



DENDROCHRONOLOGICAL DATING OF AN OAK WELL FRAME FROM WYSOKA, OPOLSKIE PROVINCE

JOANNA BARNIAK¹, WOJCIECH ŁONAK²

A u t h o r s' a d d r e s s e s: 1 – AGH University, Adama Mickiewicza 30, 30-059 Kraków, Poland, e-mail: barniak@agh.edu.pl (corresponding author), ORCID: 0000-0001-7676-6668; 2 – Wojciech A. Łonak, Badania i Usługi Archeologiczne, Kilińskiego 58, 46-300 Olesno, Poland

A b s t r a c t. The paper presents the results of dendrochronological dating of wood fragments from a well frame discovered in Wysoka. Oak wood for the well frame was obtained from trees harvested in the first half of the 14th century. The presence of sapwood in one of the samples permits the conclusion that the well was built in the 1430s. The dendrochronological analysis and visual assessment of the wood fragments show that wood from two oak trunks was used.

K e y w o r d s: dendrochronological dating, well frame, Middle Ages, Wysoka

INTRODUCTION

The dendrochronological method, which allows the dating of wood with one-year accuracy, is commonly used to determine the age of wooden elements recovered during archaeological excavations (BOLKA, KRĄPIEC 2012; CHOCHOROWSKI, KRĄPIEC 2018; PIOTROWSKA et al. 2019; RYBŃIČEK et al. 2018). It makes it possible not only to establish the age of an object, but also to determine the stages of construction or subsequent repairs of a feature (KRĄPIEC et al. 2006). Archaeological material often forms the basis for creating (GRABNER et al. 2021) or extending dendrochronological chronologies (RYBŃIČEK et al. 2018).

Wells with frames of various types are among the features with the best-preserved wood. What makes them particularly important for research is the fact that they appear with the establishment of settlements and their number increases with time (SMOLIŃSKI, WAŻNY 2011). One such interesting feature is undoubtedly the well from Wysoka (Opolskie Province, Olesno Commune, Fig. 1). The village was established in the vicinity of Olesno, close to the intersection of important trade routes: the amber route from Moravia to the Baltic coast and the royal route connecting Wrocław with



Kraków and the Black Sea (NOWAKOWA 1951; SAMSONOWICZ 1973). Records on the existence of a church in Wysoka date from 1339 (CHRZANOWSKI, KORNECKI 1960). Close to the place where the well was discovered there is an archaeological site, designated as Wysoka 5 (AZP 86-42) and dating to the late Middle Ages (14th–15th centuries) (Gminny Program Opieki nad Zabytkami Gminy Olesno na lata 2023–2026, DUWO, poz. 1886).

The aim of the present study was to dendrochronologically date the fragments of oak (*Quercus* sp.) wood constituting the frame of a well discovered during archaeological supervision in Wysoka.

MATERIAL AND METHODOLOGY

The material for the dendrochronological study was obtained in 2013 during earthworks for a new residential building. The earthworks were carried out on plot No. 316/87, located in the immediate vicinity of archaeological site No. 5 and the parish cemetery (Fig. 1). During the works, fragments of wood were encountered within clayey sand, which were elements of a well frame (Fig. 2). Unfortunately, it was impossible to document it *in situ*. The approximate dimensions of the well are 0.70×0.80 m (Fig. 3). The pointed corner posts were driven the deepest, down to about 2m below ground level. Some of the laths forming the walls have similarly tapered lower sections,

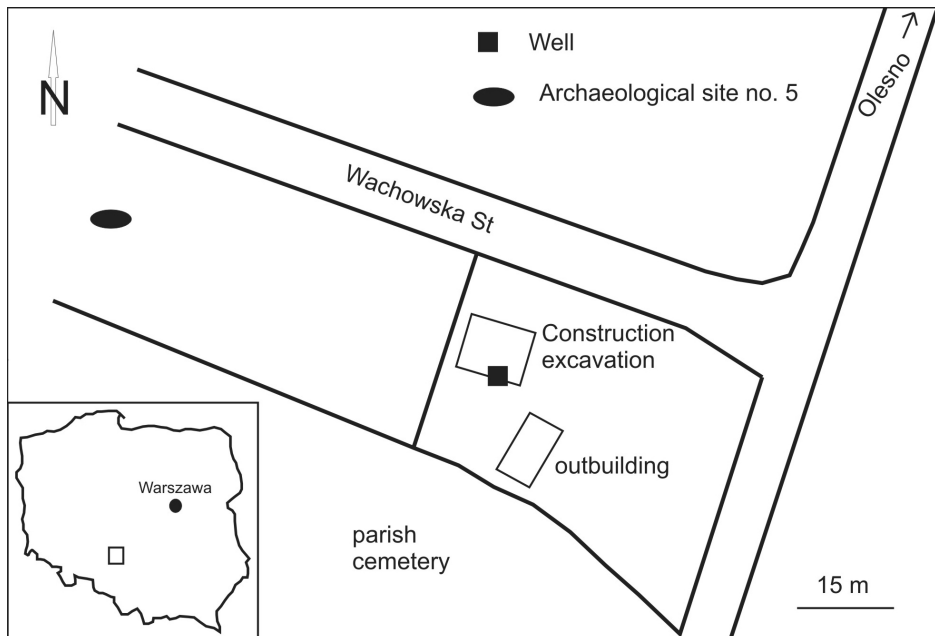


Fig. 1. Location of the investigated feature

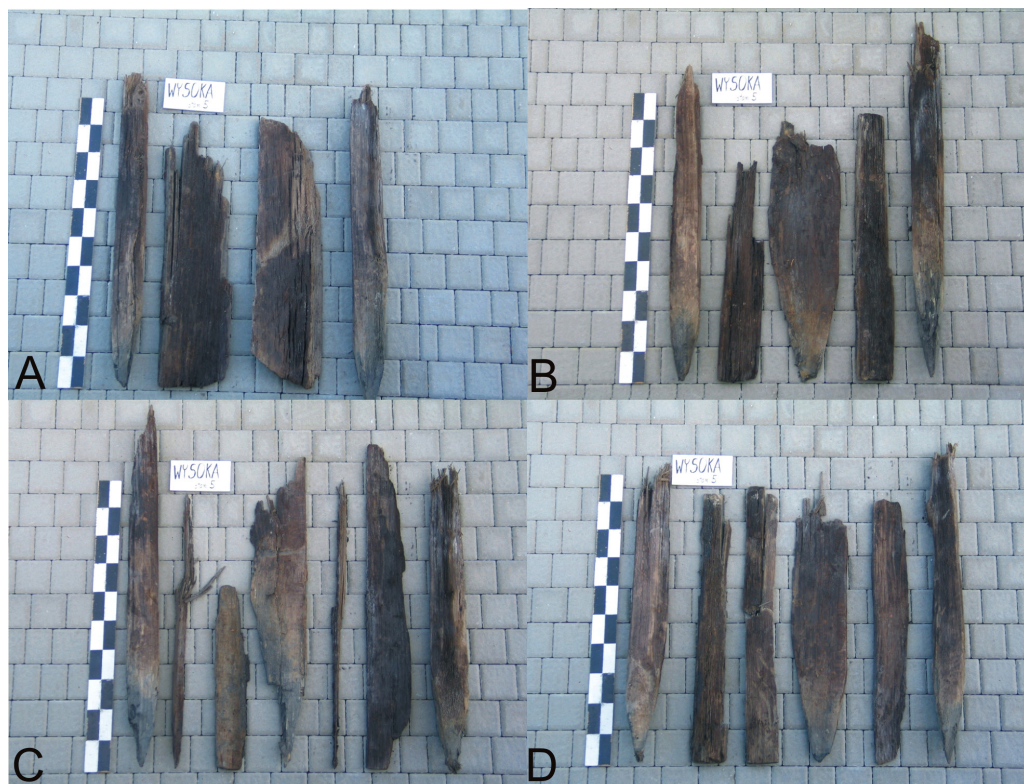


Fig. 2. Fragments of the well walls discovered during archaeological research, A – north wall, B – east wall, C – south wall, D – west wall

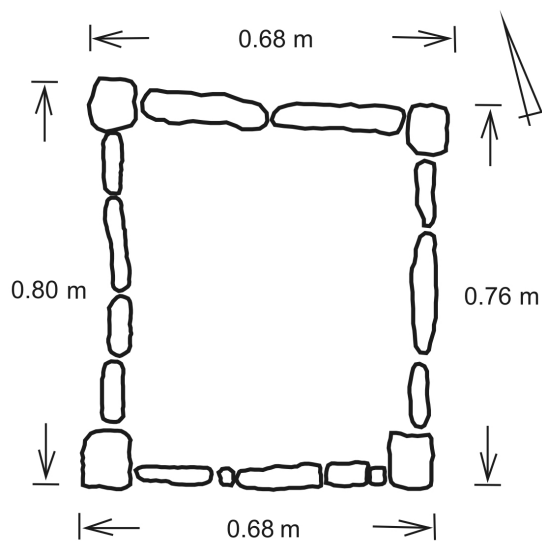


Fig. 3. Plan view of the well with approximate dimensions

suggesting that they were driven into the ground, albeit to a lesser depth than the corner posts. The average length of the wall elements is approximately 0.9 m.

Sixteen samples of wood fragments of the structural elements of the well were selected for dendrochronological analysis. Macroscopic and microscopic identification established that all samples were of oak wood and met the requirements of the dendrochronological method (ZIELSKI, KRAPIEC 2004). The good state of preservation of all samples (including one with a sapwood layer) and the adequate number of annual growth rings made it possible to carry out the study. The preparation of the wood involved cutting the outer layer of the wood with a preparation knife in order to obtain a clear image of the boundaries of the individual annual rings on the radial section. Ring-width measurements were carried out on a minimum of two radii for each sample using a Dendrolab 1.0 measuring device with digital recording of the results. The TREE-RINGS software package (KRAWCZYK, KRAPIEC 1995) was used to analyse the obtained sequences. Dendrochronological sequences were correlated using TSAPWin software (RINN 2005). The following statistical tests are included:

- The t-ratio: calculated according to the algorithm proposed by BAILLIE and PILCHER (1973) for time series analysis. Dating is considered reliable when the t-value is greater than 4–5, with correspondingly high values of the coefficient of concordance (Gleichläufigkeit);
- Gleichläufigkeit (GI): a measure of the concordance of annual trends in ring width changes in two chronologies being compared, expressed as a percentage of concordant cases (ECKSTEIN, BAUCH 1969). The statistical significance of the GI coefficient can be 95.0%, 99.0% or 99.9% and this is denoted as *, ** and *** respectively.

The absolute dating of individual sequences was obtained by comparing them with oak dendrochronological standards compiled for Poland (KRAPIEC 1998).

RESULTS AND DISCUSSION

Dendrochronological measurements produced sequences of annual ring widths covering 28 to 184 years (Table 1). Computer correlations and visual comparisons of the dendrograms made it possible to identify sequences representing trees growing at the same time. A mean WSK_AA1 curve of 204 years was compiled from the 12 tree ring sequences (Fig. 4). Its comparison with oak standards revealed that it represents the period of 1130–1333 AD. The curve shows the highest similarity to the Lower Silesian oak chronology (DSL_1, KRAPIEC 1998): $t=7.5$, $GI=63^{***}$, and slightly lesser similarity to the Greater Poland oak chronology WPL_1: $t=5.6$, $GI=64^{***}$.

The youngest rings preserved in the samples date from the late 13th and first half of the 14th century. Only in one sample (WSK7) were sapwood rings preserved, allowing the approximate year of felling of the tree to be determined as around 1338 AD. In the case of four wood samples, the dating was unsuccessful due to the insufficient number of rings (between 28 and 36 rings).

Table 1. Results of dendrochronological analysis of the wood samples

No.	Laboratory code	Description	Tree species	Number of rings	Sapwood	Sequence dating	Date of cutting down tree
1	WSK1	Sample no. 1	oak	175	–	1139–1312	after 1322
2	WSK2	Sample no. 2	oak	35	–		
3	WSK3	Sample no. 3	oak	184	–	1130–1313	after 1323
4	WSK4	Sample no. 4	oak	28	–		
5	WSK5	Sample no. 5	oak	173	–	1141–1314	after 1324
6	WSK6	Sample no. 7	oak	123	–	1145–1267	after 1277
7	WSK7	Sample no. 8	oak	183	176–183	1151–1333	1338 (–5/+8)
8	WSK8	Sample no. 9	oak	58	–	1219–1276	after 1283
9	WSK9	Sample no. 11	oak	181	–	1139–1319	after 1329
10	WSK10	Sample no. 12	oak	36	–	1242–1277	after 1284
11	WSK11	Sample no. 13	oak	35	–		
12	WSK12	Sample no. 14	oak	168	–	1147–1314	after 1324
13	WSK13	Sample no. 15	oak	111	–	1215–1325	after 1335
14	WSK14	Sample no. 16	oak	171	–	1143–1313	after 1323
15	WSK15	Sample no. 17	oak	33	–		
16	WSK16	Sample no. 18	oak	110	–	1164–1273	after 1283

By comparing the dendrochronological sequences of the individual wood samples with each other, as well as by visually assessing the dendrograms, it became possible to group the examined fragments. Samples WSK3, WSK7, WSK12 come from the same oak trunk, which was over 200 years old at the time of felling. It was split radially to produce laths (Fig. 5) used as the walls of the frame. The wood fragments coded WSK1, WSK5, WSK9 and WSK14 come from another fine-grained oak trunk. They represented corner elements of the frame and in cross-section they resemble a square with partially truncated corners (Fig. 6). No sapwood was found in these samples.

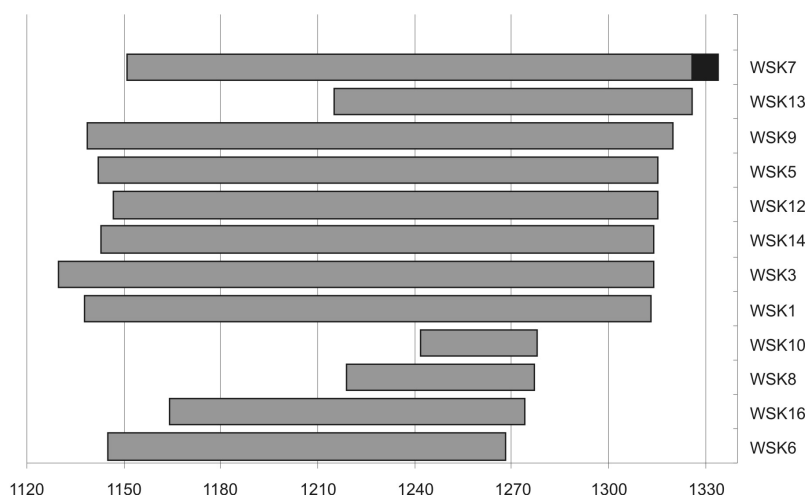


Fig. 4. Absolutely dated samples. Black colour marks sapwood rings



Fig. 5. Laths forming the walls of the well frame (cross-section)



Fig. 6. Corner elements of the well frame (cross-section)

The distribution of the dates of the youngest preserved rings makes it possible to establish that the analysed structural timber comes from trees harvested in the first half of the 14th century. On the basis of one sample with preserved sapwood, the approximate year of felling of one of the oaks could be established as around 1338 AD. In the case of samples from the other trunk and the other pieces, a *terminus post quem* could be determined. The analysis of the distribution of the youngest preserved rings in the samples allows us to conclude that the studied well is most likely a single-phase structure created at the end of the 3rd decade of the 14th century.

The presented analysis of all elements of the frame demonstrates the interpretative potential of dendrochronological analyses, unachievable with the study of single, selected samples.

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REFERENCES

- BAILLIE M. G. L., PILCHER J. R., 1973. A simple cross-dating program for tree-ring research. *Tree-Ring Bulletin* **33**: 7–14.
- BOLKA M., KRĄPIEC M., 2011. Dendrochronological and radiocarbon dating of the medieval stronghold in Ujście (Poland). *Geochronometria* **39**(1): 30–39. DOI: 10.2478/s13386-011-0057-y
- CHOCHOROWSKI J., KRĄPIEC M., 2018. Structure and chronology of Russian hunting stations on the Sørkapp-land and Hornsund Coasts (Spitsbergen). *Recherches Archeologiques. Nouvelle Serie* **9**: 137–183.
- CHRZANOWSKI T., KORNECKI M., 1960. Katalog zabytków sztuki w Polsce, t. 7: woj. opolskie, z. 10: powiat oleski. Instytut Sztuki PAN, Warszawa.
- ECKSTEIN D., BAUCH J., 1969. Beitrag zur Rationalisierung eines dendrochronologischen Verfahrens und zur Analyse seiner Aussagesicherheit. *Forstwissenschaftliches Centralblatt* **88**: 230–250.
- Gminny Program Opieki nad Zabytkami Gminy Olesno na lata 2023–2026, DUWO, poz. 1886.
- GRABNER M., WÄCHTER E., NICOLUSSI N., BOLKA M., SORMAZ T., STEIER P., WILD E. M., ECKART F., KERN B. A., RUDORFER J., KOWARIK K., STÖLLNER T., RESCHREITER H., 2021. Prehistoric salt mining in Hallstatt, Austria. New chronologies out of small wooden fragments. *Dendrochronologia* **66**: 125814. DOI: 10.1016/j.dendro.2021.125814.
- KRAWCZYK A., KRĄPIEC M., 1995. Dendrochronological database. In: Proceedings of the 2nd national conference: Computers support of scientific studies, 4–16 Dec 1995, Wrocław: 247–252 (in Polish).
- KRĄPIEC M., 1998. Oak dendrochronology of the Neoholocene in Poland. *Folia Quaternaria* **69**: 5–133.
- KRĄPIEC M., SZYCHOWSKA-KRĄPIEC E., DANEK M., KLUSEK M., 2006. Analiza dendrochronologiczna drewna pozyskanego w trakcie badań wykopaliskowych prowadzonych w Krakowie na Rynku Głównym po zachodniej stronie Sukiennic. Muzeum Archeologiczne w Krakowie, Materiały Archeologiczne **36**: 181–187 (in Polish).
- NOWAKOWA J., 1951. Rozmieszczenie komór celnych i przebieg dróg handlowych na Śląsku do końca XIV wieku. *Prace Wrocławskiego Towarzystwa Naukowego. Seria A, nr. 43* (in Polish).
- PIOTROWSKA M., OKUPNY D., TWARDY J., FORYSIAK J., 2019. Roman period well fills resulting from using and abandonment in environment of a river valley (Kwiatków site, Central Poland). *Studia Quaternaria* **36**(1): 55–69.

- RINN F., 2005. TSAP-Win. Time series analysis and presentation for dendrochronology and related applications. User Reference, Heidelberg.
- RYBNÍČEK M., CHLUP T., KALÁBEK M., KALÁBKOVÁ P., KOČÁR P., KYNCL T., MUIGG B., TEGEL W., VOSTROVSKÁ I., KOLÁŘ T., 2018. New dendroarchaeological evidence of water well constructions reveals advanced Early Neolithic craftsman skills. *Dendrochronologia* **50**: 98–104. DOI: 10.1016/j.dendro.2018.06.003.
- SAMSONOWICZ H., 1973. Przemiany osi drożnych w Polsce późnego średniowiecza. *Przegląd Historyczny* **64**(4): 697–716.
- SMOLIŃSKI A., WAŻNY T., 2011. Analiza dendrochronologiczna próbek drewna z wczesnośredniowiecznego grodziska w Płońsku woj. mazowieckie. *Acta Universitatis Lodziensis, Folia Archaeologica* **28**: 219–226. DOI: 10.18778/0208-6034.28.11.
- ZIELSKI A., KRĄPIEC M., 2004. *Dendrochronologia*. PWN, Warszawa.