draught kiln with elongated, slightly bulging ground plan, upright vertical step, as backpart of a sunken fireplace, on top of which traces of a vertical partition wall or fire grate can be seen, building material bricks. Leipzig, Sachsen D, Grimmaische Vorstadt, kiln VII, 16th century (Foto Landesamt für Archäologie Sachsen).

Abb. 47 Horizontal cross-draught kiln with elongated, slightly bulging ground plan, building material bricks. Traces of colour change on the firing chamber floor can be interpreted as an indication of temporarily installed flues. Lübeck, Schleswig-Holstein D, Dankwartsgrube 36 (Foto Stadtarchäologie Lübeck)

2.2.3.2 Horizontal cross-draught earthenware- and stoneware kilns with a vertical fire-grate and an elongated oval ground plan, "Kassel-type" kiln

Neither in Lower Saxony D nor in northeast Germany nor in Reinhardswald D have there been other kiln finds from the late 14th and early 15th centuries. From this, it can only be surmised that kilns, like that from Fredelsloh, are the typological starting form for the further development of stone- and earthenware kilns with horizontal cross-draught in Germany.

Indications of the appearance of kilns in the following centuries simply provide a few regionally widespread kilns from late 15th century or around 1500 from Leipzig D, Grimmaische Vorstadt, kilns 5–7, Ingolstadt D, Konviktstrasse, Strullendorf D, Im Stockweg 28, kiln 2 as well as possibly Bamberg D. In addition, there are two 16th/17th century kilns from Lübeck D, Dankwartsgrube 38. In all probability, a kiln from Stralsund D, Marienstraße 22 as well as one from Oberen Tor in Grebenstein/Nordhessen D should also be classified here. The well-known distribution of finds until now (northern Germany, North Hesse, Saxony, Bavaria) is clearly visible (Abb. 46).

These kilns appear as a brick variant of the clearly older near-stoneware kilns from Fredelsloh D, i.e. they have an elongated oval ground plan, a sunken brick-built fireplace, probably with a vertical partition wall or fire grate to the horizontal firing chamber. Contrary to the stone- and earthenware kilns from Frechen D and Cologne D, they do not have sunken flues. The traces of colour change on the firing chamber floor of the Lübeck D kiln can be interpreted as an indication of temporarily installed flues (Abb. 47). Whether there was a chimney, necessary for a genuinely horizontal flue, is not known. Contemporaneous kilns from northern France with the same fireplace construction and vertical partition wall tend to have a rather rectangular to trapezoidal ground plan with a virtually horizontal or slightly rising firing-chamber floor.

The possible typological development led, in the 18th century, to kiln types with a deeply sunken fireplace, a vertical partition wall, a horizontal or near-horizontal firing-chamber floor, a chimney and an oval to spindle-shaped ground plan. From the second half of the 19th century, these tended to be

called "Kassel-type kilns". The name was taken from the "Kasseler Flamm-Ziegelofen", used for bricks, roof tiles and tubes, developed in 1827 in Möncheberg bei Kassel D, but only made public in 1855 (Abb. 48). During the development of this brick kiln, the interactive technology of traditional earthenware pottery, stoneware, faïence and porcelain production, and brickworks in the early 19th century was documented. In brick production, the "Kasseler Flamm-Ziegelofen" represents the rejection of open-topped kilns and the acceptance of a clearly older, horizontal cross-draught kiln type. In the existing literature until now, this has mainly been the opposite, i.e. viewed incorrectly.

Together with historical news items, reports and excavation finds, construction drawings and still-standing kilns or remains thereof from Lower Saxony D (Duingen, Brünnighausen, Abb. 49), Hesse D (Dreihausen and Michelsberg, Stadt Schwalmstadt, Grossalmerode, Epterode, Abb. 50), Brandenburg D (Crinitz), Saxony D (Waldenburg, Rodewisch, Pulsnitz), Thüringen D (Bürgel) und Bavaria D (Obernzell bei Passau), a possibly independent southern Lower Saxony-North Hesse-central German-(Saxon?)-eastern Bavarian kiln region, spanning the period from the 16th to the 20th centuries becomes apparent. Here, kilns with a pointed to elongated oval ground plan were built, in which, as a technological linking element, both stoneware and earthenware, sometimes even in one and the same firing, could be manufactured.

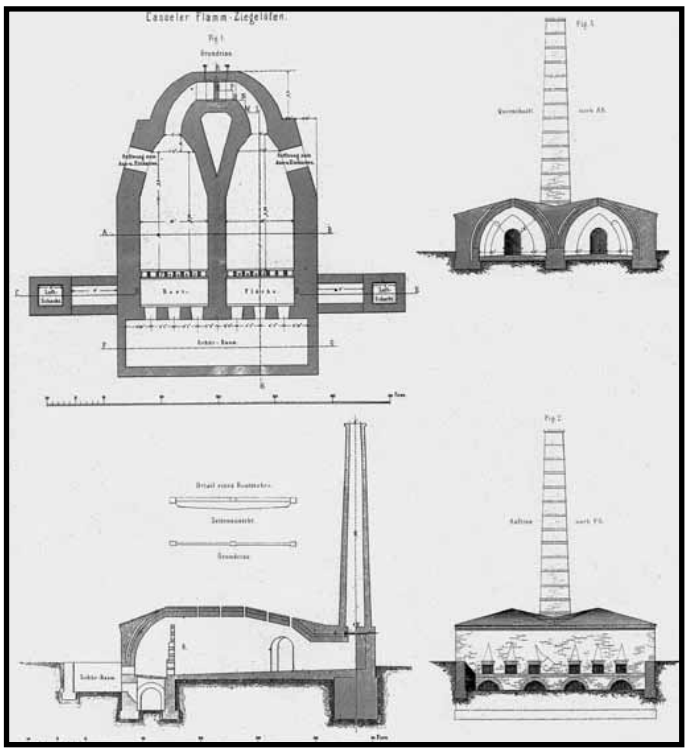

Abb. 48 Kasseler Flamm-Ziegelofen, brick-facory Möncheberg near Kassel, Hessen D, patent application 1855 (Wiegand 2000, 39–40).

2.3 Horizontal cross-draught earthenware kilns with a vertical fire-grate and a rectangular ground plan

As opposed to the kiln group just described, horizontal cross-draught kilns with a rectangular ground plan and chimney, as well as variable fireplace design details (sunken or on the same level as the firing chamber, with or without a hearth) and of the firing chamber (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 (Abb. 51). They are evenly scattered between the North Sea and the Alps, and are the "classic" 18th to 20th century earthenware kilns. They are likewise mostly referred to as "Kassel kilns". In the second half of the 19th century, they are also encountered as firing and


In der Regel ſind die Oefen von etwas roher Ausführung; ſchon zu den beſſeren gehört der Fig. 215 im perſpectiviſchem Längendurchſchnitte abgebildete

Fig. 215.

Ofen, wie er bei Duingen und Brüninghauſen im Hannoverſchen gebräuchlich iſt. *A* iſt der Brennraum, *B* der Feuerheerd für Steinkohlen, welcher durch den Roſt *r* von dem Aſchenfall *C* geſchieden wird. *A* und *B* ſind von einem gemeinſchaftlichen ellipſoidiſchen Gewölbe *a a* überſpannt. Der Zug wird durch die Oeffnung *g* mittelſt einer Deckplatte regulirt, geht durch den Roſt *r* aufwärts in die Kohlen, von wo die ſich entwickelnde lange Flamme, durch die Blendungen *i i* der Mauer *m m* möglichſt vertheilt, in den Brennraum eintritt. Sie trifft die daſelbſt aufgeſtellten Geſchirre und entweicht durch die Blendungen der zweiten Wand *n n* in einen Kanal *o*, der als Eſſe dient. Durch das Schürloch *e* beſorgt man das Feuer; Zugänge in der Rückwand und in *n n* dienen zum Einſetzen und Ausfahren, ſind aber während des Brandes vermauert. —

Abb. 49 Horizontal cross-draught stone- or earthenware kiln with a deeply sunken fireplace, a vertical partition wall, a horizontal or near-horizontal firing-chamber floor, a chimney and an oval to spindle-shaped ground plan, „Kasseler Ofen". Duingen und Brünnighausen, Niedersachsen D, first half of the 19th century (Knapp 1847, Abb. 215).

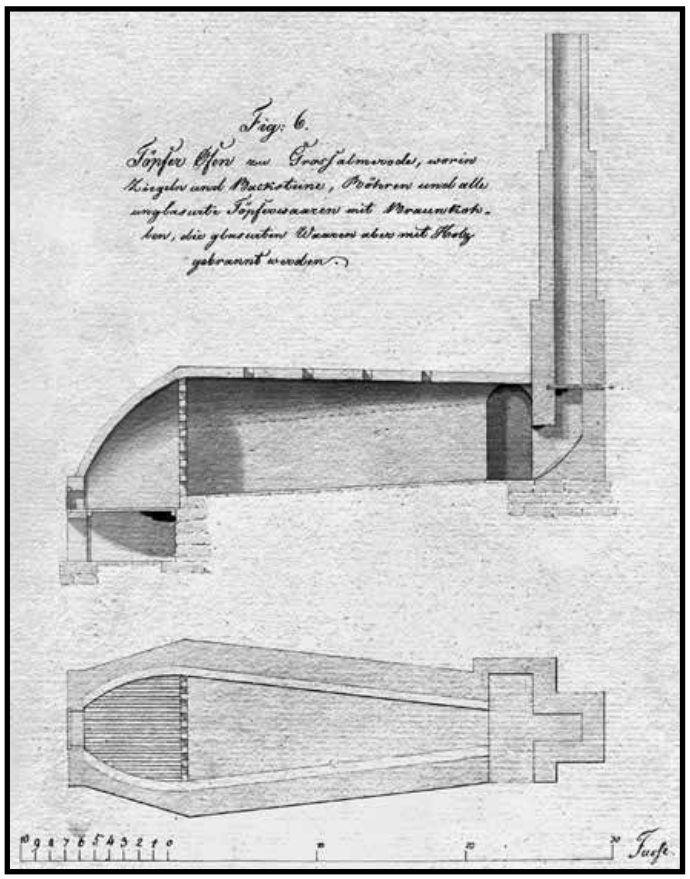

Abb. 50 Horizontal cross-draught stone- or earthenware kiln with a deeply sunken fireplace, a vertical partition wall, a horizontal or near-horizontal firing-chamber floor, a chimney and an oval to spindle-shaped ground plan, „Kasseler Ofen". Grossalmerode, Hessen D, 1851 (Wiegand 2000, 37).

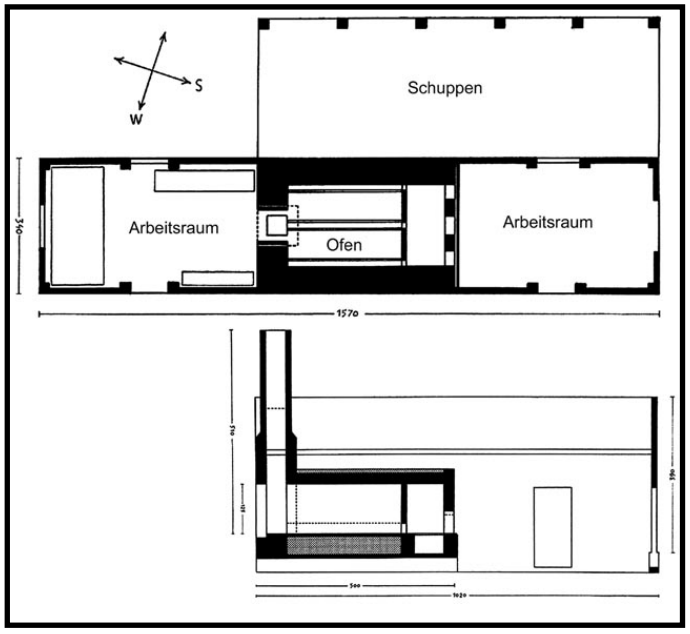

Abb. 51 Horizontal cross-draught earthenware kiln with a vertical fire-grate and a rectangular ground plan, firing chamber floor with temporarily installed flues. Hellern, Nordrhein-Westfalen D, Töpferei Ahaus, around 1925 (Segschneider 1976, 117 und 122)

glazing or reduction/smoking kilns for roof tiles and bricks (Abb. 52). Up to now, proof of kilns of this type from Belgium, Switzerland and Austria is missing. In the Netherlands, they are only known in the border area with Germany.

On what technological basis this type of kiln had developed until the first proof of it in the late 18th century has not, for the time being, been clearly explained. In any case, based on the oldest datings, it is again sure that it is not a successor, but instead a forerunner, to the "Kasseler Flamm-Ziegelofen". The two oldest examples of a horizontal cross-draught kiln with a rectangular ground plan functioning as an earthenware kiln come from Stralsund D (built 1784) and Neuss D (building application dated 1786), followed shortly after by a building application from Möncheberg in Bavaria D (1797) and Brakelsiek D in Westphalia (1826, Abb. 53). However, they also existed until the middle of the 20th century in Schleswig-Holstein D, Mecklenburg-Vorpommern D, Lower Saxony D, North Rhine-Westphalia D and the eastern part of the Netherlands, Hesse D, Thüringen D, Rhineland-Palatinate D, Bavaria D, Baden-Württemberg D and Alsace F. With this type of kiln, the development of wood-fired earthenware kilns in the 20th century came to an end. In the still-existing potteries, they were at first either converted to gas- or oil-firing at the end of WW2, or replaced by smaller electric kilns.

2.4 Mixed cross-draught / down-draught earthenware kilns

Based on excavation finds and building applications received from Frechen D, Bedburg D, Siegburg D and Coburg D (Abb. 54), one last kiln type remains to be described. This is a cross-draught kiln with a chimney and horizontal grate of bricks or iron, a vertical partition wall and, as a characteristic feature, a raised kiln floor on a double archway (Abb. 55). The chimney provided for an optimum diagonal or down-draught. Since the area of double archway was open towards the stoking pit, the flames were distributed both under the kiln load as well as being extracted over the partition wall and through the kiln floor. The oldest example of this type of kiln is in Frechen D and dates from circa 1800. A few comparable finds from the field of faïence and porcelain manufacturers should be taken as a firm indication of the basis on which this very specific kiln type was developed in Rhineland.

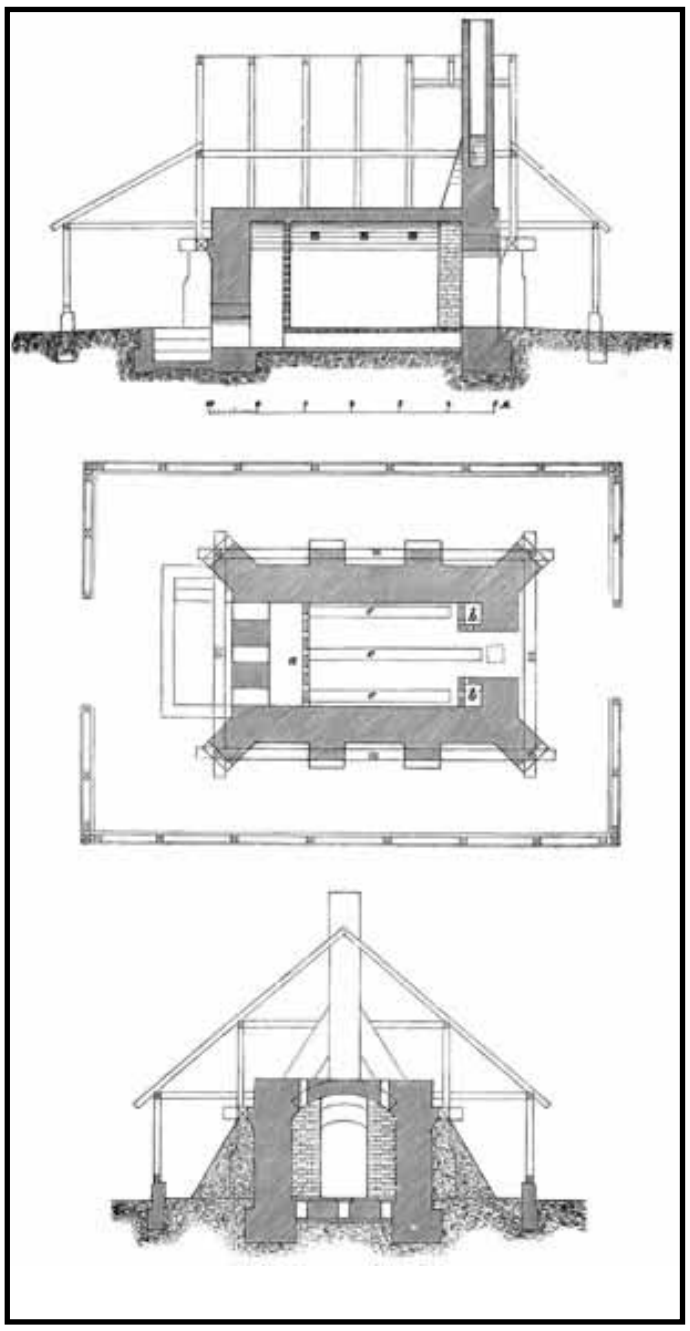

Abb. 52 Horizontal cross-draught kiln for glazed bricks and tiles with a rectangular ground plan and a vertical fire-grate. Vollenschier bei Vinzelburg, Sachsen-Anhalt D (Heusinger 1901, Fig. 426–428).

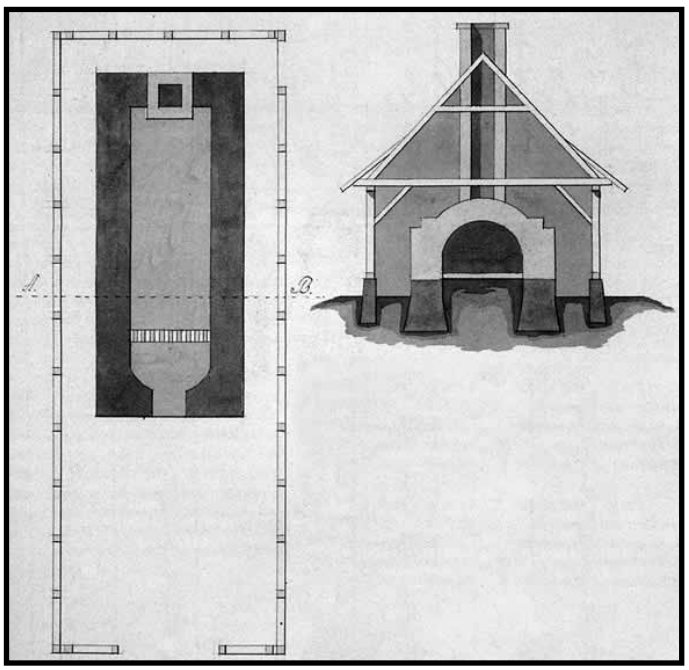

Abb. 53 Horizontal cross-draught earthenware kiln with a rectangular ground plan and a vertical fire-grate. Brakelsiek, Nordrhein-Westfalen D, Mörth, 1826 (Halle/Rinke 1991, 117).

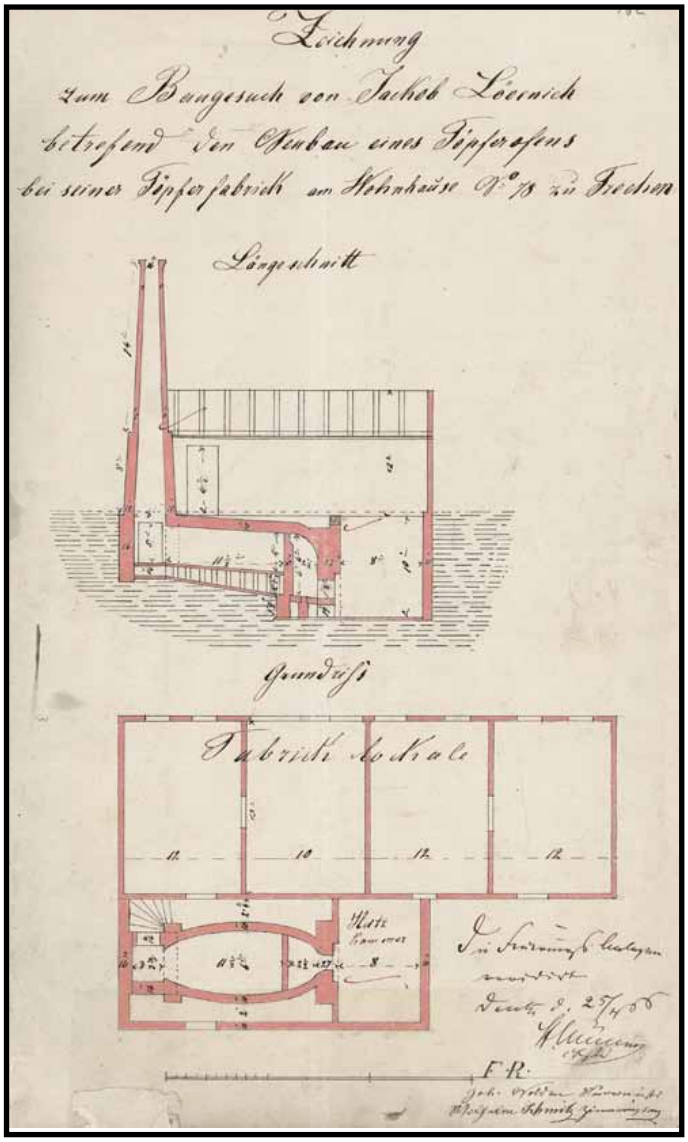

Abb. 54 Mixed cross-draught / down-draught earthenware kiln with a chimney and horizontal grate of bricks or iron, a vertical partition wall and, as a characteristic feature, a raised kiln floor on a double archway. Frechen, Nordrhein-Westfalen D, earthenware kiln of Jakob Lövenich 1866 (Stadtarchiv Frechen Akte 189, Fol. 162).

Abb. 55 Mixed cross-draught / down-draught earthenware kiln with a raised kiln floor on a double archway. Frechen, Nordrhein-Westfalen D, Alte Straße 67–73 (Foto Cornelius Ulbert, archaeologie.de).

Conclusions

All known kiln types are a functional adaptation of the thermodynamic and physico-chemical properties of fire. Amongst other things, this led to the independent construction of similar or identical ceramic firing methods and kiln types in Latin America, Asia and Europe (vertical and horizontal kilns). With regard to the various peculiarities of kilns found in the present subject matter, the spread of specific kiln types can, however, also be traced back to cultural contacts and technology transfer.

- Kiln types as witnesses of technology transfer by migrating potters and their still-existing contacts at home. As an example of this, oval stoneware kilns according to the Frechen pattern can be seen in Westphalia D and in England. The same is valid for the rectangular-based stoneware kilns in the emigration area of the Westerwald potters, or the oldest vertical majolica kiln brought by Italian potters to Antwerp B.
- Kiln types as witnesses of technology transfer by adoption. Examples here are the vertical majolica and faïence kilns in the Netherlands and the remainder of northwest Europe.
- Kiln types as witnesses of technology transfer by adoption, without however assimilating the original specific production or range of vessel forms for this type of kiln. Examples of this are the "Italian" vertical majolica kilns in Switzerland and their further development, which above all found use for normal earthenware production.

ard to the timings of technological "innovations", we can conclude that the tendency was towards relatively long and continuous development routes, during the course of which quite a few different kiln types existed side by side. Vertical and horizontal kilns had a long phase of coexistence, which continued at least until the 14th century.

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 Rhineland and the vertical kilns with a rectangular ground plan of the "Piccolpasso" type. For the former, the technological basis was developed between the 12th and 14th centuries and for the latter, in Roman times already. It seems to have been the same for the horizontal earthenware and stoneware kilns with an elongated oval ground plan from the Lower Saxony-Saxony-Bavaria region. Their development started in the 12th century and in principle seems to have ended in around 1500. In comparison, horizontal kilns with a rectangular ground plan and horizontal kilns with a firing chamber floor on a double archway only seem to have been developed from the 18th century onwards.

The present overview and the associated contributions by various authors have not only sketched the current state of research and explained the lines of development, but have also revealed obvious research deficiencies. Future research on kilns should above all fill in the regional and chronological gaps, mainly in the 10th/11th centuries and the 15th/16th centuries. The portrayal of excavation results should be carried out more comprehensively and above all with more illustrative material. In no case should the kiln length profile, which should also include the pit, be left out. For a first dating (terminus ante quem), the submission of 20-30 characteristic rim fragments of the kiln wasters would largely suffice. A search for planning documents for kilns in building files and archives still always represents a logical undertaking for the 18th to 20th centuries. Above all, this should be backed up by local research into kiln sites.

In supra-regional comparisons, the future inclusion of French and English kilns would be of particular importance, since the most varied technological ideas seem to stem from western Europe. How far these also radiated eastwards, i.e. to Poland, the Czech Republic and Slovakia, and Hungary, must be the object of a separate study to be carried out as soon as medieval and modern kilns are available in large numbers in the countries concerned.

The low number of above-ground, completely maintained wood-fired kilns of the 19th and 20th centuries should really be an inducement to graphically and photographically document every kiln still available today. These kilns are the last technical witnesses of rapidly disappearing handicraft tradition and thus technical monuments of the first order.