METU JFA 2016/2
(33:2) *183-200*

DOI: 10.4305/METU.JFA.2016.2.8

AN EVALUATION OF HEATING TECHNOLOGY IN ANATOLIAN SELJUK PERIOD HOSPITALS (DARÜŞŞİFA)(1)

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Received: 21.12.2014; **Final Text:** 09.04.2016

Keywords: Heating; historical hospitals; Anatolia; Seljuk period; architecture.

1. This article is based, in part, on the dissertation entitled "Anadolu Selçuklu ve Osmanlı Darüşşifalarında İşlevsel Sistemlerin ve Koruma Ölçütlerinin İrdelenmesi". There are other articles published by the same authors based on the above-mentioned dissertation study, and included in the bibliography of this article. However, those arcticles consist of overviews, and lack additional detailed research on the heating technology of ancient hospitals. This article is an original study without any repetition.

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INTRODUCTION

Humankind has long relied on heat for protection from the elements, for cooking, and for ritualistic purposes, and a variety of methods and techniques have been used to achieve these goals, evidence of which can be found even dating from ancient times. In her study on hearths, braziers, and chimneys in Ancient Greek houses, Tsakirgis (2007, 225-31) describes "heat and food" as "two requirements of life". Her examination of different heating sources and their varying use for heating, cooking, and domestic cults in those buildings, provide useful insights for our study of Anatolian hospitals, even though these hospitals were constructed hundreds of years later. Tsakirgis notes that fixed-hearths were usually placed in the center of early one- or two-room Greek palaces and houses, dominating the whole space, and providing warmth and light in every direction (Tsakirgis 2007, 225-6). On the other hand, fixed-hearths were less common in Classical and Hellenistic houses due to the complexity of plan layouts and larger number of rooms, and were usually located against a wall or at the corner of two walls (Tsakirgis 2007, 226, 28). From the late archaic period on, fixed-hearths were replaced by portable braziers with burning charcoal in many Greek houses, as evidenced by the scarcity of built-chimneys and chimney-pots. These portable braziers also served as the symbolic hearth fire used in birth, marriage, and funeral rituals (Tsakirgis, 2007, 228, 230-1). Nauman (1985, 189-98) also gives detailed accounts of hearths and cooking stoves encountered during the excavations of ancient sites, including those in Anatolia. For instance, in Çatal Höyük the hearths of older layers were circular in shape and found in four adjacent groups enclosed with raised stones in order to hold the ashes (Nauman, 1985, 191). Portable examples at Pulur, Kültepe and Tarsus seem to have been used as cooking stoves as evidenced by traces of cookware holes. In addition, in the Hittite settlement at Boğazköy there are traces pointing to semi-circular or rectangular limestone hearths located against the walls of the houses (Nauman, 1985, 193). Nauman concurs with the idea that smoke might have been exhausted

from the doors or windows of the rooms since chimney holes were not found beneath the ceilings (Nauman, 1985, 198). There are many other studies on heating and cooking practices in the ancient world (Wilkinson, 1944; Yegül, 1992, 358-90; Koçyiğit, 2006; Leonard, 1973; Ball and Taschek, 2007; Sparkers, 1962; Zhuang et al., 2009; Bong and Jeong, 2003), yet only the exemplary ones are cited here.

In early human history, fire was the primary means of heating, cooking, and protection from predatory animals. Yet the smoke produced by the fire of the hearths and/or the charcoal braziers located in the middle of the indoor spaces necessitated ventilation. Hence, in order to prevent the oxygen depletion and exhaust smoke, holes – primitive chimneys – were created at the top of indoor spaces (Fitchen, 1981). Tents of nomad tribes, called *otak/yurtluk*, were good examples of structures using this kind of primitive heating and ventilation (Oğuz, 2001, 449-60; Küçükerman, 1995, 45, 50, 163-70). An increasing need for indoor ventilation quality required new developments in heating of those spaces and, in turn, improved heating resulted in the need for further advances in ventilation. Both have been important factors in human survival. Moreover, heating and ventilation was needed to prevent humidity and to ensure the longevity of the building proper (Fitchen, 1981).

In addition to the above-mentioned methods, people managed to heat themselves by wearing thick, woollen clothes such as fur and felt. In the past, in contrast to the present day idea of heating, the aim was to heat the body rather than the space. To achieve this, thick fabrics were used for clothing, mats, and furnishings, and woollen blanket and comforters were preferred. To supplement warmth, people went to bed early, especially on cold winter nights, and ate high calorie foods. Animals were also used for heating purposes; to benefit from the heat emitted by animals, people either slept in the same space with them or housed them in barns that were constructed adjacent to living areas (Tuncer, 1981, 2011; Oğuz, 2001, 449-60).

The purpose of this article is to evaluate various means of heating utilized in history, and study Anatolian Seljuk period hospitals in particular, in order to enhance our understanding of the variety of heating solutions and their gradual development over time. In the following section, research on heating practices in Anatolian Seljuk period hospitals is summarized.

HEATING IN ANATOLIAN SELJUK PERIOD HOSPITALS

Seljuks placed a high level of importance on public works in Anatolia and constructed many hospitals in different parts of the region. According to sources, there were twenty-five hospitals built during the Anatolian Seljuk period **(2)** (Acıduman, 2010; Köker, 1992b, 1-12; Tuncer, 2008, 143, 155-7, 160, 163; Dişli, 2014a, 11-2). Only four of these hospitals remain today, and are the subject of this research. They are located in Amasya (Anber Bin Abdullah Hospital/Bimarhane, built in 1222-1232), Sivas (Divriği, Turan Melek, built in 1228 and Izzeddin Keykavus I. /Şifahiye Hospitals, built in 1217), and Kayseri (Gevher Nesibe Hospital/ Çifte Medrese, built in 1205-1206) (Dişli, 2015, 254).

From the 1960s to early 1990s, the general scholarly view on the heating of spaces in Anatolian Seljuk hospitals was that they the hospitals used central heating system of a nearby or adjacent bath. Yet scholars refrained from providing detailed, concrete evidence and explanations for the

2. The twenty-five Anatolian Seljuk period hospitals have been divided into three groups. 1st group: their existence is known exactly and they are partially or totally present today - Gevher Nesibe Hospital/ Çifte Medrese, Kayseri (built in 1205-1206), İzzeddin Keykavus I Hospital/ Şifahiye, Sivas (built in1217), Divriği, Turan Melek Hospital, Sivas (built in 1228), Anber bin Abdullah Hospital/ Bimarhane, Amasya (built in 1222-1232), Cemaleddin Ferruh/ Atabey Ferruh Hospital, Çankırı (built in1235), Ali Bin Süleyman/ Ali Bin Pervane Maristanı, Kastamonu (built in1272), and Muinüddin Süleyman/Pervane Bey Hospital, Tokat (13th c.); 2nd group: their existence is known exactly from archival sources but they are not present today - Emüneddin / Necmeddin Gazi Hospital, Mardin (built in 1108-1122), Konya Maristan-ı Atik, Konya (built in 1254), Alâeddin Hospital, Konya, (built in 1219-1237/38), Aksaray Hospital, Aksaray (13th c.), Kadı İzzeddin Hospital, Konya (built in 1254); 3rd group: mentioned in the literature but their existence has not been proven yet - Silvan Hospital, Diyarbakır (built in 1176-1184), Old Malatya Hospital, Malatya (built in the mid. 13th century), Akşehir Hospital, Konya (built in the late 12th to mid 13th centuries), Erzincan Hospital, Erzincan (?), Erzurum Hospital, Erzurum (?), Elbistan Hospital, Kahramanmaraş (?), Antakya Hospital, Antakya (?), Atabey Hospital, Kastamonu (built 1270-1275), Kütahya Hospital, Kütahya (13th c.), Harran Hospital, Şanlıurfa (?), Şehzadeler Hospital, Sivas (?), Harput Hospital, Elazığ (?), and Kars Hospitals, Kars (built in the 12th century). (Dişli, 2014a, 11-12)

technical and physical possibilities of this method (Akçay, 1967; Köker, 1992a, 28-29; Köker, 1992c, 40; Terzioğlu, 1970; Ünver, 1980, 14). Some scholars argued that the smoke circulating in the hypocaust section of a nearby or adjacent bath was distributed to the hospital rooms by means of terracotta pipes installed beneath the ground, and others proposed that the hot water coming from the water storage depot of the bath was circulated inside the pipes buried in the walls of the hospital rooms. For example, Köker (1992a) argued that the terracotta pipes found under the main entrance of Kayseri, Gevher Nesibe Hospital/Çifte Medrese during the 1955-56 restorations were part of a central heating system provided by a nearby bath. Similarly, Ünver (1980, 14) claimed that the heating of the hospital was made possible with the help of the adjacent bath discovered on the left side of the entrance during excavations in 1965. Ünver further speculated that the same arguments were valid both for the hospitals in Sivas and Amasya – claiming that Sivas, hospital of Izeddin Keykavus I/ Şifahiye might have been heated by means of the bath discovered during 1961-1963 excavations between Sivas, Buruciye Medrese, and Kale Mosque, and Amasya, Anber Bin Abdullah Hospital/Bimarhane was similarly heated with a nearby bath. However, Kale bath – situated on the plain area between Buruciye Medrese and Kale Mosque and on the northern side of Izzeddin Keykavus I Hospital/Şifahiye – was built in 1580, approximately three hundred and sixty years after the hospital was built (Denizli, 1995, 147-8). The bath is approximately sixteen meters away from and nearly half a meter below the exterior north wall of the hospital **(Figure 1, Figure 2)**. During 2011 restorations, no traces of heating pipes or canals were discovered lying through the bath towards the hospital. Instead, what was found were terracotta pipes unearthed around the passage between the hospital and Çifte Minareli Medrese, mostly uncovered on the foundation level and near to the edge of eastern exterior wall of the building **(Figure 3, Figure 4)**. Additionally, a stone water distribution box and terracotta pipes of varying sizes were discovered inside and at the entrance passage of the hospital (Disli and Ozcan, 2014, 171). Similarly, Mustafa Bey/Mehmet Paşa Bath – located on a plain area approximately twenty meters away on the north side of Amasya, Anber Bin Abdullah Hospital/Bimarhane – was built in 1436-37, two hundred years after the hospital itself (Urak, 1994, 414, 479) **(Figure 5, Figure 6)**.

In the same way, Ünver (1980, 35-6) suggested that Divrigi, Turan Melek Hospital was probably heated by a nearby bath that may be found on

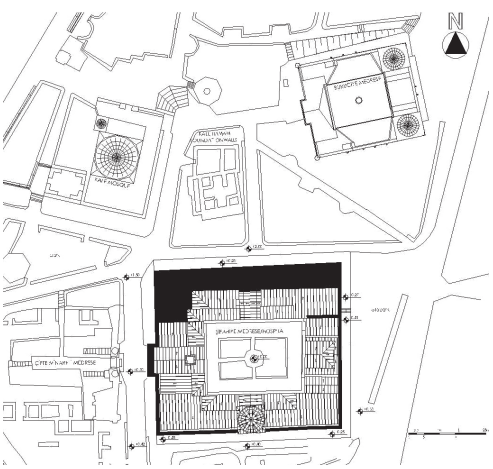


Figure 1. A view from Sivas, Izzeddin Keykavus I Hospital /Şifahiye and foundation wall traces of Kale Hamam on the north side (Photo by the authors, 2011).

Figure 2. Site plan of Sivas, Izzeddin Keykavus I Hospital /Şifahiye, including the bath, Kale Mosque and Buruciye Medrese (Archives of Directorate General of Foundations, 2011).

Figure 3. Terracotta pipes unearthed at the passage between Sivas, Izzeddin Keykavus I Hospital /Şifahiye and Çifte Minareli Medrese, found in situ at the foundation wall level of the medrese during 2011 restorations (Photos by the authors, 2011).

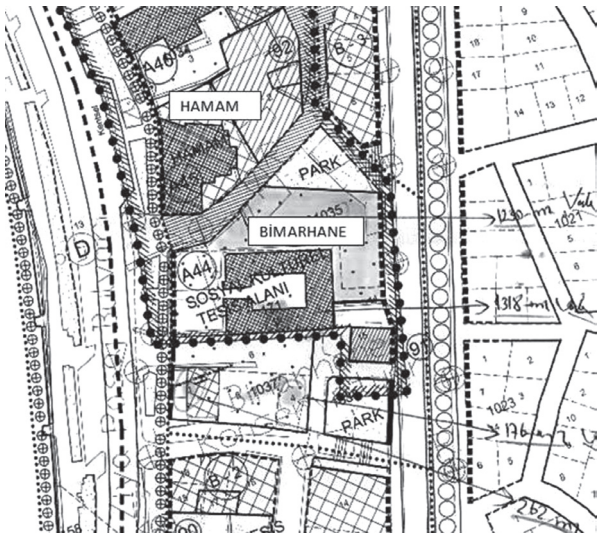
Figure 4. Terracotta pipes unearthed on the passage between Sivas, Izzeddin Keykavus I Hospital /Şifahiye and Çifte Minareli Medrese, found in situ at the foundation wall level of the medrese and stored inside the entrance *iwan* of the hospital during 2011 restorations (Photo by the authors, 2011).

the eastern side of the building upon excavations. In 2010 excavations were conducted on the eastern side of the Divriği mosque complex, yet no trace of a bath were recovered (Altın, 2011); instead a bath called Bekir Çavuş/ Yukarı Hamam/ Bala Hamamı was discovered on the west side of it in the 2003 excavations. The 2010 excavations revealed that the traces of the building unearthed on the east side most likely belonged to a public kitchen, as suggested by traces of six *tandırs* and four hearths were detected. (Altın, 2011) (**Figure 7**). Özbek (2004, 194) dates Bekir Çavuş Bath to 1332-33, suggesting that it was built nearly a hundred years after the Divriği mosque complex. The bath is at least fifteen meters below and sixty meters away from the platform on which the attached buildings are built (**Figure 8, Figure 9**). Unless a syphon system had been constructed, it would not have been possible to direct hot water or vapour to a higher level, and the most of the heat would have been lost through this long passage.

Hence, the unmatched building dates of the aforementioned hospitals and nearby baths, the lack of material evidence such as fixed-heating pipes and canals between the buildings and the inside the walls of the hospitals, and considerable distance between the hospital and bath buildings, refute the long-standing theory that Seljuk period hospitals were heated by nearby baths. Önge (1995, 41-76, 93-4) and Tuncer (1979, 1981) also disprove the theory that Anatolian Seljuk period hospitals were heated by means of smoke, vapour, or hot water from nearby baths circulated by terracotta pipes either underneath the ground or inside the walls of the hospitals.

Figure 5. View from Amasya,Anber Bin Abdullah Hospital/Bimarhane with Mustafa Bey/Mehmet Paşa Bath on the north side (Photo by the authors, 2011).

Figure 6. Site plan of Amasya,Anber Bin Abdullah Hospital/Bimarhane with the approximate location of Mustafa Bey/ Mehmet Paşa Bath (Archives of Directorate General of Foundations, 2015).



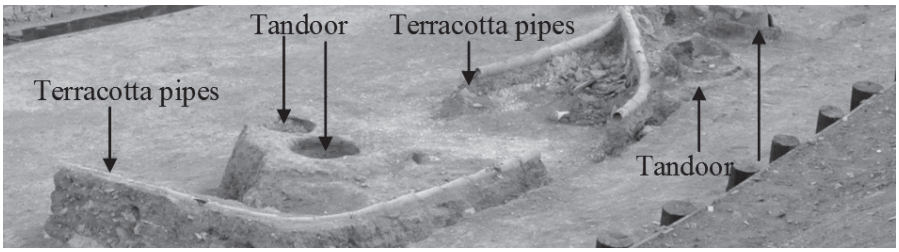


Figure 7. A view from *tandırs* and terracotta pipes unearthed during the excavations on the east side of Divriği Great Mosque and Darușşifa (Archives of Sivas Museum, 2011).

Figure 8. A view from Sivas, Divriği Great Mosque and Darüşşifa with remains of the Bekir Çavuş Hamam on the west side (Photo by the authors, 2011).

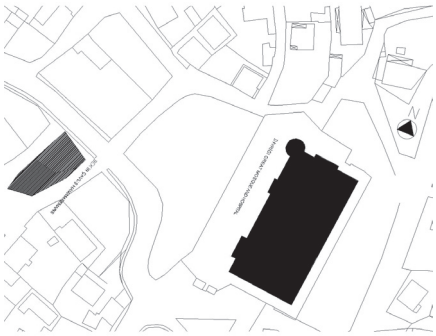


Figure 9. Site plan of Divriği Great Mosque and Darüşşifa, including the Bekir Çavuş Hamam (Archives of Directorate General of Foundations, 2015).

3. A tüteklik is a vertical terracotta pipe located inside the walls of a Turkish bath.

First, they argue that in none of the hospitals were terracotta pipes used for heating purposes visible; the ones observed were for water systems, not heating. Second, they argue that it would have been technically and physically impossible to generate enough natural pressure to pump air, hot water, vapour, or smoke from a nearby bath. Even if we assume that of such a system was created, *tütekliks* lying inside the walls would have been needed to emit smoke through the roof **(3)**. Our field surveys and archival research conducted during 2010-2014 also confirm the arguments of these scholars; traces of a central heating were not encountered in any of the Anatolian Seljuk hospitals studied, except for in the baths themselves. The bath sections of Seljuk hospitals were heated with underfloor hypocaust heating systems, composed of a furnace, flue passages created with pillars under a stone slab, and flue emitting chimneys inside the walls lying up to the ceilings. For instance, Köker (1992a, 26-7) noted that, during the 1980s, a stone pillar that belongs to the hypocaust section was found on the northwest corner of the bath beneath the stone slab in Kayseri, Gevher Nesibe Hospital/Çifte Medrese. This hypocaust underfloor central heating system was also quite common in ancient Roman baths (Yegül, 1992, 358-90). Although Romans were given credit as the inventors of hypocaust heating, archaeological research has shown that these systems were developed in Asia as early as in the eleventh century BCE (Bean et al., 2010, 40-1) These similar underfloor space heating systems were called *kang*/*dikang* (heated floor), and later *ondol*/*gudul* (warm stone) in China and Korea. In archaeologic sites in Shenyang and Xi'an in China, excavations have found remains of "raised surfaces treated by fire" that were dated to 5300-4300 BCE (Bean et al., 2010, 42). A typical *kang* – consisting of a stove, *kang* body, and a chimney – was used simultaneously for various functions, such as for heating, for cooking, as a bed, and for ventilation (Zhuang et al., 2009, 111). *Tawa-khana* in Afghanistan, and *steinluftheizung*/*steinofen* in Germany are other similar underfloor space heating arrangements. In *tawa-khane*, the underfloor heating system found in traditional Afghan houses, heat flows from the clay *tandır* oven in the kitchen, which is connected

4. A külhan is a boiler and fuel storage room in a Turkish bath.

to continuous flue channels constructed beneath the rooms, and escapes through the chimneys within the opposite walls (Kazimee, 2006, 56-7; Szabo and Barfield, 1991, 258). In the German *steinluftheizung/steinofen* heating system:

> "…first seen in the twelfth century, layers of stones were heated by burning wood in an enclosure, and the after the fire died out, the heat accumulated in the stones was transferred to the air slowly moving up to the chimney and entering into the house through floor vents kept close during the burning process" (Koronakis, 2009).

In Anatolia, it was not until the eighteenth century that adjacent baths were used for the heating of nearby rooms, but not to heat the entire building complex. The Ishak Paşa Palace (built in 1784) in Doğu Beyazıt, was constructed hundreds of years after the Seljuk era hospitals. In Ishak Paşa Palace, with the help of the copper boiler located in the furnace of the *külhan*/, the bath itself was heated with hot smoke circulated in the hypocaust section located beneath the caldarium section of the bath **(4)**. The *külhan* of the bath is situated between the big salon and kitchen of the complex, with a hot water tank above it. The adjacent kitchen, salon, and some of the nearby harem rooms were heated with terracotta pipes that circulated hot water/vapour within the walls of those rooms were connected to the *külhan*/furnace (Gündoğdu, 1991, 56-57; Bingöl, 2009, 173-5, 181-2) (**Figure 10**). In addition, by means of a separate service area situated on the north side of the second courtyard portal, the central floor heating system circulated hot air thorough earthenware ducts (Goodwin, 1971, 405-6; Bingöl, 2009, 18, 92, 181-2) (**Figure 11, Figure 12**). These 0.60 x 0.80 meter tunnels lie beneath the floors of the council chamber, mosque, medrese rooms, and the big salon. All of these spaces were heated from the floor by hot air carried through terracotta pipes within the ducts. The ducts could also serve as passages in case repairs were needed (Goodwin, 1971, 405; Bingöl, 2009, 182). The rest of the rooms were heated with fireplaces located on one wall of the room (**Figure 13**). Similarly, in Konya Karatay Medrese (built in 1251) underfloor terracotta pipes ducted with a carved canal were found at the main *iwan* during the 2006 excavations. (Erdemir, 2009, 171-2, 173, 175). However, these pipes were built to supply water to the pool rather than for heating purposes. That this canal is directed toward the pool of the courtyard is evidence of its usage for water supply; it was located beneath the wooden beams under the original brick floor covering of the *iwan*. The only find in Karatay Medrese pertaining to heating was traces of an ancient circular hearth approximately 1.60 meter below the original bricklayer of the *iwan* (Erdemir, 2009, 175) **(Figure , 14).**

None of the Anatolian Seljuk hospitals studied here have wall fireplaces or other traces of heating technology, implying that portable heating devices such as braziers or *tandırs* were used for heating and/or cooking purposes. Only in Sivas, İzzettin Keykavus I Hospital/ Şifahiye were niches on wall surfaces of the rooms thought to be traces of fireplaces (Bilget, 1990, 7). Yet this finding is uncertain because no traces of built chimneys or chimney pots to exhaust smoke have been found (Hersek, 1993, 219, 241-2, 250). No traces of chimneys were encountered on the roof during previous interventions (in the 1930s, 1960s, or 1970s) or during the last restoration work completed in 2011. A semi-circular niche with a possible chimney extension was observed on one of the wall surfaces of the northwest corner of the building, yet there is no evidence that it was part of an original wall fireplace built at the same time as the building itself (**Figure 15**). Evidence of built chimneys or chimney pots has not been found either in situ, in

Figure 10. Caldarium of the bath section showing hypocaust channels in Doğu Bayezid,Ishak Pasa Palace Photo by the authors, 2012).

Figure 11. Terracotta pipeline underneath the floors of Doğu Bayezid,Ishak Pasa Palace (Photo by the authors, 2012).

Figure 12. Control tunnel of the central heating system in the service room in Doğu Bayezid,Ishak Pasa Palace (Photo by the authors, 2012).

Figure 13. A view from the fireplace of Doğu Bayezid,Ishak Pasa Palace (Photo by the authors, 2012).

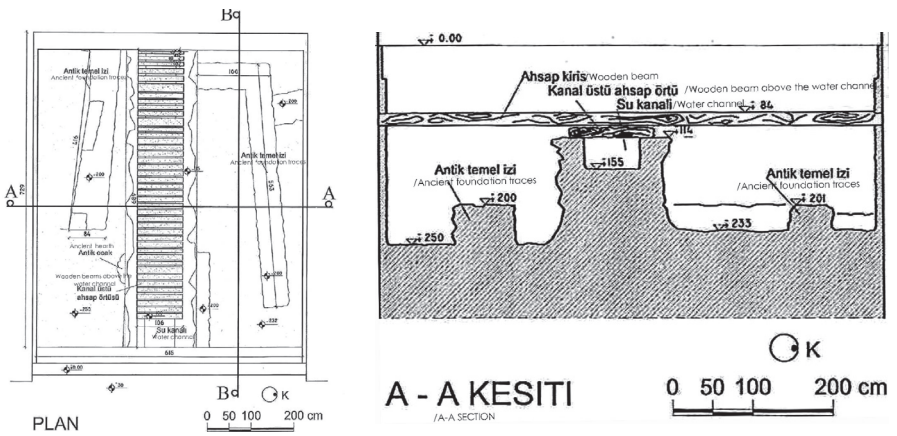


Figure 14. Plan left and section right drawings of the main *iwan* of Konya,Karatay Medrese, showing the underfloor terracotta pipes ducted with a carved canal and an ancient hearth, unearthed during excavations in 2006 (Drawings by Halil İbrahim Kunt, 2009, reproduced from Erdemir, 2009, 175).

historic records, or during surveys in Anatolian Seljuk hospitals in Kayseri and Amasya. Ventilation holes are observable in the vaulted ceilings of the rooms, however, this may be due to the prevalence of the portable braziers or buried *tandırs* used for heating (**Figure 16**). Tuncer (1981) claims that

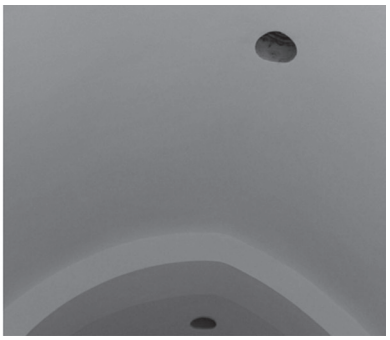


Figure 15. Fireplace on the northwest wall of Sivas İzzeddin Keykavus I Hospital/Şifahiye (Photo by the authors, 2011).

Figure 16. Holes on the vaulted ceiling of Kayseri Gevher Nesibe Hospital/Çifte Medrese (left) and Amasya Anber Bin Abdullah Hospital/Bimarhane (right) (Photos by the authors, 2011).

braziers were used to heat the cells in Sivas, Izzeddin Keykavus I Hospital/Şifahiye. Similarly, *tandırs* were used both to heat enclosed spaces and as cooking devices. The use of a *tandır* as a heating device was especially common in the Eastern Region of Anatolia (Karpuz, 1989, 23). When used for heating, a brazier was placed under a table with a cover over it. In this system, people sat around that table with their legs underneath it, and slept on beds laid around the *tandır* (Oğuz, 2001, 449-60; Yavuz, 1997). Another heating system that bears a striking resemblance to the *tandır* system was *kürsübaşı*, which was relatively abundant in Divriği houses up to the second quarter of the twentieth century (Kültür, 2011, 39-47). Kursubasi consisted of a square elevated gathering platform with a circular stone sunken hearth at its centre under a wooden table covered with quilts. Traditional charcoal-based heating arrangements that are similar to the *tandır* system heating in Anatolia include the Japanese *kotatsu*, the *korsi* in Iran, the *sandali* in Afghanistan, and the *mesa camilla* in Spain (Sdei, 2005; 942; Tehrani and Duffy, 2015, 357-8; Szabo and Barfield, 1991, 258; Brenan, 1957, 85). The *kotatsu* system is composed of two parts: an earthenware container for charcoal and ashes, and a wooden grill placed between the mattress and the quilt at the foot of the bed (Sdei, 2005, 942)

A typical *tandır* oven used for cooking is a hollow clay structure approximately one meter in height with a stoking hole at its base (Parker and Uzel, 2007, 7; Yılmaz, 2012, 33-5). *Tandır* ovens and open-pit fireplaces and ovens were either the centrepiece of outdoor work areas or located in interiors. *Tandır* was a common bread making method in ancient Anatolia in the Seljuk and Ottoman periods and is still in use in southeastern Turkey (Parker and Uzel, 2007, 7-8; Painter-Foster, 2009, 160, 176; Yılmaz, 2012). For instance, *tandır* ovens found in Harşena Castle, Amasya have been dated to the Ottoman period (Doğanbaş, 2007, 12, 20), while those unearthed in Kenan Tepe, Diyarbakır were dated to the Late Chalcolithic period, the first half of the Early Bronze Age, and the Early Iron Age (Parker and Uzel, 2007, 18).

Having examined this distinct building type – the hospital – we must turn our attention to similar buildings such as medrese/madrasahs, caravansaries, and khans built in the Anatolian Seljuk period, in order to clarify the heating technology of the time **(5)**. According to Tükel-Yavuz (1997), who quotes Haluk Karamağaralı and Hüseyin Ünal, *tandırs* were found on the floors of student cells in the Çifte Minareli Medrese and along the platform in Susuz Han in Sivas. She also indicates that a *tandır* was detected on the platform in Kızılören Second Han (Tükel-Yavuz, 1997). Similarly, Karpuz (1994) states that a *tandır* with a diameter of 45 cm was discovered buried in the ground of one of the cells in Dokuzun Derbent Han during excavations in the 1990s, suggesting that it was used

5. A medical madrasah, or medrese, in Turkish "is the school in which courses related to medicine are taught generally consisting of a central courtyard with classrooms and student cells around it and built attached to or near a hospital" (Disli, 2014b, 50).

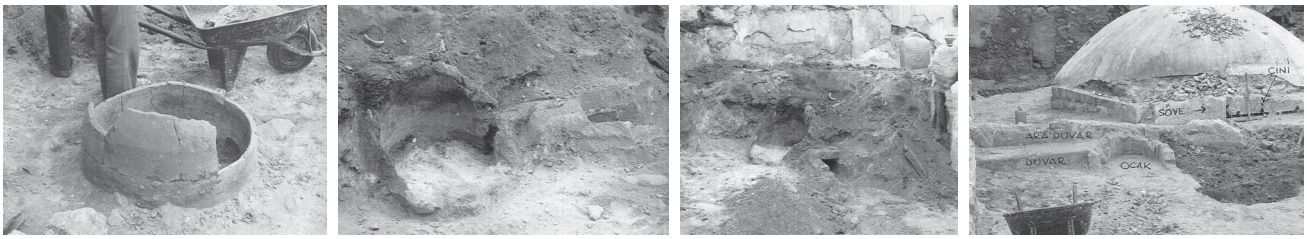


Figure 17. Unoriginal earthenware *tandır* ovens (left-two) a hearth (middle), and another original hearth-like fireplace (right) uncovered above the entrance *iwan* of Sivas, Gök Medrese during 1978 excavations (Tuncer, 2008, 155-7).

for heating purposes, rather than for cooking. Also, in Sivas, Gök Medrese, two hearth-like fireplaces and two *tandır* ovens were discovered above the entrance *iwan* during the 1978 excavations, however, the *tandırs* were not a part of the original building (Tuncer, 2008, 143; Tuncer, 2004, 127) **(Figure 17)**. In Yerhan, on the other hand, two original fireplaces were found in the middle of the east and west walls (Ünal, 1979). Tükel-Yavuz (1991) interprets these hearth-like fireplaces as early examples of wall fireplaces observed from Ottoman period Anatolia. In light of all those findings, Tükel-Yavuz (2000) argues that *tandırs* were the heating and cooking technology used in Seljuk period caravansaries, and also in other building types of the period, including hospitals.

In other examples of Ottoman period buildings, the heating technology is less complicated and easier to ascertain than in Seljuk period buildings. During this period, wall fireplaces were used for heating, ventilation, and cooking, and built chimneys lying up to the roofs are clearly observable (Özcan and Dişli, 2014,1016; Disli, 2014b, 47) (**Figure 18**). Considering that the wide chimney openings on roofs would have let cold air inside during the winter, Tükel-Yavuz (2000) argues that the primary purpose of the fireplaces was ventilation rather than heating. Wall fireplaces with ornate caps were placed in patients' rooms as decorative elements; and were smaller than the fireplaces in kitchens, pharmacies, and baking rooms that were used for cooking and the preparation of medicine, not heating. In some cases, more than one fireplace was located inside a room, such as in the kitchen space of Süleymaniye Hospital and in the pharmacy of Bursa Yıldırım Bayezid Hospital (in this case, one fireplace was used for the preparation of medicine and the other for heating). Furthermore, in Süleymaniye Hospital's ward for mentally ill patients, located beneath the courtyard, there are no fireplaces, but several ventilation and illumination holes on the upper parts of the long sidewalls, unlike other rooms located on either side of the two courtyards (Disli, 2014b, 47). This might be due

Figure 18. Fireplaces in Haseki (left), Bayezid II (middle-two), and Süleymaniye (right) Hospitals (Photos by the authors, 2011).

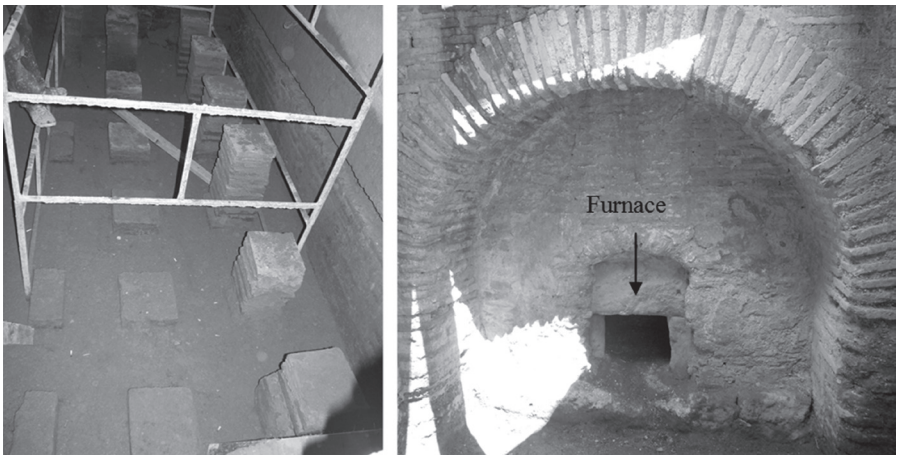


Figure 19. Hypocaust section of the caldarium part (left) and furnace of the bath (right) in Süleymaniye Hospital (Photos by the authors, 2011).

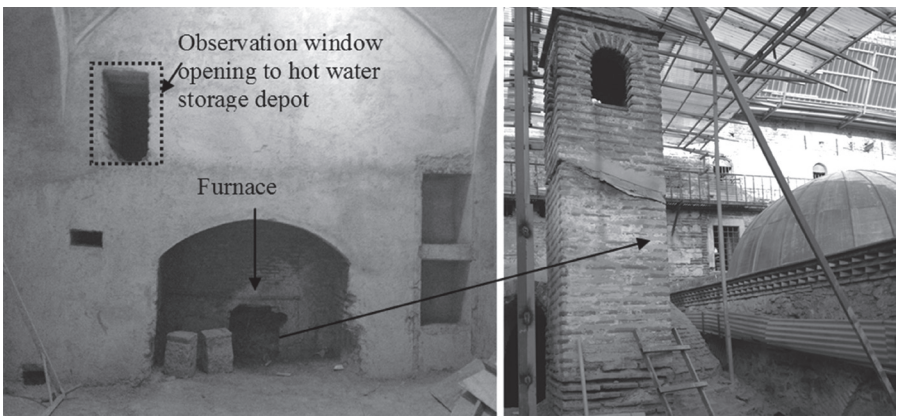


Figure 20. *Külhan* section of the bath (left) and the chimney of the furnace (right) in Atik Valide Hospital (Photos by the authors, 2014).

to the layout of the building complex and/or the technical difficulty of installing wall fireplaces and built chimneys in the space beneath the courtyard. Hence, we assume that braziers were used to heat that space.

The typical layout of Ottoman period hospitals is similar to that of Anatolian Seljuk hospitals, featuring a central courtyard – often with a pool in the middle – with semi-open spaces in places instead of *iwans* (Dişli, 2015, 275-276) **(6)**. In addition to fireplaces, *tandırs* and braziers were used to supplement heating. Central heating systems with hypocaust were only used in the baths of the hospitals, because were baths located in separate sections. Atik Valide, Süleymaniye, and Haseki Hospitals' hypocaust sections are some examples of this type of central heating system. In the first two, hot water storage rooms, *külhan*, and terracotta tüteklik pipes were observed during the in situ survey as the evidence of this central heating system (**Figure 19 and Figure 20**).

Vapour vents – developed to facilitate heating and to exhaust the resulting vapour in the bath section of the hospitals – are an important detail of ventilation technology. In Atik Valide Hospital, vapour vents were clearly observable during the 2014 restorations (still in progress). They are located inside the *pendentives* (dome transition elements) in the bath and their extensions above the roof. (**Figure 21**). These vents are concentrated in the caldarium section of the baths so as to exhausting the excess vapour inside. Another detail observed in the same hospital was adjacent terracotta pipes, mostly broken and lying horizontally in four-rows between the two domes on the roof of the *külhan* section. (**Figure 22**). During a conversation

6. An iwan is a vaulted room with one side opened to a courtyard.

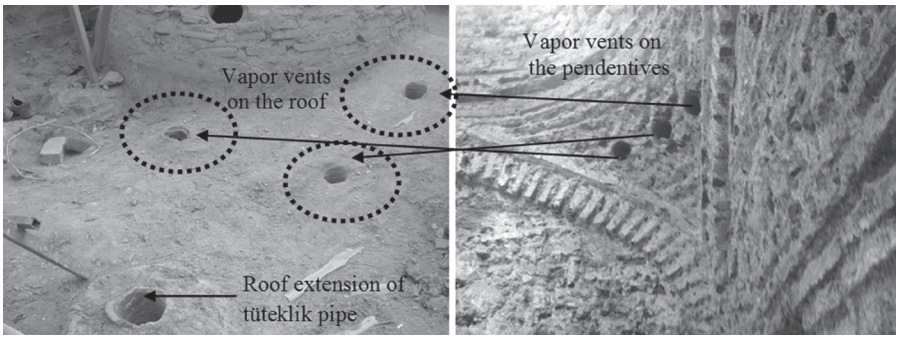


Figure 21. Views from the vapour holes and *tüteklik* pipe at the roof (left) and on one of the *pendentives* of the bath (right) in Atik Valide Hospital (Photos by the authors, 2014).

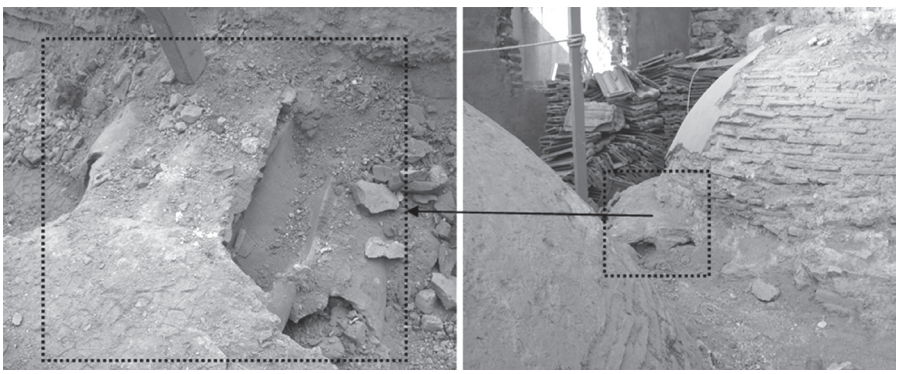


Figure 22. Horizontal terracotta pipes lying between the domes (left) above the *külhan* section of the bath (right) in Atik Valide Hospital (Photos by the authors, 2014).

in early June 2014, Ayşıl Tükel-Yavuz argued that the function of these horizontal pipes was to lighten the weight of the roof structure by means of their hollow interiors. During the 2013 restorations, a similar terracotta pipe system was detected in Istanbul, Küçük Mecidiye Mosque (nineteenth century). Covering the whole brick dome of the mosque, approximately 3,200 terracotta pipes with heights of 38 cm, diameters of 29-26 cm, and thicknesses of 1.8 cm were found on a vertical axis, adjacent to each other. Yücel et al. (2014) point out that they were used to raise the dome with a light material. Even though their exact purpose and their relationship with the heating, drainage, or water systems are unknown, they might be valuable for future research on the subject.

EVALUATION OF THE RESULTS

It is obvious that solar power was the primary source of heating in both Seljuk and Ottoman period hospitals. Even though the *iwans* in Seljuk period hospitals and the semi-open spaces in Ottoman hospitals seem to have alleviated the problem of heating, their function was to enable the patients to get fresh air and to benefit from the sun on the sunny days. It is also assumed that solar heat was used in hospitals to dry clothes and to dry fruits, flowers, and other plants used for making medicine.

In situ finds and archival work carried out as part of this research support the following observations about the heating technology of Anatolian Seljuk hospitals. First, even though no provision against the cold weather has yet been detected in Anatolian Seljuk period hospitals, there are signs verifying the possible usage of portable heating devices, such as braziers and *tandır* heating systems. For instance, ventilation holes found in the ceilings of Amasya Anber Bin Abdullah Hospital/ Bimarhane and Kayseri Gevher Nesibe Hospital/Çifte Medrese point to the possibility that portable devices were used for heating. Second, although no *tandır* or

tandır-like features were likely used solely for heating have been excavated in Anatolian Seljuk period hospitals (as explained in detail in pervious section), earthenware *tandır* ovens/holes have been unearthed on the floors of nearby or adjacent buildings. For instance, there are indications that the *tandır* ovens found on the floor of the Çifte Minareli Medrese in Sivas and on the eastern side of the Divriği Complex were used for cooking, not only heating. The *tandir* ovens found in Gök Medrese were a later addition. The lack of wall fireplaces in this period hospitals also lead us to believe that, apart from portable braziers and *tandır* heating devices, furnishing elements such as mat, rugs, carpets, and straw, thick comforters, thick woollen clothes, and high-calorie foods were also effective in the heating the bodies and, to some extent, the spaces in these buildings (Tuncer, 2011). Travellers' accounts reveal that it was common to sleep on straw and use fur clothes in caravansaries and inns (Özer, 2005, 40-1, 43). This research challenges the previous hypothesis on the heating system used in Anatolian Seljuk hospitals: that they were heated by heat from a nearby bath. The lack of architectural and archaeological evidence with regard to hypocaust heating, except for in bath sections, and the mismatch between the construction dates of nearby baths and the hospitals may lead one to conclude that these *darüşşifas* were not heated.

Hence, in the Anatolian Seljuk period, the focus was on heating of the body rather than the whole space. Only the bath sections of hospitals, such as Izzeddin Keykavus I Hospital/Şifahiye and Gevher Nesibe Hospital/ Çifte Medrese, had hypocaust underfloor heating systems. Furthermore, the earthen roofs of Seljuk period hospitals might have been effective in providing warmth, as pumice stone, a kind of light and porous volcanic material, was mixed with earth used on the flat roofs of traditional Anatolian buildings, thus providing thermal insulation (Önge, 1995, 41-76, 93-4).

On the other hand, fireplaces with built-in chimneys can be observed in all Ottoman period hospitals. Thus, for the Ottomans, in addition to heating the body, heating the space was deemed of importance to provide a decent level of warmth. During the Ottoman period, portable direct heating devices such as *tandırs* and braziers were used to support fireplaces. Whereas, in both period's hospitals, one of the biggest challenges in regard to heating spaces, as well as ventilating and illuminating them, was the loss of heat through ceiling holes or built chimneys for wall fireplaces. Even though this problem was solved by means of a hypocaust system applied under the bath section of the hospitals, it was a major drawback in other rooms that needed heating.

CONCLUSION

The joint interpretation of in situ finds, archival documents, and comparative studies provide evidence for the assessment of heating systems in Anatolian historical hospitals. It is understood that, throughout history, people have sought the best solutions for assuring comfortable indoor conditions, according to their knowledge. In order to heat spaces and bodies, the heating systems that used, ran, and collected heat, and emitted smoke, such as the hypocaust system and wall fireplaces, were used with in conjunction with supplementary devices such as *tandırs* and braziers. Yet, until the development of mechanical ways of heating, hospitals in Anatolia lacked advanced heating systems; thus the focus was on the heating of the body, not the heating of the space. From the details

recorded above, one can conclude that ensuring an adequate provision against cold was one of the essential problems for hospitals of both periods. This provision influenced the architectural features of the hospitals, such as the construction of smaller recessed windows, and the use of stone for the construction of thick walls. Even though open courtyard plan type and semi-open spaces like *iwans* observed in Seljuk period hospitals would have increased the effects of cold in winter, these elaborative devices also point to the fact that the hospitals were built for use in both in summer and winter, regardless of the extreme weather conditions.

ACKNOWLEDGEMENT
The authors would like to thank to Prof. Dr. Gediz Z. Urak, Prof. Dr. Can M. Hersek and Adjunct Assistant Prof. Todd Grover for all their valuable suggestions incorporated into this manuscript.

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AN EVALUATION OF HEATING TECHNOLOGY IN ANATOLIAN SELJUK PERIOD HOSPITALS (DARÜŞŞİFA)

The need for heating of the body and space is among the main requirements of human survival. Therefore, heating technologies are essential. However, in situ observation of heating systems in historical buildings – either for the purposes of diagnosis and monitoring purposes of old technologies or for their maintenance and preservation – is quite limited, and more thorough analyses are necessary. There are a few studies on the heating systems of Roman and Turkish baths in Anatolia, but not much research has been conducted on other building types. Hence, this manuscript examines thirteenth century Anatolian Seljuk period hospitals, (darüşşifas) – the primary places for the treatment of patients – in order to investigate the development and use of different heating systems in historic buildings. This manuscript consists of an in-depth study of historic hospitals, carried out through literature review, historical survey, archival research, field observations, and comparative analysis. Most heating systems and complementary elements observed in historic hospitals are not functioning at present due to inappropriate interventions, lack of maintenance, deterioration, and overall changes in living practices. Thus, the examination of heating systems in historic hospitals in this study could be useful not only for the assessment of such functional systems, but also for understanding their technological development in order to determine effective conservation measures.

Alındı: 21.12.2014; **Son Metin:** 09.04.2016

Anahtar Sözcükler: Isıtma; darüşşifalar; Anadolu; Selçuklu dönemi; mimarlık.

ANADOLU SELÇUKLU DÖNEMİ DARÜŞŞİFALARINDA KULLANILAN ISITMA TEKNOLOJİSİNE İLİŞKİN BİR DEĞERLENDİRME

İnsan vücudunun ve yaşadığı mekânın ısıtılması ihtiyacı, insanlığın hayatta kalması için temel gereklilikler arasındadır. Bu nedenle, ısıtma teknolojisi geleneksel anlamda da oldukça önemlidir. Ne var ki, ısıtma teknolojisini de içeren özgün işlevsel teknolojilerin tanısal ve izlemeye yönelik amaçlarla ve koruma ve bakım nedeni ile yerinde incelenmesi, kapsamlı analiz çalışmalarını gerektiren zahmetli bir uğraştır. Anadolu'daki, özellikle Roma ve Türk dönemi hamamlarında uygulanan ısıtma sistemleri üzerine çalışmalar mevcuttur, ancak diğer yapı tipleri özelinde bu tür çalışmalar oldukça azdır. Bu nedenle, tarihi yapılarda uygulanan farklı ısıtma sistemlerindeki gelişimin araştırılması amacı ile yürütülen bu çalışma, on üçüncü yüzyılda inşa edilen ve hastaların tedavisi için kullanılan ana mekânlar olan, Anadolu Selçuklu dönemi darüşşifalarına yoğunlaşmaktadır. Örnek yapılar olarak seçilen darüşşifalar, kaynak ve tarihi araştırmalar, arşiv incelemeleri, arazi çalışmaları ve karşılaştırmalı analizler ile konuyu aydınlatmak için kapsamlı olarak incelenmiştir. Araştırma kapsamında incelenen darüşşifalarda tespit edilen ısıtma sistemlerinin ve tamamlayıcı elemanlarının çoğu uygunsuz restorasyon müdahaleleri, bakımsızlık, zamana bağlı yıpranma ve insan gereksinimlerindeki değişimler nedeni ile günümüzde kullanılamaz durumdadır. Bu nedenle darüşşifa yapılarındaki ısıtma teknolojisinin tespit edilmesi, sadece bu işlevsel sistemlerin değerlendirilmesi için değil aynı zamanda ısıtma teknolojisinde zaman içindeki gelişmelerin anlaşılması ve böylece bu sistemlerin korunmasına yönelik dersler çıkarılması ve koruma ölçütlerinin belirlenmesi içinde de gereklidir.

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