A MEDIEVAL SUNDIAL FROM THE BENEDICTINE MONASTERY OF KAPOSSZENTJAKAB (SOMOGY COUNTY, HUNGARY)

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This article is based on one originally published in Hungarian in *Study Volume of the Fifth Annual Conference of Young Medieval Archaeologists*, Szentendre (2014).[1] This version is published here as the find is an extremely interesting one. The Editors have some reservations about the authors' interpretations of the item and readers are cautioned to form their own opinions on the details of the gnomonics. *Ed.*

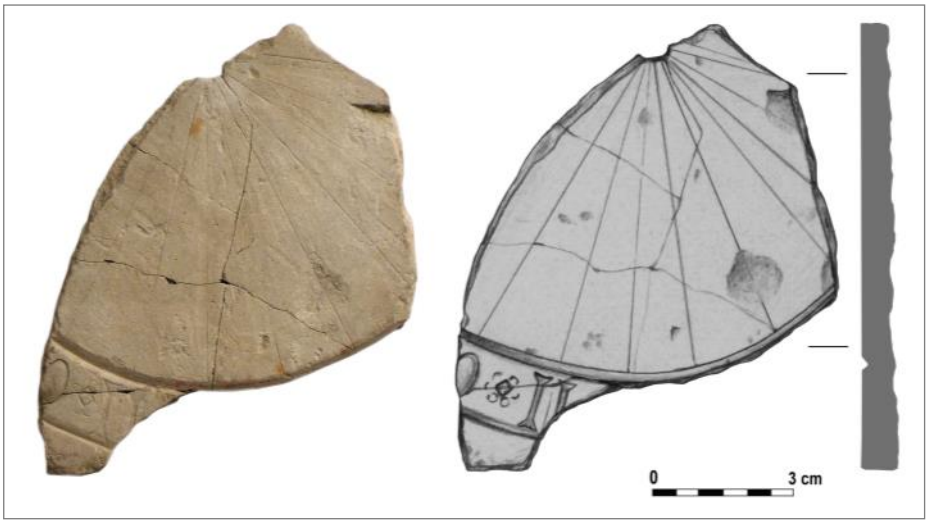

Fig. 1. The fragment of the sundial of Kaposszentjakab. Photo and drawing: Zsolt Nyári.

In the course of excavations in 1960–6 at the Benedictine monastery of Kaposszentjakab (in modern Kaposvár) which flourished between the 11th and 16th centuries, there came to light a fragment of a medieval sundial carved in stone. This rare and extraordinary object is one of few similar examples occurring in Hungary and is worthy of note from the point of view of archaeology, history and astronomy. A sundial can be seen as an artistic creation or a technical masterpiece since the choice of material and the craftsmanship involved in its construction require great ability. This is why we think it is worth describing this unique discovery in a short article.

Provenance and Description of the Fragment

The fragment (Fig. 1) is kept in the Rippl-Rónai Museum in Kaposvár (inventory number 1067.716.1). It was found in 1964 at the south-eastern corner of the monastery of Kaposszentjakab in a layer of building rubble dating from the 15th century according to a note in the inventory book. Neither the details of the results of the excavation nor those of the collection have appeared until recently so we are at present unable to assign a more precise date. The discovery site is at 42° 22′ N, 17° 48′ E though we do not know the exact position where the fragment was found. It measures 14 × 7.5 cm and is between 1 and 1.5 cm thick. It is a thin slab of grey slaty sandstone; on its surface can be seen the finely scored divisions of the sundial with numerals lying between two more deeply carved semicircles. The hour lines diverge from a focus. The dial plate could have had 12 hour lines and possibly lines above the sunrise–sunset line as well. The numerals are Arabic as we can see from the presence of a zero and since they proceed anticlockwise we know this must have been a vertical dial. The rosettes between the numerals could mark the half hours as in the case of the sundial of the Saxon St Bartholomew's Evangelical church at Brasov (Romania). The missing gnomon presumably had its origin at the focus of the hour lines. Comparing the Kaposvár dial with others of a medieval origin it appears to be of better quality and made by more skilful hands.

On Vertical Sundials

Vertical dials tended to be located on the southerly aspect of buildings though these did not usually face due south so that dials often needed to be slightly asymmetrical. They were often placed high on buildings which made for more difficulties though it also helped to ensure their survival. They would show local solar time though in 1848 unified local time was introduced from Budapest, connected with the Hungarian train service. On a vertical dial the hour divisions are closer together around midday and further apart towards the morning and the evening hours. We often find that the divisions are incorrect owing to the ignorance of the maker to or the age of the dial. The number of correctly delineated dials in Hungary increased from the 15th century onwards. In ancient and medieval times the daylight hours were divided into 12 equal parts as were the hours of darkness. In the earliest examples the day was divided into four or eight parts relating to the rites of the

church and though their divisions were equal they did not represent equal periods of time. To mark equal periods of time it is necessary that the divisions have varied angles as detailed above. The earliest example in Europe dates back to 1342.

Sundials in many cases formed parts of buildings or, in later times, monuments. The database of Hungarian sundials contains 405 entries of which 234 are vertical dials, few of these being medieval or modern. We can date only one to the Árpádian age (1000–1301) and this is on the Roman Catholic church in Pozsonyi Street in Sopron. We can date six examples to the late Middle Ages (1301–1526): Rudabánya, Mátraverebély, Szentendre, Narda, Kőszeg and Ráckeve. There remain eight examples from the early modern period (1526–1711): Kőszegdoroszló, Kőszeg, Győr, Balf (four dials) and Sopron. It is difficult to find exactly similar parallels in Hungary – as Adrienne Buka writes – because the majority were sited on monasteries or churches which were later destroyed. Even if painted or carved sundials survived the centuries they could still be destroyed during restoration work because of lack of interest in such archaic structures. Only two sundial fragments have been discovered by archaeological excavations apart from that at Kaposszentjakab. A sundial fragment was found at the nunnery of Veszprémvölgy (Veszprém, Veszprém county) and a further one came to light near Buda Castle (Budapest) when excavations in Öntőház Street were made by Károly Magyar.

Reconstruction and Dating

As the majority of sundials are systematically designed according to astronomical principles it is theoretically possible to reconstruct the dial at Kaposszentjakab. It could originally have been semi-circular or rectangular, the gnomon being at or above the focus of the hour lines and probably polar-oriented. The radius of the dial from the focus of the hour lines to the outer semicircle is 17 cm, the part of the fragment outside this being 2.0 cm, and the part outside the upper surface of the dial being at least 1.5 cm. The area of the original slab was at least 38 × 19 cm and may have been as large as 46 × 25 cm.

This slab could have been fixed to a south facade, showing the time on the south wall of the monastery courtyard. It was either pulled down and destroyed or it fell and was found by later excavation. The church and monastery of Kaposszentjakab have by and large an east–west alignment, taken from the western nave to the eastern apse. The main walls of the monastery face the four main compass points so that the northern wing of the monastery courtyard faced south. Its exact measured azimuth is 93.3°, only 3.3° from due east.

On the polished surface of the sundial radial lines from the focus end at a double semicircle, the 12 divisions representing the 12 daylight hours, the six on the right representing the afternoon hours. On the left only three sections remain. Here also can be seen the inner pair of semicircles terminating the hour lines. The hour lines are straight and seem to have been carved with a sharp tool. They converge with millimetre accuracy to a point. Five (from 9 am to 2 pm) are complete while the remainder (3 pm to 6 pm) are partial but still accurate in direction. After extending the hour lines we have measured the exact angles with a goniometer as:

10 – 11	14.8°
11 – 12	13.6°
12 – 1	14.0°
1 – 2	13.9°
2 – 3	15.3°
3 – 4	14.8°
4 – 5	14.1°
5 – 6	14.4°

These lie between 13.6° and 15.3° and if we ignore the two outside values the rest vary between 13.9° and 14.8° with an average of 14.3°. In practical terms the angles are almost equal and the scratched lines on this hard but friable material mark out equal sections.

If the dial were a complete semicircle each of the 12 divisions would measure 15°, but in the case of the Kaposszentjakab dial the vertical noon line and the 6 pm line are not orthogonal but are at an angle of 86.5° to one another. This difference of 3.5° makes the reconstruction of the fragment more difficult and we can imagine two explanations for this difference:

1. The noon line of the dial is the vertical axis of symmetry. The six 14.4° sections of the afternoon hours would equal about 86.5° and this could be true of the morning hours as well. The upper edge of the dial would not be horizontal and the 6 am and 6 pm lines would each depart from it by 3.5°. With a vertical noon line and morning and afternoon hours equalling one another the sundial would be totally symmetrical.

2. The 6 pm line of the sundial could be horizontal with the noon line being shifted 3.5° to the right. This would mean that the 6 am line would be shifted down 7° from the horizontal making the sundial asymmetrical.

The second explanation is more probable and connected to the fact that the southern wall of the monastery does not face due south but deviates from it by 3.3°. At the foundation of the monastery in the 11th century it was intended to orientate the wall exactly south but this was not achieved. The designers and makers of the dial could take this into consideration. The sun's course across the sky is a regular 15° per hour from east to west but at our latitude a vertical dial plate is at a fairly large angle from the ecliptic. We have calculated, using the program *www.kompf.de/gps/sunclock.php*, all the hour line angles for 46.35° N, 17.84° E. Present-day sundials take into account standard time (for us Central European Time, CET) which agrees with modern time signals. Until the introduction of

standard time in 1892, sundials showed local solar time. This is why we have made the calculation for 15° E which is in the middle of our 7.5° to 22.5° E CET time zone.

Assuming an exact south-facing wall and a vertical noon line the angles of the 12 sectors were: 21.2, 18.7, 15.3, 12.9, 10.5, 10.5, 10.5 11.2, 12.9, 15.3, 18.7, 21.2, with an average of 15° though the individual hours are considerably divergent from 15°.

If the program takes into consideration the 3.3° deflection of the wall at Kaposszentjakab the hour lines alter somewhat and the sundial is asymmetrical. A calculation on another wall produced different angles and the 6 am line was not included since sunlight would not fall on that wall at that time. The angles from 7 am were: 19.7, 16.4, 13.6, 11.6, 10.6, 10.4, 10.9, 12.3, 14.6, 17.7, 20.6. The noon line on the wall is vertical. The average of the sections of the correctly calculated sundial is 14.4° (as only 11 sections add up to [71.9 + 86.5] = 158.4 degrees), but the angles of the sectors are between 10.4 and 20.8 degrees. These are very different from the 15 and 14.4 degrees. It is interesting that the average of the sectors calculated with a modern program is in accord with the medieval sundial discovered here. It is even more interesting that the 6 pm line calculated from the computer program is not horizontal either but lies at 86.5° as is the case with our sundial.

So the sundial used to be a chronometer divided into 12 equal parts and could be used for so-called monastic or temporal timing (‘ancient timing’) so that prayer times (Fig. 2) were related to it. The times of prayer were:

Prime – at dawn
Terce – at the third hour ca. 9 am
Sext – at the sixth hour ca. midday
None – at the ninth hour ca. 3 pm
Vespers – at eventide

The sundial was a transition between the equiangular ones of the early Middle Ages (4–8 sectors) and the ones with varying angles from the late Middle Ages (12 sectors). Though the dials with varying angles showed equal hours, the hours shown by the equiangular ones could be anything from 40 to 80 minutes in duration. According to these we could construct a sundial which accords with the first theory but will show considerable variation (Fig. 3).

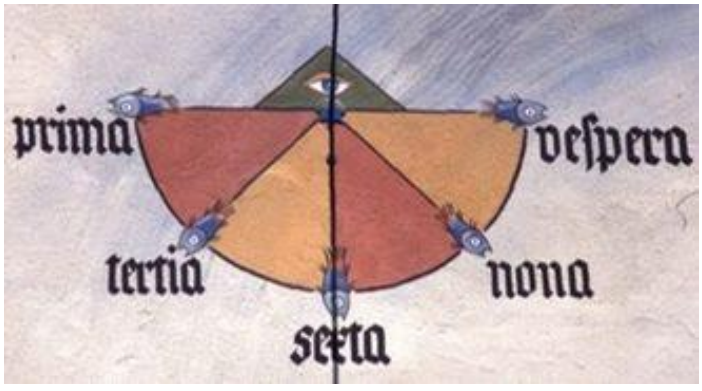

Fig. 2. So-called monastic sundial.[2]

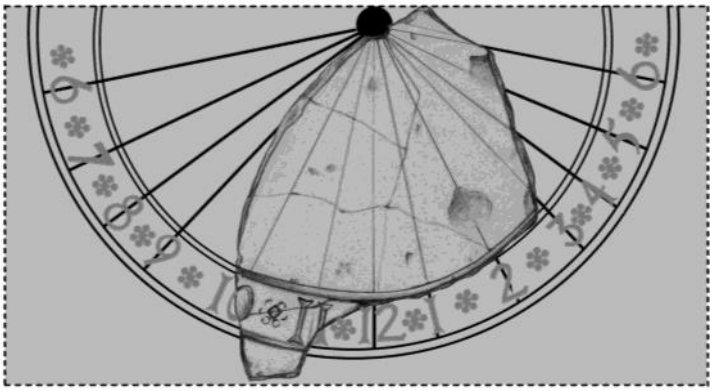

Fig. 3. Reconstruction of the sundial of Kaposszentjakab. Design: Máté Varga, drawing: Zsolt Nyári).

Script with Arabic numerals spread through our homeland during the 15th century though Roman numerals were in use earlier. For a while both styles were to be found on both documents and sundials. Some say that the first inscription using Arabic numerals is in the sanctuary of the church of Magyarvalkó (Valeni, Romania) where there is a mixture of Arabic and Roman numerals. The numbers 1 and 4 were written and followed by V and II representing the date 1452. We know an earlier inscription which uses an Arabic numeral. On a headstone in Segesd (Somogy county) is inscribed M●CCC●XL followed by an Arabic 6 which dates the stone to 1346. Since we do not know from the fragment which script method was used we are using standard Arabic numerals in use in the 16th century, though it is still possible that a mixed numbering was used.

Although there is no date on the fragment we can assign a *terminus ante quem* to its date of installation. The territories outside Somogy county came under Turkish rule in 1543, but Kaposvár with its fortified monastery of Kaposszentjakab and its direct surroundings were occupied by the Turks in 1555. According to these facts we date the design of the sundial to the second half of the 15th century or the beginning of the 16th.

Parallels

There are no sundials similar to that of Kaposszentjakab in the Carpathian Basin but the one which most resembles it is to be found at Szentendre in Pest County (Fig. 4) where there is a round-arched sundial with 12 equal sections (all around 15°) but no numerals. There is another similar sundial on the wall of the medieval church at Kolozsmonostor in Transylvania (Fig. 5) with Roman numerals but no lines above the 6 o’clock hour lines. It may date from 1440.

There are more sundials with similar structures in other countries. In Germany particularly we can easily find parallels since over 6,000 sundials have been recorded there. Those most similar to our discovery are at Stendal (Fig. 6), Oebisfelde (Fig. 7), and Erfurt (Fig. 8). All three have Arabic numerals lying between two semicircles. The

Fig. 4. The sundial of Szentendre.[3]

Fig. 5. The sundial of Kolozsmonostor.[4]

first sundial is semicircular while the other two occupy a full circle and we can date all three to the turn of the 15th/16th centuries.

Summary

In medieval Hungary many different types of sundial were in use but few are left for us to investigate today. In particular we know of very few from excavations, so the review and analysis of the one at Kaposszentjakab is important for several reasons. Vertical sundials are often located on medieval churches or monasteries because the daily life of their residents was governed by them. At first sight it seems that the vertical sundial carved in stone at Kaposszentjakab is a well-constructed work but its compilation is a little imprecise. From the sundial fragment we can reconstruct the whole: on an equiangular sundial one sector can represent between 40 and 80 minutes. The semicircle was divided into 12 equal parts showing the time between 6 am and 6 pm. The average angle of the 12 sections is 14.4°. The rod of the gnomon which was polar oriented is lost but its root can be seen. The numerals of the sundial are located between two semi-circles and we can see fragments of the Arabic numbers 10 and 11. We can find parallels with this sundial in Szentendre and Kolozsmonostor in the Carpathian Basin, while foreign parallels are in Stendal, Oebisfelde, and Erfurt in Germany. From these and their dating we can date the construction of the sundial to the second half of the 15th century or at the very latest to the beginning of the 16th century. It could not have been made later than 1555.

Fig. 6. Sundial in Stendal.[5]

Fig. 7. Sundial in Oebisfelde.[6]

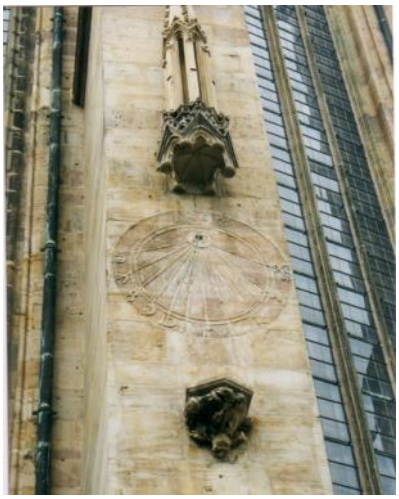

Fig. 8. Sundial in Erfurt.[7]

ACKNOWLEDGEMENTS

The authors are grateful to Krisztián Szigetvári for translating the text of the original article into English, and to John Lester for help with the preparation of this version.

NOTES and REFERENCES

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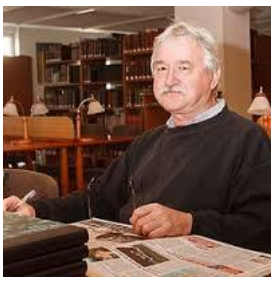

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