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How to Heat a Medieval or Early Modern Monastery? Heating System in Monasteries in Poland

Abstract: In the second half of the 20th century, many archeological excavations were conducted in the area of the Dominican Order in Cracow, Poland. A plethora of objects was discovered, among them remnants of heating devices. One of them, a type of hypocaust, was located in the basement of a building commonly known as the “Romanesque building”. During excavations led by father Adam Studziński, but also later in 1996 and after 2009, a great number of stove tiles were also identified. Based on their technical and technological features and an analysis of their ornamentation, these remains were dated back to the late medieval and modern periods. This detailed research contributed to the possibility of reconstructing the heating system in the Dominican monastery in Kraków.

Key words: heating devices, hypocaust stove, tiles, monastery, Poland

In the Middle Ages Polish climate was associated with cold winters and temperatures below zero. For this reason heating was needed for a couple of months in a year.¹ Due to the large size of monasteries and the strict monastic rules, unusual results were achieved. Orders had to tackle this problem and find a way to heat their huge monasteries.

One of the element sources of heat in a heating system is the hypocaust stove. Using hypocaust heating in monasteries is verified by historical sources, e.g. the story of Saint Bernard of Clairvaux. When Saint Bernard of Clairvaux was old and weak, concerned monks decided to build a special little heated room. However, Saint

¹ Katarzyna Moskal, *Kafle w zbiorach Muzeum Historycznego Miasta Krakowa* (Kraków: Muzeum Historyczne Miasta Krakowa, 2012), 9.

Bernard's opinion on heating differentiated from theirs. Then the monks decided to build unseen heating devices. Thanks to this story, we can suppose that monks used stones with an opening as an element of a heating device during this period.² Subsequently, hypocaust stoves became more and more common. The confirmation of this speculation can be found in one of the monastic rules, which says it is permissible to have one heated room in a monastery. For the next few years, monastic rules became less strict and it was possible to develop a heating system.³

The hypocaust stoves came to Poland in the 13th century, probably as a Cistercian influence. Stove construction was a continuation of a Roman tradition. However, adding stones as heat-accumulators and letting heated air into the rooms was a medieval improvement.⁴ Heating devices worked in two stages. At first – lighting the stove. During this process, conduits were closed but the baffle was opened. During the second part of the process, conduits were opened, but the baffle was closed. Relics of this type of heating devices were identified in many monasteries during archaeological explorations.

In the area of the Dominican Monastery in Cracow (Poland) many archaeological and architectural excavations were conducted in the second half of the 20th century. After World War II some of them were headed by father Adam Studziński. The basement of the so-called Romanesque building (east part of the monastery) was explored in 1996.⁵ In 2009, and later, excavations were conducted in the crypt in the church of the Holy Trinity, a room located close to the north wall of the chapel of Saint Mary Magdalene, cloisters, the first and second quadrangle, a site

² Wojciech Bis, „Ze studiów nad dziejami pieców typu hypocaustum z terenu ziem Polski”, *Architectus* 1-2, no 13-14 (2003): 7.

³ Anna Bojęś-Białasik, „Średniowieczne urządzenia grzewcze w klasztorze cystersów w Jędrzejowie i augustianów-eremitów na Kazimierzu w Krakowie”, *Wiadomości Konserwatorskie* 25 (2009): 82.

⁴ Bis, „Ze studiów”, 7-9.

⁵ Maria Filipowicz, „Sprawozdanie z badań architektonicznych budynku dawnej biblioteki klasztornej”, in *Dominikanie w środkowej Europie w XII–XV wieku*, ed. J. Kłoczowski, J. A. Spież, (Poznań: W drodze, 2002), 294-298.

close to the north wall of the third quadrangle, and courtyards.⁶ Based on this research a lot of remains of heating devices were identified.

One of the relicts of the heating system, a hypocaust stove, was located in the basement of the so-called Romanesque building. The 16th c. stove was built as a rectangular brick and clay construction (Fig. 1).⁷ The inclined bottom of the stove was covered by finger-marked bricks. Both new and reclaimed Romanesque bricks (mostly 6.5-7 x 13-13.5 x 26-27 cm) were used to construct the internal walls. The front wall was rebuilt many times. The rear wall was made from reclaimed brick and stone. The furnace chamber was the lower of the two chambers. The bottom chamber was capped by six brick arches. Remnants of what was identified to have been a grate were also found. The upper part of the stove, used as an accumulation chamber and filled with stones, was capped by a brick barrel vault. The inside of the stove shows traces of soot. The stove heated the middle room of the "Romanesque building", which was used as a lobby located between the west part of the monastery and the library. During the excavations the archaeologists also discovered tiles with openings used for conveying hot air.⁸

In the second half of the 17th c. a basement in the north part of the "Romanesque building" was converted into another hypocaust. This heating device had a similar construction. Walls were made from modern bricks (5,5-6,5 x 12,5-13 x

⁶ Anna Bojés-Białasik, Dariusz Niemiec, „Kościół i klasztor Dominikanów w Krakowie w świetle badań archeologiczno-architektonicznych w latach 2010–2012”, in *Sztuka w kręgu krakowskich Dominikanów, Kraków*, ed. A. Markiewicz, M. Szyma, M. Walczak (Kraków: Esprit, 2013), 257-313, 257-313; Anna Bojés-Białasik, Dariusz Niemiec, „Medieval ceramics techniques in architecture of cracow's Dominicans”, *„Forum Urbes Medii Aevi”* 13 (2016): 35-48; Dariusz Niemiec, „Piece do wypału budowlanej i wapna w XIII-wiecznym klasztorze Dominikanów w Krakowie”, *Archaeologia Historica Polona* 25 (2017): 7-35.

⁷ In this location another, older hypocaust may have been located.

⁸ Another type of device was also discovered in the Dominican monastery — a bread stove. Monks used it for baking bread and smoking foods. Obviously, the main purpose of the bread stove was to bake bread. However, while baking a baker could also keep themselves warm while watching over the food and sitting on a stone shelf, which the stove included. Bread stoves had been used since the mid-16th century (Anna Bojés-Białasik, „Piece w klasztorze Dominikanów w Krakowie. Badania w latach 2009–2010”, in *Sztuka w kręgu krakowskich Dominikanów, Kraków*, ed. A. Markiewicz, M. Szyma, M. Walczak (Kraków: Esprit, 2013), 337-340, 342-345).

23,5-24,5 cm). The hypocaust had two chambers — the upper one used as an accumulation chamber and the lower one used as the furnace chamber. Archaeologists discovered traces of a brick grate and tiles with openings for conveying hot air. This stove heated at least one small one-storey room decorated with late Renaissance polychrome.⁹

Excavations also provided the dating of another type of heating device used in the monastery. During archaeological works, diggers discovered over one thousand and twenty fragments of stove tiles.¹⁰ Based on their technical and technological features and an analysis of their ornamentation, the group of artefacts was dated to the late medieval and Renaissance period and up to the late 19th c. The study of the artefacts focused on technological and technical analysis. All stove tiles were made of iron clay. The analysis also explained the method used to shape them. The ornaments were made in a mould. Tile surfaces were then smoothed and corrected with fragments of cloth. The raw clay tiles were subsequently baked and glazed. Very often the inner surfaces of the tiles show traces of smoke, which proves that they were used for heating.

The stove tiles were covered with colourful and varied decorations. Most of them shared a common style. Two of them, multicolour Renaissance stove tiles, were decorated with a flower bud in a square panel surrounded by an edging and glazed yellow, blue and white (Fig. 2. 1, 2). Stove tiles with a rosette and ornamented edging were also found in Kanonicza street in Cracow, Nowy Wiśnicz, Biecz, Będziemyśl, Inowłódz.¹¹

⁹ Bojeń-Białasik, „Piece”, 345-346.

¹⁰ I would like to thank Dariusz Niemiec, PhD (the researcher of the Dominican order in Cracow) for his help and constructive remarks.

¹¹ Moskal, „Kafle”, 130-132; Jerzy Okoński, „Renesansowe kafle „Wawelskie” z zamku w Nowym Wiśniczu”, *Rocznik Tarnowski* 3 (1993): 241; Gabriela Ślawska, Tadeusz Ślawnski, „Garncarstwo i kaflarstwo w Bieczu od późnego średniowiecza do czasów współczesnych”, in *Garncarstwo i kaflarstwo na ziemiach polskich od późnego średniowiecza do czasów współczesnych. Materiały z konferencji – Rzeszów, 21-23 IX 1993*, ed. A. Gruszczyńska, A. Targońska (Rzeszów: Muzeum Okręgowe w Rzeszowie 1994), 220-225; Sylwester Czopek, „Renesansowe kafle z Będziemyśla”, in *Garncarstwo i kaflarstwo na ziemiach polskich od późnego średniowiecza do czasów współczesnych. Materiały z konferencji – Rzeszów, 21-23 IX 1993*,

A fragment of a multicolour stove tile decorated with an image of a man holding a heraldic shield (Fig. 2.3) was found by father Adam Studziński. This motive was common in Renaissance Poland.¹² During the excavations, the archaeologist also found a few tiles with images of people which had not been known until then. Another type of person was depicted on three green glazed stove tiles (Fig. 2.4). A man wearing characteristic headgear with bells is a jester. Another example of advanced Renaissance ornamentation is an image of a man wearing a fur topped robe and a chain (Fig. 2.5). He is holding a rod, probably a sceptre, which might identify him as a noble. Examples of depictions of nobles can also be found on stove tiles in Gdańsk, Elbląg, Wawel in Kraków, Toruń and Poznań.¹³

The most common ornamentation style found on Renaissance and early Baroque stove tiles in the Dominican monastery consisted of geometrical and floral patterns and glazing (green enamel). A high prevalence of green glazed tiles (78%) could prove that most tiled stoves were green. Tiles were covered with, for example, a round bulge or niche, a roof tiles pattern, multiple stripes, strapwork, a rosette, multiple rosettes, leaves (e.g. oak or birch), a palmette, a moresque (Fig. 3.9, 3.8, 3.5, 3.7, 3.6, 3.4, 3.10). Tiles decorated with a Moresque motive were also glazed white or yellow, as well as blue and navy blue. One of the white and navy blue glazed tiles has floral ornamentation and an image of unicorns adoring the tree of life (Fig. 3.3).

ed. A. Gruszczyńska, A. Targońska (Rzeszów: Muzeum Okręgowe w Rzeszowie 1994) 106; Izabela Motylewska, *Renesansowe kafle z zamku w Inowłodzu* (Łódź: MAiE 2008), 104–107, 111, 118.

¹² Agnieszka Góral, „Renesansowe kafle z Polkowic na Śląsku”, *Dolnośląskie Wiadomości Prahistoryczne* 5 (1999): 175-176; Elżbieta Kilarzka, „W przededniu przebudowy pieca w dworze Artusa w Gdańsku”, *Porta Aurea* 1 (1992): 151-189.

¹³ Barbara Babińska, „Kafle piecowe z XIV–XVIII w. pozyskane z badań archeologicznych prowadzonych na terenie Gdańska w latach 1996-2006”, in *Stan badań archeologicznych miast w Polsce*, ed. H. Paner, M. Fudziński, Z. Borcowski, (Gdańsk: Muzeum Archeologiczne w Gdańsku, 2009), 393; Barbara Pospieszna, „Późnośredniowieczne kafle z kościoła pod wezwaniem św. Walentego w Matarni pod Gdańskiem”, *Materiały Sesji Oddziału Warszawskiego Stowarzyszenia Historyków Sztuki* 2 (2001): 86; Maria Piątkiewicz-Dereniowa, „Kafle Wawelskie okresu wczesnego renesansu”, *Studia do Dziejów Wawelu* 2 (1961): 303-375; Elżbieta Kilarzka, Maciej Kilarzki, *Kafle z terenu dawnych Prus Królewskich* (Malbork: Muzeum Zamkowe, 2009); Zisopulu-Bleja, „Kafle”, in *Średniowieczny system obronny miasta Poznania. Odcinek północno-zachodni. Wyniki badań archeologicznych*, ed. P. Pawlak (Poznań: Muzeum Archeologiczne w Poznaniu, 2013), 166.

Another mythical creature, a griffin, was depicted on a green glazed tile (Fig. 3.1). A white eagle depicted on the red heraldic background was a fragment of the topmost part of the stove (Fig. 3.2).

Analogous white and navy blue stove tiles decorated by a moresque and a heraldic eagle were identified as elements of a stove in Hetmańska Tenement in Kraków (Fig. 4.1) dated to the first half of the 17th cent.¹⁴ [insert Fig. 4. 1: – A stove located in Hetmańska Tenement in Cracow, Poland, and stove tiles discovered in the area of the Dominican monastery in Cracow, Poland; 2 - A possible reconstruction of a tiled stove from Wawel and stove tiles discovered in the area of the Dominican monastery in Cracow, Poland.] A full ornament of an eagle-topped stove consists of a crowned eagle in an oval frame, balusters, and a continuous Moresque motive. Research conducted on another example decorated by an eagle, found in a Norbertine monastery, proved that this type of stove could be an innovation from the times of king Władysław IV Vasa.¹⁵ Based on 23 fragments of findings discovered at the Dominican monastery, one wall of a stove was reconstructed with another type of white and navy blue moresque (Fig. 5).

Unfortunately, in the area of the Dominican monastery no foundations of the tile stove were found. However, a few attempts at reconstructing the stoves were made.

Recreations are meant to demonstrate how the stoves functioned, as well as partially reconstruct the appearance of the monastery's interior. Based on visual similarity, as well as dimensional, technical and technological features, possible reconstructions were made for another two stoves (Fig. 6.). Both of them are dated to the mid-16th c. The reconstruction of the first stove offers the possibility of recreating two chambers. The lower one could have been decorated by green tiles with a round bulge mirror.

¹⁴ Maria Piątkiewicz- Dereniowa, *Artystyczna ceramika ceramika europejska w zbiorach polskich* (Warszawa: Wydawnictwa Artystyczne i Filmowe, 1991), 31.

¹⁵ Dariusz Niemiec, „Uniwersytet Krakowski w badaniach archeologicznych”, in *Archeologiczne ślady Uniwersytetu Krakowskiego. Katalog wystawy w Collegium Maius Uniwersytetu Jagiellońskiego* (Kraków 2006), 31.

The walls of the upper chamber could have been covered by a portrait of a lord and small oak leaves. This chamber can be reconstructed as a cylindrical or cuboid chamber (Fig. 6.1, 6.2). A possible appearance of the second green stove could include a lower chamber ornamented by a round niche and acorns and an upper part decorated with portraits of jesters (Fig. 6.3). In the Dominican monastery, many green tiles decorated in a typical early 17th c. style from Cracow, the so-called rosette in a square, were discovered.¹⁶ A possible reconstruction of these objects can be found in a detailed study of this type of ornamentation made by Joanna Renner (Fig. 4. 2.).¹⁷ A well preserved heating device featuring analogous ornamentation made it possible to reconstruct the look of a white and navy blue stove topped with tiles with an eagle, as mentioned above.

Among the plethora of stove tiles, an unusual one from the 19th c. was found. One side of this object was covered by brown glaze and a small rosette. The other side has an imprint with a name of a workshop: "W.WOJTYGA /WYRÓB /PIECÓW KAFLOWYCH /W KRAKOWIE" ("W. WOJTYGA/ PRODUCTION/ OF TILED STOVES /IN CRACOW") (Fig. 7). Based on this signature, the site of production of the tile was identified as a workshop operating in the late 19th and early 20th c. in Dębniki, now one of the districts of Cracow. The analysis of the objects discovered at the Dominican site provides evidence the tiles were also made at the monastery. A mould found during explorations of father Adam Studziński and its re-identification indicates that in the area of the Dominican monastery tiles were produced during the Renaissance (Fig. 8). The mould was used to create tiles ornamented with depictions of a bishop and another person. Based on the image of the kneeling second figure, his

¹⁶ Based on historical study we know that some of the stoves from Cracow could have been glazed not only with green or other color enamels, but also, at the end of the whole building-the-stove process, a gold. Cola Antionio Carmignano panegyric is mentioned: "The four chambers are there, and accordingly all have their brocades, decorations, sleek cloths and tapestries in silk, gold-plated stoves were there" (Maria Piątkiewicz-Dereniowa, "Rekonstrukcja dawnych wawelskich pieców kaflowych", *Biuletyn Historii Sztuki* 22 (1960): 369-370). However, in this case, any remnants of gold were not identified.

¹⁷ Joanna Renner, "Późnorennesansowe kafle wawelskie z motywem rozety w kwadracie", *Studia Waweliana* 1 (1992): 57-58.

hands pointing down, as well as the attributes of a bishop the image contains, we can suppose that this is a fragment of a typical iconographic theme of St. Stanislaus and the resurrection of Piotr. St. Stanislaus of Szczepanów, one of the patron saints of Poland, was very popular in the 16th c. and was depicted very often.¹⁸

Research shows that the heating system in the Dominican monastery during the early modern period consisted of two main elements — tiled stoves and hypocaust stoves. It is probable that in some periods, e.g. in the 16th and 17th century, different types of stoves were used concurrently. The reason for this was that every type of heating device had a different function. Tiled stoves were used for smaller areas. Combining these with the hypocaust system allowed for heating a larger space.

This complicated heating system was a result of long-term development. Comparative study shows that exploiting a double heating system was common only in monasteries and castles.¹⁹ Hypocaust stoves are commonly known from different sites in Poland.²⁰ The oldest hypocaust stoves in Poland were discovered in Cistercian monasteries in Sulejów, Lubiąż and Wąchock and in the Ostrów Tumski castle in Wrocław. Those stoves were used to heat monasteries or baths.²¹

¹⁸ The tradition of long-term ceramics production was also confirmed by the following findings: dated to the 1240s, the kiln for burning lime, roof tiles, and floor tiles; the mid-13th century kiln which was used to burn lime, bricks, brick fittings, and floor tiles; another mid-13th century kiln; a site with raw clay and raw bricks; intermediate products of floor tiles, a copper slag (Bojęś-Białasik, Niemiec, *“Medieval”*, 313; Niemiec, *“Piece”*, 7-17).

¹⁹ Jadwiga Olbrot, *“Nowożytnie urządzenia grzewcze w klasztorze dominikanów w Krakowie”*, *Hereditas Monasteriorum* 8 (2016): 101-108.

²⁰ Cezary Buśko, *“Średniowieczne piece typu „hypocaustum” na Śląsku”*, *Archaeologia Historica Polona* 1 (1995): 149, 156, 176; Grabowski, Romanow, *“Pocysterski zespół cysterski zespół kościelno-klasztorny w Krzeszowie w świetle badań archeologiczno-architektonicznych w 2006 roku”*, *Z Otchłani Wieków* 64 (2009): 253; Barbara Łuzyniecka, *“Średniowieczny kościół i klasztor cysterski w Lubiążu”*, *Kwartalnik Architektury i Urbanistyki* 33 (1988): 83; Anna Bojęś-Białasik, Barbara Kopka, *“Średniowieczne urządzenia grzewcze w klasztorze cystersów w Jędrzejowie i augustianów-eremitów na Kazimierzu w Krakowie”*, *Wiadomości Konserwatorskie* 25 (2009): 77-87; Bis, *“Ze studiów”*, 14-15.

²¹ Bis, *“Ze studiów”*, 9; Buśko, *“Średniowieczne”*, 152; Józef Kaźmierczyk, Janusz Kramarek, Czesław Lasota, *“Badania na Ostrowie Tumskim we Wrocławiu w 1972 roku”*, *Silesia Antiqua* 16 (1974): 275-276.

In Lubiąż one of six stoves (the best preserved one) was used for heating a bath. This stove had three chambers — stove corner, furnace, west stove corner chamber — and a grate. Brick arches were used to hold heat-accumulator stones.²² Relicts of a hypocaust stove were discovered in a monastery in Strzelno. They are dated back to the late 15th - early 16th c.²³ Another example from the late medieval period was identified in the Kazimierz district of Krakow. In the west section of an Augustinian monastery researchers have found relics of a construction with a chamber (a slab with an opening, a smoke flue). These hypocaust stoves were used to heat rooms in the first half of the 15th c.²⁴ Other examples of hypocaust stoves were dated to the Renaissance period and were also discovered in Cracow in a Cistercian monastery in the Mogiła district.²⁵

Remains of tiled stoves were also identified in others monasteries in Poland, e.g. in a monastery of the Franciscan order in Barczewo, in a Dominican complex in Brześć Kujawski, at a Cistercian site in Jemielnica, at the Order of Friars Minor Capuchin in Kraków, in the Poor Clare monastery in Kraków, in the Benedictine women's monasteries in Staniątki, at a Dominican order in Oświęcim, at the Franciscan order in Łąki Bratiańskie, at the Cistercian complex in Rudy, and at the

²² Buśko, „Średniowieczne”, 152. Remains of a medieval bath chamber were also discovered in the Holy Ghost Hospital in Frombork. Archaeologists discovered a brass cover used to cover an opening, which links a stove and a hospital bath (Jerzy Kruppe, „Szpital kapitulny Świętego Ducha we Fromborku”, *Studia i Materiały z Historii Kultury Materialnej* 66 (1998): 190-193).

²³ Bis, „Ze studiów”, 16-17.

²⁴ Bojęś-Białasik, „Średniowieczne”, 84-86.

²⁵ Bojęś-Białasik, „Piecze”, 335-347.

Carmelite order in Kraków.²⁶ Stove tiles were decorated in various styles and dated to the late medieval period, the Renaissance and later, until the late 18th c. To build elements of heating devices, typical, local style ornamentation was used for tiles. Due to the varied and rich ornamentation they didn't only heat the rooms but were also elements of monastic decoration.

In some cases two kinds of heating devices could work together or interchangeably at different times. Examples of binary heating systems were confirmed at monasteries in Bierzwnik, Sulejów and Trzemeszno.²⁷ At a site at the Cistercian monastery in Bierzwnik an atypical combined binary heating system was identified. In this area during archaeological excavations, diggers discovered stove tiles dating back to the period from the 15th to the 18th century. One of the most beautiful examples of tiles is the Renaissance tile decorated by a gryphon and an escutcheon. At the same time monks also used other types of heating devices. During research archaeologists have found remains of hypocaust stoves. The heating device was made of clay and brick. The hypocaust stove had a grate. Archaeologists also found original conduits conveying hot air. Analyses show that this hypocaust stove

²⁶ Aleksander Andrzejewski, Leszek Kajzer, „Sprawozdanie z archeologiczno-architektonicznych badań weryfikacyjnych zespołu franciszkańskiego w Barczewie przeprowadzonych w 2003 roku”, *Łódzkie Sprawozdania Archeologiczne* 9 (2004-2005): 237, 243; Aldona Andrzejewska, Leszek Kajzer, „Badania zespołu poddominikańskiego w Brześciu Kujawskim”, *Archaeologia Historia* 1 (1995): 127-148; Aleksander Andrzejewski, Leszek Kajzer, Janusz Pietrzak, „Zespół pocysterski w Jemielnicy na Śląsku Opolskim w świetle badań terenowych”, *Folia Archaeologica* 22 (1998): 167-178; Maryla Dryja, Sławomir Dryja, „Pozostałości pieca grzewczego z pierwszej. ćwierci XVI wieku z badań przy ul. św. Tomasza 34 w Krakowie”, in *Rzeczy i ludzie. Kultura materialna w późnym średniowieczu i w okresie nowożytnym. Studia dedykowane Marii Dąbrowskiej*, ed. M. Bis, W. Bis (Warszawa: IAE PAN, 2014), 105-124; Moskal, „Kafle”, 364, 392, 393; Adam Chmiel, „Kafle średniowieczne znalezione w Oświęcimiu”, *Teka Grona Konserwatorów Galicyi Zachodniej* 2 (1906): 343-353; Andrzejewski, Kajzer, „Zespół”, 266, 269; Andrzejewski, Kajzer, Pietrzak, „Opactwo”, 388; Alina Wałowcy, „Badania przy kościele i klasztorze oo. Karmelitów na Piasku w Krakowie w 1963 roku (wykop II)”, *Materiały Archeologiczne* 25 (1990): 14.

²⁷ Iwona Hetmaniak-Malicka, „Kafle gotyckie z klasztoru w Bierzwniku”, *Zeszyty Bierzwnickie* 4 (2002): 187; Janusz Tomala, „Krótkie posumowanie wyników badań archeologicznych opactwa cysterskiego w Sulejowie”, *Kwartalnik Historii Kultury Materialnej* 38 (1990): fig. 6; Buśko, „Średniowieczne”, 176; Marcin Wiewióra, *Zespół klasztorny Kanoników Regularnych w Trzemesznie w świetle badań archeologiczno-architektonicznych*, (Toruń: Wydawnictwo Uniwersytetu Mikołaja Kopernika, 2000), fig. 87; Krystyna Sulkowska-Tuszyńska, „Wyposażenie łaźni klasztoru kanoników regularnych w Trzemesznie”, *Archaeologia Historica Polona* 14 (2004): 189–210; Magdalena Suchy, „Średniowieczny system grzewczy na terenie opactwa w Bierzwniku, woj. zachodniopomorskie”, *Zeszyty Bierzwnickie* 4 (2002): 179.

was used to heat a daily working room, a so-called fraternia. At this site another unique element of a heating system was studied. The relicts of a foundation of a tiled stove and the remnants of a hypocaust prove that air heated in the hypocaust was delivered to a tiled stove and used by this tiled stove to heat a room.²⁸

To sum up, in the Dominican monastery in Cracow, and in many other aforementioned monasteries, tiled stoves could not supersede hypocaust stoves. Despite gradual phasing-out of heating by hypocaust stoves in other sites and many advantages of tiled stoves, such as decorative ornamentation and more ergonomic and practical issues, hypocaust stoves remained in monasteries at least until the 17th century. A hypocaust was able to heat a bigger room and did not produce smoke.²⁹ As mentioned, both types of heating devices were very important for the heating system of a monastery. Tiled and hypocaust stoves could complement each other. Multi-element sources of heat in heating systems in monasteries were necessary due to the large size of the monasteries. Maintaining a complicated heating system was possible due to the large number of people living and working in the monastery. They were able to provide the appropriate amount of wood and time to maintain the fire, annual conservation and other services for stoves, including a particularly high-maintenance hypocaustum.³⁰ Traces of heating systems are still being discovered in monasteries, such as the Dominican monastery, and sometimes they are an example of a significant element of decoration in monasteries and of a small piece of art.

²⁸ Suchy, „Średniowieczny”, 167-185; Barbara Stolpiak, „Warsztaty rzemieślnicze średniowiecznego placu budowy na przykładzie opactwa cysterskiego w Bierzwniku, woj. zachodniopomorskie”, *Wielkopolskie Sprawozdania Archeologiczne* 7 (2005): 101.

²⁹ Dąbrowska, „Oświetlenie i ogrzewanie średniowiecznych wnętrz zamkowych”, *Archeologia Historica Polona* 14 (2004): 182.

³⁰ Dąbrowska, „Oświetlenie”, 182-183.

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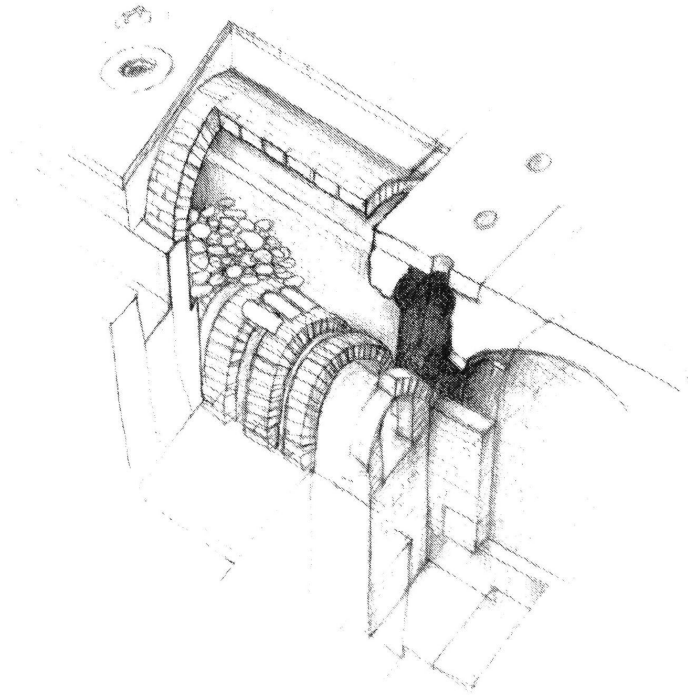
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Fig. 1. 16th c. Hypocaust stove located in the basement of the so-called Romanesque building (east part of the monastery) in the Dominican monastery in Cracow, Poland (edited by J. Olbrot based on A. Bojęś-Białasik 2013).

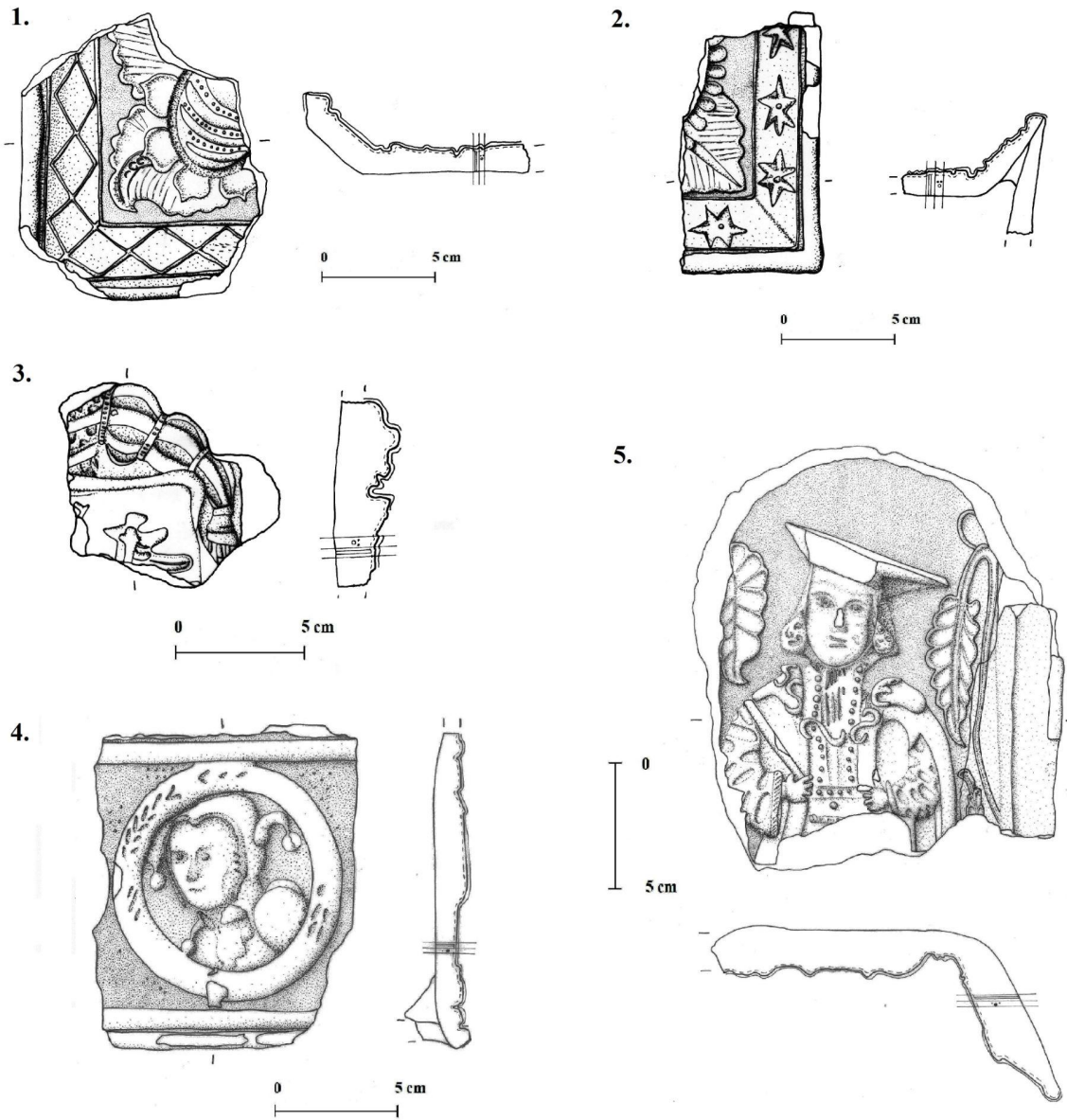


Fig. 2. Stove tiles discovered in the area of the Dominican monastery in Cracow, Poland (made by J. Olbrot).

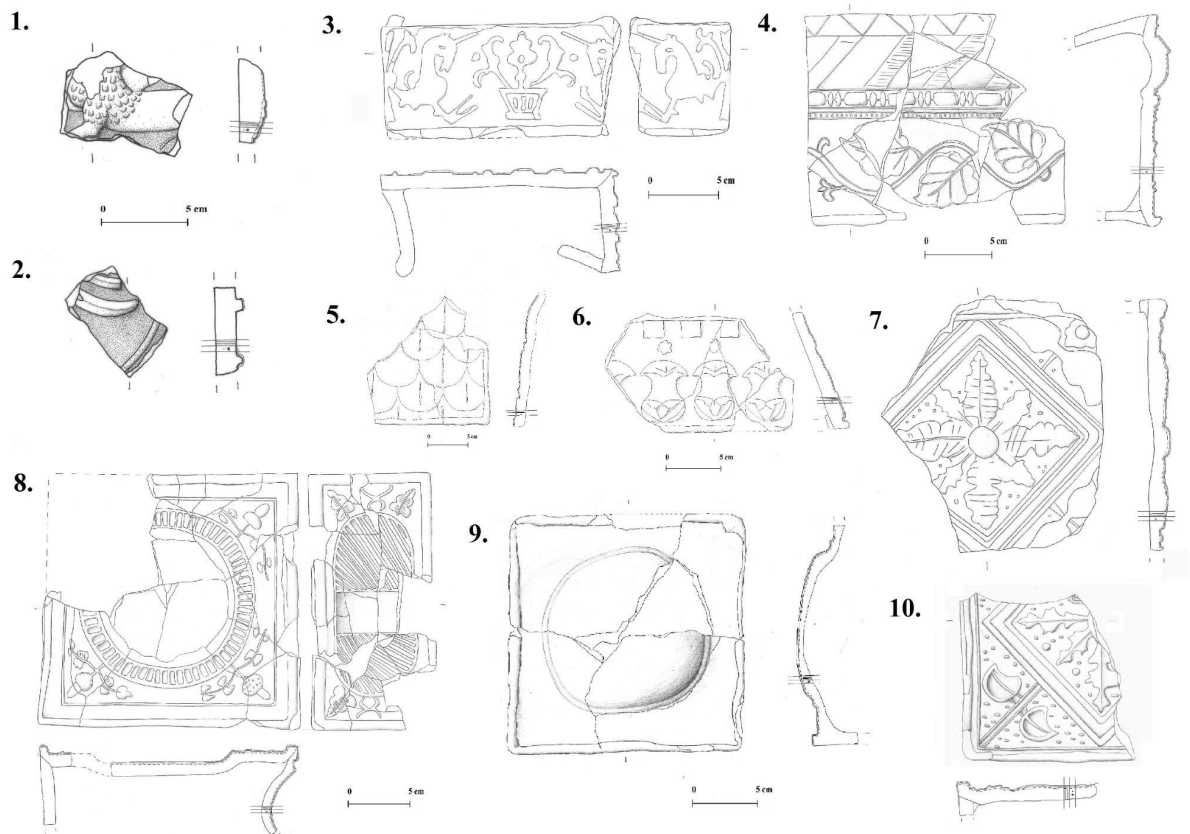


Fig. 3. Stove tiles discovered in the area of the Dominican monastery in Cracow, Poland (made by J. Olbrot).

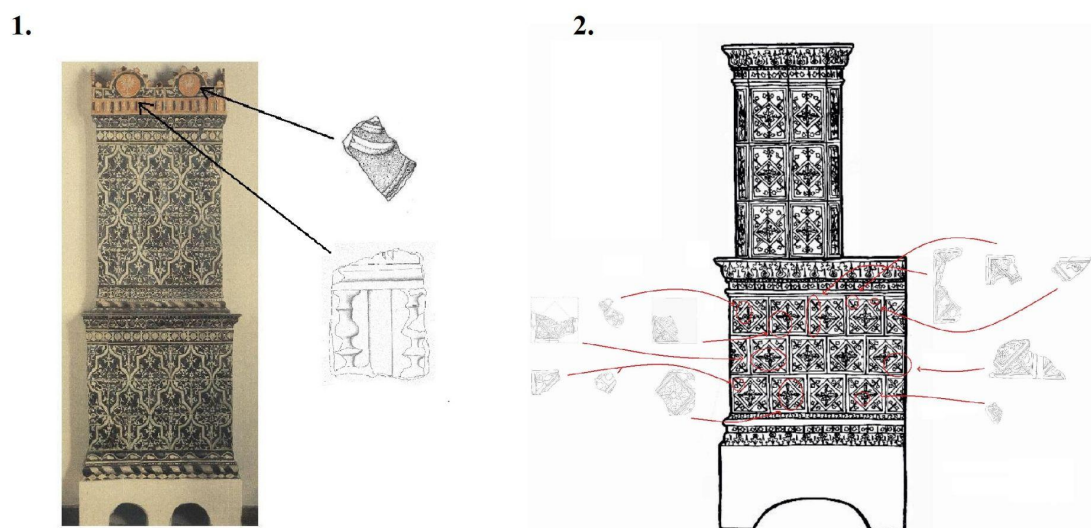


Fig. 4. 1. – A stove located in Hetmańska Tenement in Cracow, Poland, and stove tiles discovered in the area of the Dominican monastery in Cracow, Poland; 2 - A possible

reconstruction of a tiled stove from Wawel and stove tiles discovered in the area of the Dominican monastery in Cracow, Poland (edited by J. Olbrot based on M. Piatkiewicz-Dereniowa 1991, J. Renner 1992, figures made by J. Olbrot)



Fig. 5. A possible reconstruction of one wall of a stove decorated with white and navy blue moresque (made by J. Olbrot).

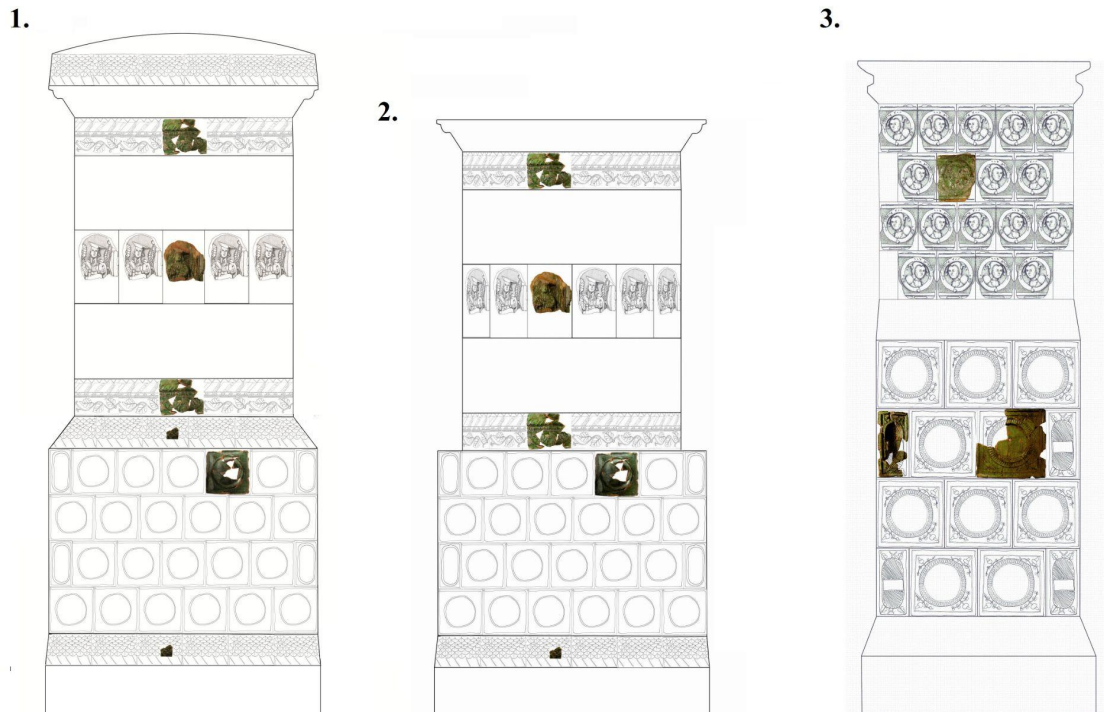


Fig. 6. Possible reconstructions of two stoves (the mid-16th c.) (made by J. Olbrot).

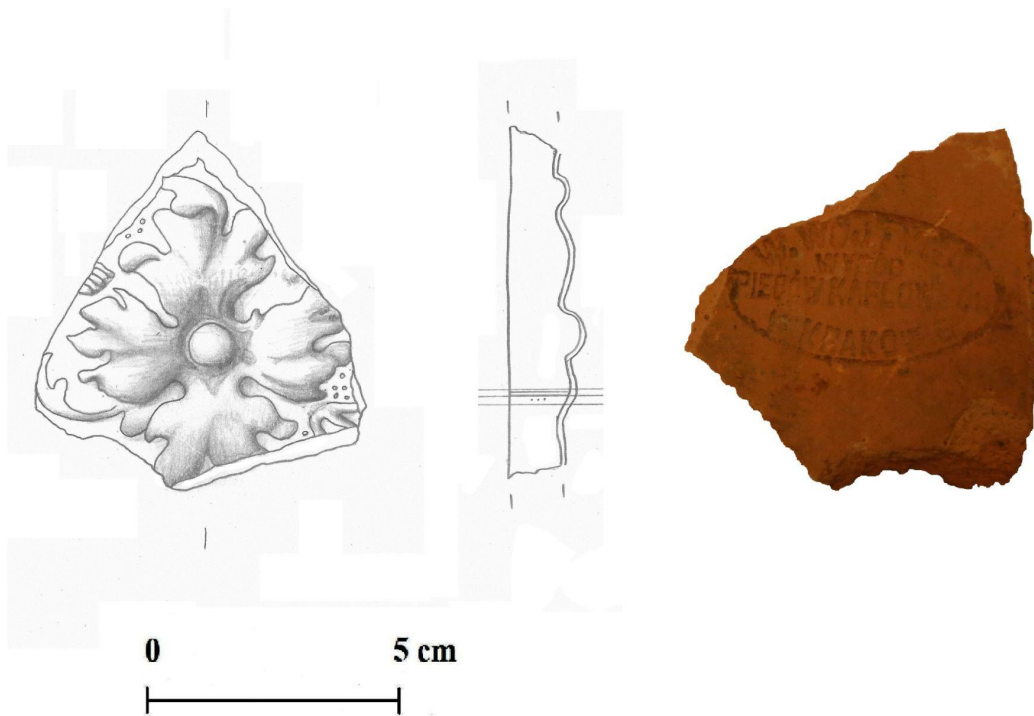


Fig. 7. Two sides of the 19th c. stove tile (made by J. Olbrot).

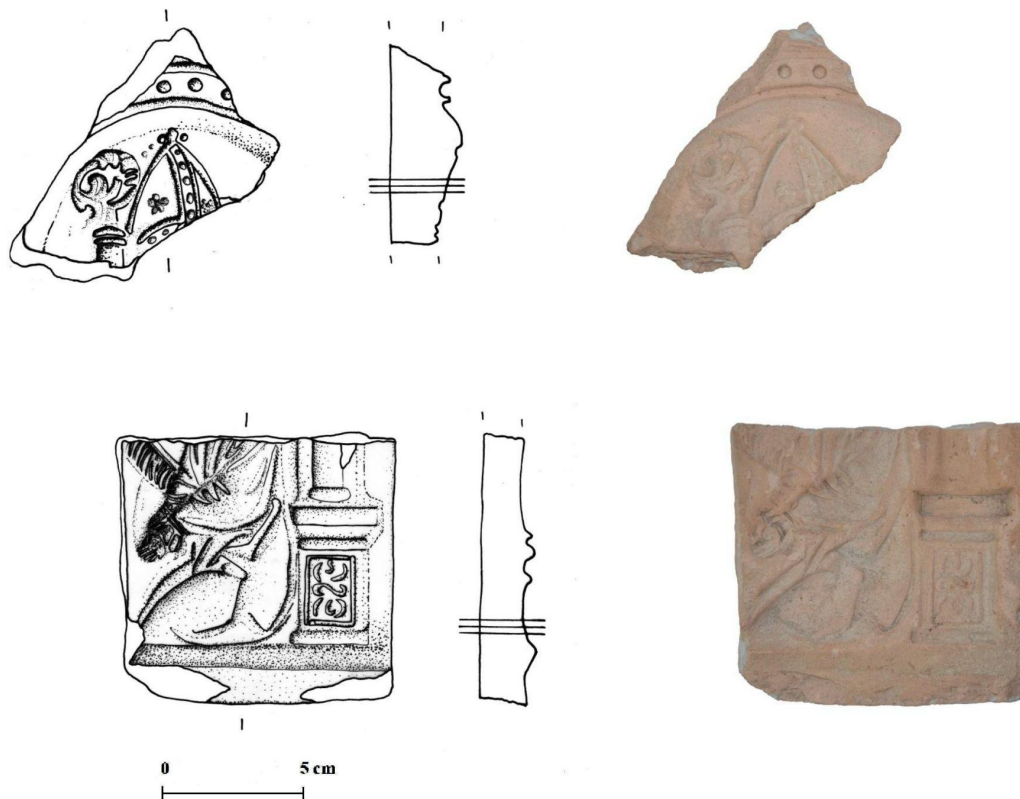


Fig. 8. The mould ornamented with depictions of a bishop (St. Stanislaus) and another person (Piotr) (made by J. Olbrot - drawing and U. Bąk - photo).