

# Dwellings, Identities and Homes

*European Housing Culture from the Viking Age to the Renaissance*



Edited by Mette Svart Kristiansen & Kate Giles

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JUTLAND ARCHAEOLOGICAL SOCIETY

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# The ‘Stube’ and its Heating

## Archaeological Evidence for a Smoke-Free Living Room between Alps and North Sea

*Rainer Atzbach*

### Abstract

*This paper discusses the concept of smoke-free heated living rooms between the Alps and the North Sea with a special focus on the tile stove. In the circum-Alpine zone, a new heating system was invented between the 8th and 11th century. It consisted of a clay cupola oven with inserted ceramic vessels and was mostly run as a ‘breechloader’ (the term is used throughout the article to describe an oven which is fired from an adjacent room). This provided not only a comfortable living room, but also tended to create a specific ground plan for the house – with a core of the heated ‘stube’ and an adjacent kitchen. In the 12th or 13th century, this concept was differentiated into an elaborated system of stube, kitchen, central corridor and unheated chambers. The tile stove and the corresponding ground plan spread, but was also modified, in the area between the Upper German speaking region and Southern Scandinavia until the 16th century.*

“The German stove [Kachelofen] is by long odds the best stove and the most convenient and economical that has yet been invented. One firing is enough for the day; the cost is next to nothing; the heat produced is the same all day, instead of too hot and too cold by turns; one may absorb himself in his business in peace; he does not need to feel any anxieties of solitudes about the fire; his whole day is a realized dream of bodily comfort.

The American wood stove, of whatsoever breed, it is a terror. There can be no tranquillity of mind where it is. It requires more attention than a baby. It has to be fed every little while, it has to be watched all the time; and for all reward you are roasted half your time and frozen the other half. It warms no part of the room but its own part; it breeds headaches and suffocation, and makes one’s skin feel dry and feverish; and, when your wood bill comes in, you think you have been supporting a volcano.”

*Mark Twain 1891 (Twain 1923: 176)*

### Introduction

In archaeology, the distinction between a dwelling house and a subsidiary house is often defined by the existence of some form of permanent heating. Since mankind learned to light a fire, a central hearth has been the most important kind of heating in the home. Until the 19th century, in some regions until the present day, the presence of a fireplace in prestig-

ious halls and a hearth in the kitchen was common. Both solutions have provided warmth, energy for preparing warm meals and – at least to some degree – lighting during the dark hours of the day. But there is rarely fire without smoke. On the one hand, smoke can be used for the conservation of food, esp. meat or grain; on the other hand this smoke is poisonous.

Until chimneys became common, smoke more or less freely streamed through all of the house protecting the wooden construction from vermin, but also causing dirt and disease, problems which are evident in developing countries still today (Ryhl-Svendsen et al. 2010; Skov & Fenger 2008; Skov et al. 2000). The easiest solution for dealing with smoke accumulating within the house is to build a chimney which leads the smoke out of house directly. But a chimney has two major disadvantages. Firstly, warmth disappears with the smoke; secondly, an effective chimney tends to pull sparks from the fire onto the own roof or that of the neighbour. The best way to prevent a fire from smoking and sparking is to enclose the flames completely which is addressed in technical kilns which feature a clay cupola. It is possible that the baking oven forms a missing link between kilns and more sophisticated heating systems. If the oven is run as a breechloader, *ie* fired from the adjacent room – usually the kitchen – where a funnel gathers the smoke, the step to a smoke-free heated living room is achieved. In this paper, the German word ‘stube’ will be used hereafter to refer to this kind of smoke-free heated living room, in the absence of an equivalent English term.

Two more refined systems provide a better solution for a smoke-free heated living room, which are also discussed in this paper: subfloor convection air heating in ancient construction traditions, and the tile-stove consisting of a clay body with inserted ceramic tiles constructed and fired as a breechloader (Bingenheimer 1998; Roth-Heege 2012: 22-35). Until today, the economic and ecological use of energy resources is a central question in society. Against this background, the Archaeology Section of Aarhus University is currently engaged in a research project entitled ‘Housing Culture Between Climatic and Social Challenges in Medieval and Early Modern Europe’ which beyond others explores the role of such stoves in heating the European house.

## Subfloor convection air heating

This system is the oldest medieval form of smoke-free heating in Europe. Although styles varied as far as construction is concerned, the basic principle was

similar to the late 14th-century example discovered in the Bishop’s castle at Forchheim in 1996 (Figure 1). The space under the floor of the room was either filled with stones, or by empty air channels, and heated by convection. A separate burning chamber, usually fired from a working place in the cellar or beyond the building, provides the heating core of this system. The stones or the walls of the channels respectively are heated by the fire in the burning chamber and act as a convection mass. After having been heated, they emit their energy to fresh, smoke-free air, which is then channelled into the room to be heated using outlets in the floor or in the walls. Elaborate systems dissipate the smoke from the fire through a chimney from the burning chamber out of the building, allowing these models to be fired permanently. In this case a thin but gas-proof wall that works as a heat-exchanger separates the fire from the convection mass. The earliest example is known from the castle Runneburg in Thuringia (Bingenheimer 1998: 133). Simpler systems like the one in Forchheim (Kohnert 2008) have to be run in two different phases for firing and for heating. In the first phase (Figure 1a), smoke and warmth is delivered directly through the convectational space while the outlets must be closed. In the second phase (Figure 1b), after the fire has been extinguished and the burning chamber cleaned, the outlets are opened and fresh air streams through the empty burning chamber and the convectational space heated into the room. An air convection heating system is easy to detect archaeologically, either through the identification of the characteristic remains of the fire chamber in the basement, outlets in the floor and even fragments of their closing lids. So far, about 500 systems have been identified in Central Europe, but this is probably only the tip of the iceberg (Bingenheimer 1998).

According to Bingenheimer’s study, the air convection heating system is not to be regarded as a misunderstood or simplified medieval imitation of ancient Roman hypocaust, but rather represents a further stage in the development of this ancient technology; an antique example was discovered on the castellum Saalburg (1st century AD) by Jacobi (Jacobi & Cohausen 1897: Fig. 37). This special version of a hypocaust could be run as ‘conventional’ hypocaust



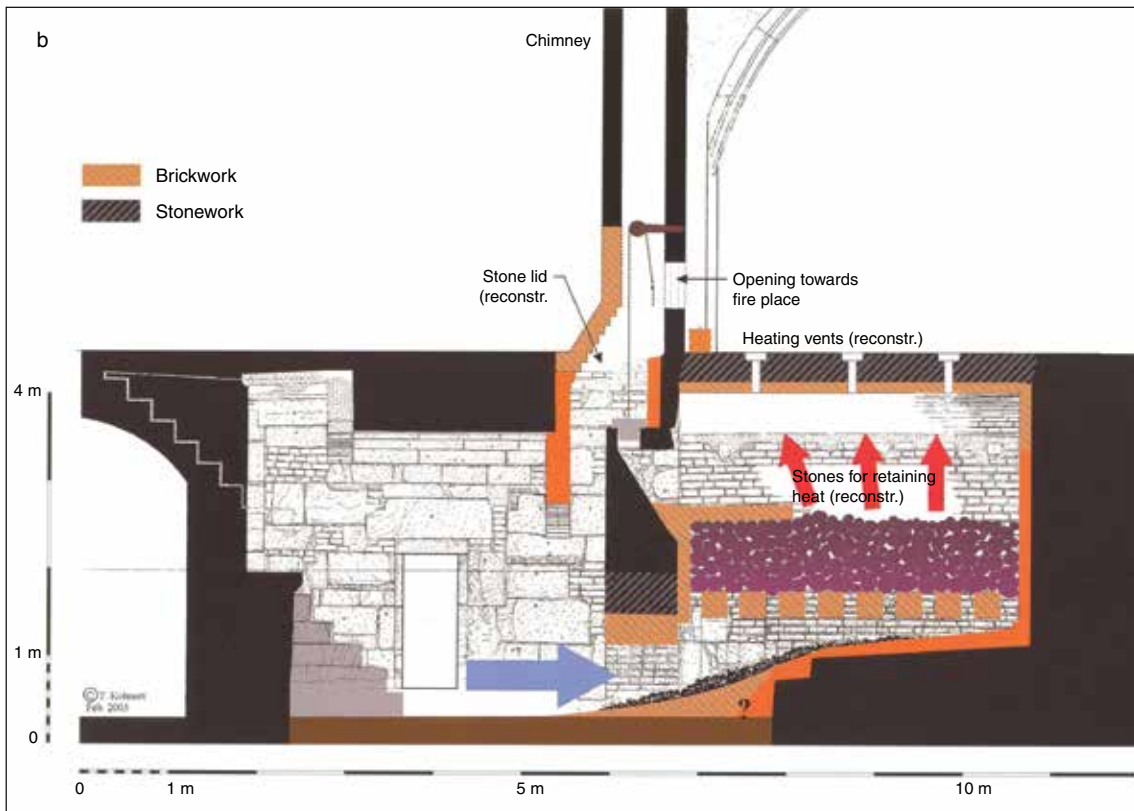
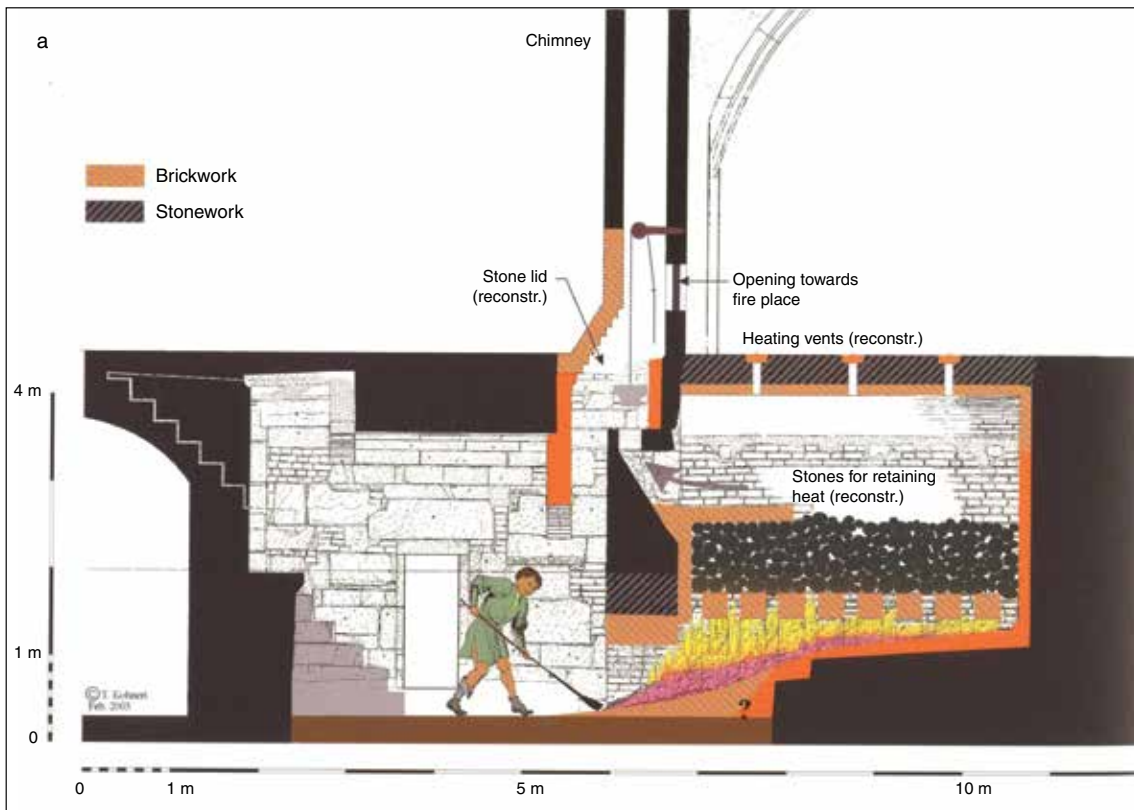


Figure 1. Subfloor convection air heating, bishop's castle in Forchheim. a. the burning chamber heats the convection mass; b. fresh air streaming through the hot convection mass is heating the hall. After Kohnert 2008: 62-63.

with heated smoke streaming under the floor and through tubuli in the walls. A lateral opening in the wall and outlets into the rooms also facilitated its use in the medieval, indirect way after the fire had been extinguished. The structural difference between this ancient form of construction and its medieval successors was principally the lack of pillars made of flat tegula plates in the latter examples. Early medieval examples are shown on the St. Gall Monastery plan – drawn probably on the island Reichenau between 825 and 830 AD (Hecht 1983; Jacobsen 2002; online-version in high resolution: Frischer & Geary 2012). Several rooms were warmed by hypocausts here, whereas the majority of rooms were heated by simple hearths and fireplaces, mostly positioned in the corner of a room and frequently using a common chimney with an adjacent one in the next room as shown, for example, in the *'mansio abbatis'*. The building to the southeast of the church is heated by an air convection heating system, whose separate

chimney is drawn and marked as *'evaporatio fumi'* on the plan. Until recently, this has been thought to be one of the earliest known examples of medieval air convection heating (Bingenheimer 1998: 46-53). The excavations on Reichenau – as the archetype for the plan – have discovered heating channels under the dormitory, too. In monastic contexts, smoke-free heating was primarily important for the work performed in the scriptorium and for the assemblies in the chapter house. In addition, this warm room also heated the dormitory above – as is indicated on the St. Gall plan *'subtus calefactoria domus/supra dormitorium'* (Sennhauser 1996: 296-298; Zettler 1988: 262f). In Cistercian monasteries, the calefactorium was usually the only heated room, mostly situated close to the refectory in the southern wing of a cloister. Most of these monastic calefactoria were warmed by an air convection heating (Binding & Untermann 1985: 61, 207). Apart from monasteries, further early examples are situated in representative ecclesiastical



Figure 2. Hypocaust heating palatium, Tilleda.

buildings, such as that in the Bishop's house at the cathedral castle in Minden, built around 1000 AD (Peine 2001: 43).

It seems likely that noble families became familiar with this technique whilst visiting their relatives living in a monastery or a convent – and became eager to use this comfortable way of heating in their own homes. It is not surprising to see the earliest secular examples under buildings on imperial castles in Quedlinburg, Werla and Tilleda in the 10th and 11th century AD. They belong to the older type of the hot air channelling system with a burning chamber on the outside of the building, primarily acting as heating for the assembly hall (Figure 2). In the 12th century, the later type with a stone filled camera as convection mass under the room to be heated was erected at the imperial castle in Goslar and at the ducal castle Dankwarderode in Brunswick (Bingenheimer 1998: 27-197; Dapper 2007; Feld 2006: 102). The construction principle is very similar to heating in bathrooms or houses, such as the castle Schlössel (Barz 2008; Tuchen 2001: 196).

This type of heating spread until the 14th century throughout Central Europe. It was not restricted to large halls and also came into use as heating for the lord's apartment at the castle of Rochlitz. Here, the Prince of Saxony installed an elaborate heating system in his private rooms around 1400 (Figure 3): In the corner of the complex, from the Querhaus to the Fürstenhaus, a subfloor heating with a burning chamber in the cellar and outlets in the first floor, was built. Its smoke was delivered through the wall into the adjacent room, where some type of tile stove as a reservoir for its warmth might have been positioned. This made it possible to warm at least two rooms with one source of heating (Reuther 2003; 2009). During the first (firing) phase, the tile stove was heated by the smoke from the burning chamber; during the second (convictional) phase, the room upon the hypocaust was heated through the outlets. Similar combinations of tile stove and air convection heating are known from the Castle of Marburg, Hesse, and from the Castle Neuenburg in Sachsen-Anhalt (Roth Heege et al. 2004; Schmitt 2007: 70; 2012: 106-108).

Bingenheimer (1998) has suggested that air convection heating was characteristic in the region

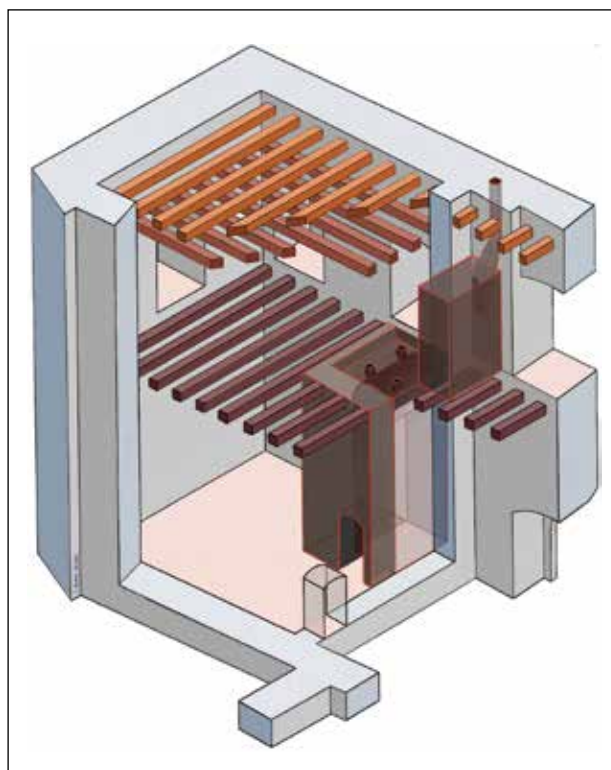


Figure 3. Hypocaust /tile stove hybrid on castle Rochlitz. After Reuter 2003: 117.

around the Baltic Sea, especially for dominions associated with the Teutonic Order. Indeed, nearly every Teutonic Order castle appears to have had such a heating system, but this may simply reflect the state of current research. The castles of the Teutonic Order have been in the focus of research for about 200 years (Biller 2001), and were used for early experimental archaeology. In 1822, Voß and Gersdorff commenced work on a remarkable experiment to heat the Winterremter, the winter refectory hall at the Teutonic Order's castle of Marienburg in Western Prussia. The Winterremter was built after 1310 and was equipped with a well-preserved subfloor air convection heating. Voß and Gersdorff fired this heating system and took measurements of the temperatures in the Winterremter. The air volume of this hall is about 9.100m<sup>3</sup>. In the beginning of this tremendous experiment, the outer temperature was about 2.5 centigrade, the inner about 6.3 centigrade. The air streaming out of the outlets into the hall reached about 200 centigrade and heated the room air within

20 minutes up to 22.5 centigrade. By the next morning, the room had cooled down to 13.8 centigrade, but it was possible to reheat the room again up to 19 centigrade – simply by opening the outlets for one hour and without additional fire. The air streaming out still maintained a temperature of 147 centigrade – and even six days later, 46 centigrade (Ring 2001: 32; Voß & Gersdorff 1830). This experiment is a clear proof that a convectional air heating system does not provide only ‘warm air’, but is to be regarded as a highly efficient type of heating.

The Spanish traveller Pero Tafur described the importance of this heating system in Breslau during his travel through Central Europe in 1438. Evidently, he was not familiar with this kind of heating, because the ancient hypocaust system fell out of use on the Iberian Peninsula in the Early Middle Ages: “The country is [...] cold. The chimneys and stoves do not give sufficient warmth; but there is another kind of stove for heating which they use. They make a fire beneath an upstairs room, and in the floor are covered holes, and they place seats above, also with holes in them. The people then sit down on those seats and unstop the holes and the heat rises between the legs to each one.” (Tafur 1926: chapt. XXVI).

All known examples of air convection heating belong to upper social contexts such as monasteries, castles or patrician urban houses as examples from Uelzen, Lübeck und Lüneburg attest (Mahler 2001; Meyer 1989; Ring 2001). Evidently, this efficient and widespread heating system was still in use until the 16th century, such as the well-known example in Lüneburg townhall. The heating in the monastery Lüne, which was built in 1497, was renewed in 1663 and only stopped being used at the 17th century. In the monastery at Ebstorf the late medieval construction was renewed in 1671 before being finally replaced by a tile stove heating in 1689 (Ring 2001: 29-31). It is unclear why this system fell out of use. It is possible that it was found impractical to run a heating system from a distant room in the cellar. Moreover, it was easy to heat the room directly above the burning chamber, but it was growing difficult to warm remote rooms using funnels as at the castle of Rochlitz. Indeed, no air convection system is known with the burning chamber situated in an

upper storey. This solution would have been not only structurally difficult, but – bearing in mind the danger of fire – it would have been possible only in stone buildings.

## The tile stove

The second way to heat a room smoke-free is provided by the tile stove. Its body is made of clay, which serves as storage for warmth, whereas the integrated ceramic tiles are able quickly to conduct the heat into the room. This combination allows a room not only to be heated relatively quickly, but also for a longer period. In contrast to the open hearth which provides considerable but concentrated source of heat in a small radius around the fire, a tile stove produces a constant radiant heat. Once fired it warms a room for about 24 hours. The ‘classical’ tile stove is mostly run as a breechloader. This keeps the stube free of smoke. Basically, a breechloader can be serviced from each adjacent room or passage, but the most efficient combination is with the hearth to the rear, which makes it possible to preserve the embers after preparing meals safely. This efficiency is the core of a new concept of living in the late medieval house: the dwelling is differentiated into two adjacent rooms: the stube and the kitchen. A chimney is not necessary, the smoke might either stream free through the house, frequently the staircase is built close to the kitchen for that reason – or it is directed through a smoke stack into the roof. On its way, the smoke can be used to fumigate meat, fish or other foodstuffs.

## The etymology of ‘stube’, ‘stue’ and ‘dornse’

In philological research, the German word ‘Stube’, Danish ‘stue’ or English ‘stove’ (medieval latin: ‘estuarium’) was traditionally seen as closely related to a construed, but not recorded latin verb ‘extufare’, ‘tufus’ (= damp) which is interpreted as a clue to its relationship to ‘bath’ or ‘bath room’. According to Joachim Hähnel’s etymological study (1975), the word ‘stube’ in the context of ‘living room’ has been documented since the 10th century, an even earlier



Figure 4. Reconstruction of a Slavic smoke oven, Wollin. Photo Katrin Atzbach

record is known from Chur in 765 AD. Its use in the context of ‘bath’ does not appear before the 13th century – and might derive from the use of similar kind of heating in living room and bathroom. Hence, Hähnel reconstructs an origin in the Upper German speaking area from the word stem ‘stubbe’ (German), similar to ‘stub’ (Danish), which signifies a stub (preserving in English the same root) of a tree or a container made of wood, also used as an expression for a fire-retaining vessel – which still survives in English as ‘stove’ or German ‘Stövchen’ (= burner or rechaud). The common origin is the wooden, encapsulated construction in the house, known from the earliest upright preserved stube constructions in the zone Northern to the Alps (see below). Derivations of the term ‘stube’ are used throughout Germany, Northern Europe and England (Hähnel 1975: 328-333, 412-417).

Apart from the ‘estuarium’, which appears as a latinized version of ‘stube’ in 1170 (Helmold von Bosau), in the Low German language area and Southern Denmark, a second root is also in use. Variations on the word ‘dornse’, ‘dorntze’ are documented since 1270 (Halle an der Saale). The variation ‘thürnitz’, ‘turniza’ or ‘Dürnitz’ is documented since the 11th century in Southeastern Germany. Both versions are derived from the same Slavic root of uncertain ori-

gin used in the Slavic languages alongside the loan word ‘izba’, which again derives directly from ‘stuba’. ‘Dornse’ primarily names heated living rooms in the area of the Hanseatic league between North Sea and Russia, whereas ‘Dürnitz’ is used as a synonym for ‘Hofstube’, ie a representative, heated hall on the ground floor in a castle (Hähnel 1975: 333-343).

## Archaeological evidence for the ‘stube’

In general, Europe is divided into a Western part with a mild climate consisting of Spain, England, France and Italy, which is dominated by fireplaces and hearths, and the Central and Eastern part from Switzerland to Russia, where several types of oven heating are in use (Figure 4). Eastern France, the BeNeLux-countries, Northern Germany and Scandinavia are a cross-over area, where the tile stove was adopted or transformed in the late medieval and post-medieval period (Stelze-Hüglin 1999: 12-44).

The use of oven heaters has a long tradition in Europe. In the Western Slavic area, stone and clay ovens have been known since the very beginning of the Slavic settlement in the late 6th-7th century, usually they were placed in a corner of the house

(Brather 2001: 99-101). Future research within the framework of the research project "Housing Culture" will explore the connection between these Slavic ovens and the Southern Scandinavian smoke ovens with clay cupolas. Both traditions used ovens serviced from inside the house. The earliest example of a Scandinavian smoke oven was documented at Hedeby, dendrochronologically dated in 870/882 AD, and Hedeby was situated in the transition zone between Danes, Slaves and Germans fostering the transmission of ideas and techniques between Central Europe and Scandinavia (Jankuhn 1986; Roesdahl 2009: 277-79). The Scandinavian smoke oven could also be run as a breechloader, as an example from Viborg proves which was fired from an adjacent room providing a smoke-free heated living room in the 12th century (Roesdahl 2004: 86-88). However, these ovens are constructed without tiles. The Slavic clay oven heating perhaps came in contact with Roman construction knowledge in the Alpine Zone. In late ancient Roman vaults in buildings, but also in kilns, ceramic vessels plugged into each other formed the wall. The earliest written source mentioning this kind of kiln made hundreds of 'caccabos' and placed 'in pisile' (MGH LL 1868: 179) derives from the Langobard kingdom in the 8th century. This pottery-based vaulting technique has been delivered in the circum-Alpine region until the Middle Ages, as an example of a pottery kiln in Winterthur, Switzerland, of the 14th century also demonstrates (Roth Kaufmann 1997: 473; Stelze-Hüglin 2004: 320), a similar constructed pottery kiln was recently excavated in Cottbus, dated into the 15th century (Wacker 2012: 325f). It is only a short step from these pottery vaulted kilns to a tile stove, thus the connection between both types is probable.

The earliest ceramic vessels which could be interpreted as beaker tiles – or as vaulting pottery – have been found in Alsace. They are dated into the early 8th century, while further findings from Northwest Switzerland and the Middle Neckar region belong into the 9th century (Roth Kaufmann 1997: 475; Stelze-Hüglin 2004: 325). Their cylindrical beaker shape typologically differs slightly from the well-known later examples of the 10th and 11th century, which were part of the oldest reliable tile stove

context from the castle Runder Berg close to Urach, Baden-Württemberg. On the castle of Frohburg, Kanton Solothurn in Switzerland, a tile stove with similar beaker tiles was excavated. It has been dated into the late 11th century (Kluge-Pinsker 1992: 215f). Both sites show the developed concept of two combined rooms, probably the one serving as a stube, the other as a kitchen. This is the earliest form of the medieval ground plan of houses in the Upper German speaking region. Apart from dislocated tiles, the first known urban tile stove in situ probably was a part of a similar ground plan in Winterthur, it was found in the remainder of a wooden building dendrochronologically dated from 1208 (Matter & Wild 1997: 79). Nevertheless, not every early tile stove was operated as a breechloader from the adjacent room: the earliest pictorial sources – in the Würzburg Psalter (1250/59) and on the wall painting in Rindermarkt 26, Zürich (dated to the early 14th century) – show openings on the front and thus some early tile stoves might have worked as a smoke oven at least until the early 14th century and possibly later (Stelze-Hüglin 2004: 322; Tauber 1980: 361).

In contrast to an air convection heating system that must be placed under the room to be heated, a tile stove widely is independent of subconstructions under the floor, apart from trimmed joists supporting the burden of the clay body and tiles. Thus, a tile stove can be lodged not only in the basement, but also in upper storeys. Apart from remains of the furnace itself, relics of the stube construction are the most important indicator for this heating system. Even in stone buildings, the earliest examples are erected as a wooden 'box' made of spruce wood, usually in a log construction between four corner posts. Since the 14th century, the outer face has been plastered with clay held by wooden pegs on the log surface (Bedal 2002). This box was mostly covered by a differentiated suspended beam and panelled ceiling, known as a 'Spunddecke' or 'Bohlen-Balkendecke' in German. This construction forms a closed space above – under the floor of the next storey. This void primarily has an insulating function, but also can be filled with straw or simply rubbish. Although the earliest-preserved constructions were found in Regensburg and are dated from the 13th century (see

below), the centre of this innovation is located in the Alps and in Suebia (Furrer 2002). It therefore seems likely that the construction of suspended ceilings or beam and panel floors with an additional board covering began in the 13th century in the Alps and spread, together with the innovation of the stube from there throughout Central Europe.

The oldest upright preserved examples of a stube have been detected in Untere Bachgasse 6 (dendrochronologically dated to 1264) and Wahlenstraße 8 (dendrochronologically dated to 1307), both located in Regensburg, Bavaria (Bedal 2002: 13; Kirchner 1988). Their ground plan corresponds to that of the oldest farmhouse in Southern Germany, the House from Höfstetten, built in 1368. Bedal coined the expression ‘neunfaches Grundrissraster’ (= ninefold ground plan), which is defined by three aisles and three bays. The stube usually is located in a corner of the first bay, sharing a wall with the kitchen, which either is placed in the adjacent aisle or in the central bay. This central bay works as traffic zone and gives access to all rooms. In multi-storey buildings, the staircase also is positioned here (Figure 5) (Bedal 1987: 44f).

## The spread of the stube and the ‘ninefold ground plan’

The stube as log construction is spread between Alsace, Switzerland, Tyrol, Bohemia, Bavaria, Suebia, Eastern Franconia, Thuringia, Sachsen-Anhalt and Saxony (Bedal 2002: 13-15). Since the 14th century, variations of the characteristic ninefold ground plan are common in Southern Germany, sometimes reducing the scheme to two aisles in three bays, *eg* in Geislingen an der Steige, Suebia (Cramer 1988: 356). In the Eastern part of Upper Bavaria, Keim has detected houses with a similar ground plan, but they were heated with a smoke oven until the 16th century (Keim 2002: 70f). Evidently, the concept of a smoke-free heated living room was invented before the 13th century and spread from the Alpine zone in all directions. In the Grand Est of France, the combination of kitchen and adjacent stube (French: ‘poêle’) was introduced starting in the Alsace before the 15th

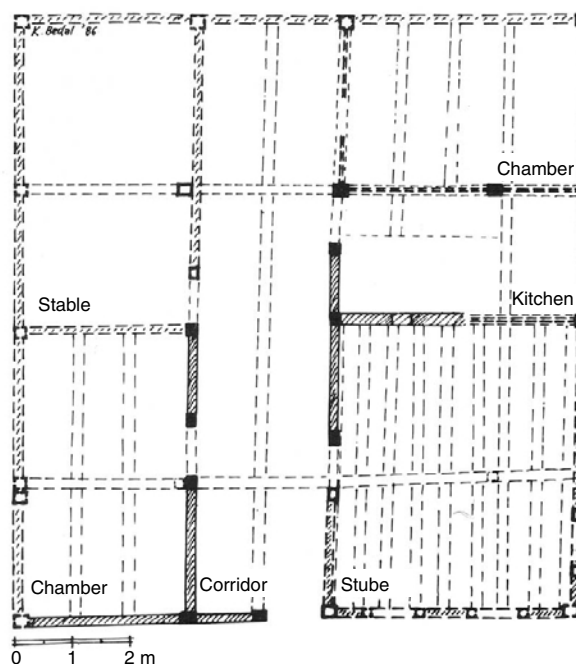


Figure 5. Ninefold ground plan. After Bedal 1987: 37.

century. It spread into Burgundy, Lorraine and Dauphiné by the 19th century. In contrast to the Alsace, the poêle does not work as an ordinary, everyday living room, but is used only during winter (Trochet 2006: 493-506).

The dissemination of the ninefold ground plan towards the North progressed slowly, although the tile stove heating itself had already reached the Baltic Sea in the 12th century (Hofmann & Schneider 2001). The Lower Mountain Range Zone did not take part in this ground plan development before the end of Middle Ages. In this area, medieval houses followed a different plan: the so-called Gothic hall house. In Limburg, Hesse, a group of late medieval citizens' houses have been preserved. The house Kolpingstraße 6/Bergstraße 7 was built in 1291. Originally, the ground floor and the first floor were timbered as a single storey structure, *ie* in high post construction (German: ‘Ständergeschossbau’). The first two zones toward the street were filled by a great hall, while the last zone contained two sub-storeys, the lower one probably containing the stube. The hearth was situated in the great hall, while the staircase was located in front of the third zone and also worked as a fun-

nel. The upper floor the house was subdivided into three bays, the central one probably with an opening into the roof (Altwasser et al. 1997: 61-115). This ground plan unites an older concept of living, the open hall with a hearth, and a differentiated concept consisting of three zones on the upper storey. We have no examples of older preserved standing urban or rural buildings in the Lower Mountain Range Zone, but excavations in Hesse have proven the existence of buildings that consisted only of one single room until the late 12th century, even in an upper social context, such as the manor house of Holzheim, close to Fritzlar, and the site of 'Krutzen' in Frankfurt am Main (Dohrn-Ihmig 1996: 66-76; Wand 2000: 90f). The subdivision of the upper floor into three zones is, however, known from imperial or baronial castles of the second half of the 12th century like the Pfalz Gelnhausen or the Wartburg castle (Großmann 2010). Further research is required to explore whether these upper class buildings either followed an older building tradition in the circum-Alpine region or represent the origin of this ground plan themselves.

What was probably an older concept of living in a big hall was common in the region between the Lower Mountain Range and Schleswig, known as the region of the 'Niederdeutsches Hallenhaus'. This derives from the longhouse of the 11th century that consisted of a hall with a central hearth and also accommodated livestock – usually in the lateral aisles (Reichmann 1991, Zimmermann 2002). Before the 15th century, a new development occurred. The ground plan was enlarged by an additional zone at the gabled end with the fireplace, the 'Kammerfach' (= chamber's partition). Frequently this zone is erected on a low cellar, and it is containing an 'upkammer', a stube with a tile stove adjacent to the kitchen zone and side chamber (Stiewe 2007: 73, 101).

In urban context, the Niederdeutsches Hallenhaus is built in a reduced version, the 'Dielenhaus'. Originally a big hall without compartments, in the 13th century, the Stube was constructed as a small, built-in room at the gabled end towards the street. This way of constructing compartments in the hall remained common until the end of the Middle Ages and thereafter. Like the 'Kammerfach' of the rural Hallenhaus, the stube could fill the whole width of

the house to the rear. These compartments may be heated by an air convection heating or a tile stove. In Lüneburg a house of the late 16th century was planned originally to be heated with a convection heating but was altered to accommodate a tile stove heating system during construction (Ring 2001: Abb. 2, Abb. 12).

Denmark was not reached until the 16th century by the differentiated ground plan concept consisting of a stube with a tile stove and adjacent kitchen and a central corridor as a traffic zone, which can be regarded as an adaptation of the ninefold ground plan (Danish: 'midtforstueplan') (Krongaard Kristensen 2004: 78f). The earliest tiles are known from finds of the 13th century at the monastery of Sorø (Kristiansen 2008: 245-247). The medieval ground plan of Danish houses can be characterized as a linear scheme: since the 10th-11th century a house consists of a row of rooms, each one as wide as the house. The central room, the 'stue', is heated by a hearth, but in the late medieval period smaller, unheated annexes were added. Since the second half of the 16th century this linear scheme was differentiated: a corridor (named with the German word 'Diele') gave access to the group of 'dørns' (Stube) and adjacent kitchen at the front, and the 'pisel', a high status room with a hearth at the rear, in the tradition of the older 'stue' (Krongaard Kristensen 2004: 77f, Svart Kristiansen 2008: 117). The Northern part of Jutland seems to be reached not before the last decades of the 16th century, as the rebuilding of Vestergågade 9 in Aalborg shows in 1580 (Engqvist 1976: 185).

## Archaeological witness for the process of innovation

The existence of a stube is unambiguously connected to stove tiles, *ie* a find of used tiles that show traces of smoke on the rear side clearly mark the former existence of a tile stove, whereas the find of unused tiles clearly mark the workshop of a stove maker and his kiln. Thus, it is possible to study the diffusion process of this innovation in the distribution of excavated tile deposits. Although the typological and chronological development of stove tiles has not yet



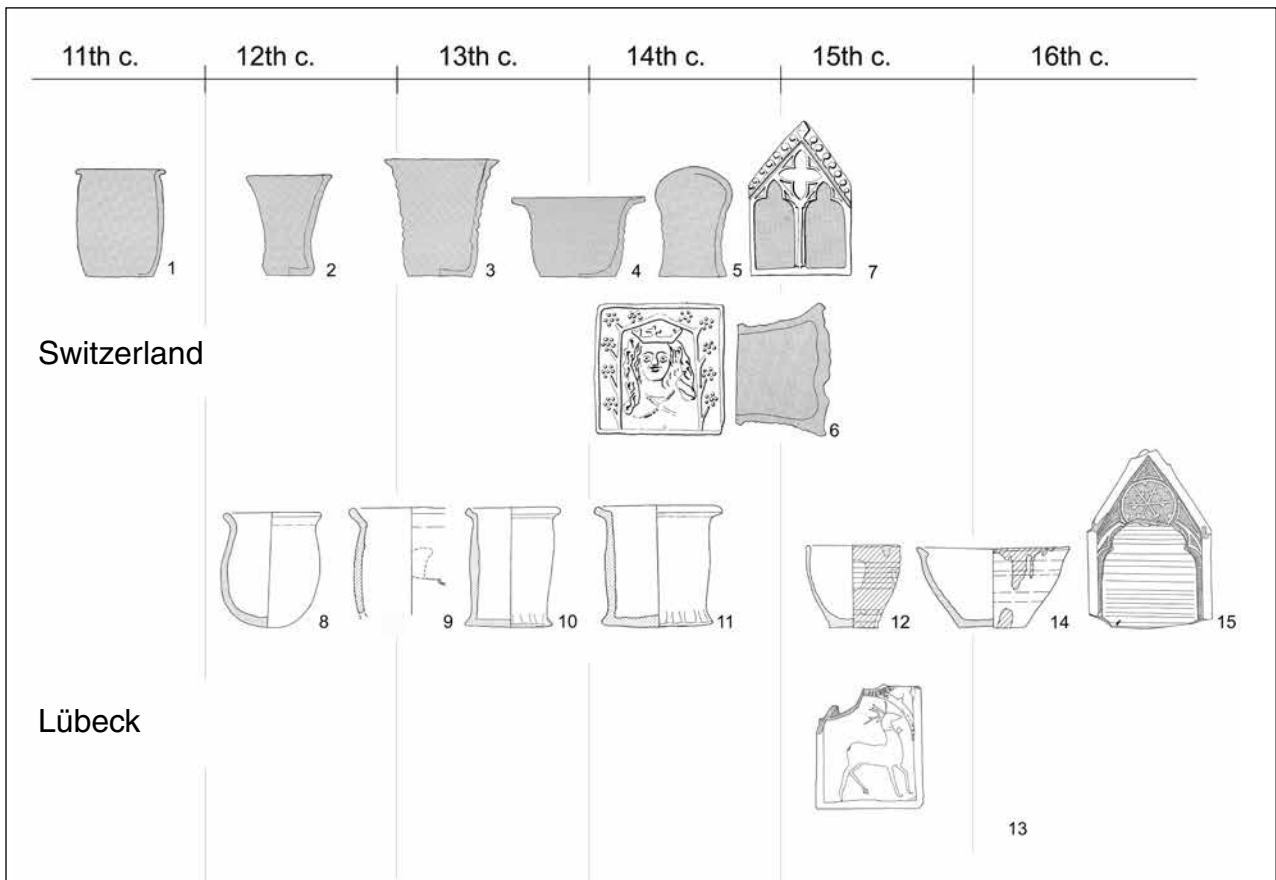


Figure 6. Typological development of tiles in Switzerland and Lübeck. Graph Katrin Atzbach, vignettes after Tauber 1980: 210 and Falk 2001: 67.

been established for all regions, several monographs describe its main features between Alps and North Sea. Franz (1969) and Liebgott (1972) have published systematic overviews from the art-historian point of view, Tauber's study (1980) put the focus on the Swiss tiles, Stelze-Hüglin (1999, summary 2004) published the material in the adjoining German region and Alsace, Harald Rosmanitz is working on his doctoral thesis about the southern Lower Mountain Range area. Hallenkamp-Lumpe (2006) and Henkel (1999) covered Westfalia and Hildesheim in Southern Lower Saxony. Hofmann and Schneider's congress transactions (2001) truss short studies on Lüneburg, Lübeck, Stralsund and the Baltic Sea area, Kristiansen's publications are an important contribution on the Danish material (2008 with further references).

The basic lines of development are very similar (Figure 6). In Switzerland, the typology starts with

beaker types of the late 11th century until the 13th century (Figure 6: 1-3), over dish-shaped vessel tiles of the 13th-14th century (Figure 6: 4). A very important, innovative step is visible in the appearance of the 'mushroom' tile in the 14th century (Figure 6: 5). It represents the fundamental turning inside-out of the vessel base towards the face of the tile stove. This change enables to apply moulds on the base and transforms a bare heating system into a decorative room feature. It is only a short step from moulded mushroom tiles to panel tiles (Figure 6: 6), which was achieved in the 14th century. The composite niche-tiles as last step and most complex product in this development appear by the 14th century (Figure 6: 7) in Switzerland (Tauber 1980: 341f).

In the Lower Mountain Range area, conical vessel tiles mark the beginning of the development in the late 12th century; the western region close to

the Rhineland seems to prefer niche tiles, whereas the eastern area uses dish-shaped vessel tiles in the 14th century before both regions adopted panel tiles (Hallenkamp-Lumpe 2006).

In Lübeck, a flourishing city with widespread trade contacts, tile stoves evidently came into use in the 12th century (Figure 6: 8). Here, the Swiss pattern of evolution is repeated in an abbreviated development which omits the 'mushroom tile' from beaker tiles (Figure 6: 8-11) over dish-shaped vessel tiles (Figure 6: 12, 14). The first panel tiles appear in the 15th century (Figure 6: 13). Finally, niche tiles (Figure 6: 15) are known in the 16th century (Falk 2001). Denmark followed a hundred years later, starting with Kugeltopf-shaped beaker tiles in the 13th century until the 14th century. Dish-shaped vessel tiles have been known since the 15th century, which is the moment when Danish developments appear to parallel those in Lübeck (Kristiansen 2008).

Consequently, the tile stove as a comfortable and economic heating system spread within a hundred years in the zone between Alps and Baltic Sea. Not surprisingly, this innovation was first apparently used by the upper classes in monasteries and on castles, trickling down by the late Middle Ages to urban and rural houses. The interesting aspect is, in how far the connected ninefold ground plan was also diffused. This house structure started in the 12th or 13th century in the Upper German speaking region and it reached the urban buildings in the Lower Mountain Range zone between the 13th and 16th century. The Northern Region soon was adopting the heating system, but it took until the end of the Middle Ages to start the adaptation of the ninefold ground plan ('midtforstueplan'). So, evidently, the system of heating is one, but not the only key to the explanation of a social system of a house.

## Conclusion

This paper has suggested that the layout of a house and its ground plan not only reflects practical needs, such as the creation of a heated comfort zone for daily work and life, close to the kitchen providing warm food. Symbolic and traditional values determine the sequence of rooms and access routes within

and between them. Hierarchical divisions could be created in traditional forms of common living rooms used for cooking, preparing meal and daily living. However, the position of the stove and its separation by a corridor that enabled access to the majority of rooms without crossing or entering the living room could facilitate the creation of more formalised degrees of privacy and expressions of hierarchy. The tile stove heating was more appropriate to such a subdivided use of a house than the older subfloor heating, which was quite efficient, but rather inflexible. The use of a more differentiated ground plan afforded inhabitants the opportunity of controlling who could, and who could not, enter this smoke-free heated, comfortable room. Future research will seek to examine how this new heating system was technically implemented and transformed, why it fell out of use in the early modern period, where and why the ninefold ground plan was overtaken. Last but not least, it will seek to explore who was responsible for this process of innovation and its wider meanings.

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