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NEW MEDIEVAL SUN COMPASSES? THE PROBLEM OF THE FUNCTION OF STONE DISKS FROM SOUTHERN RUS'

ABSTRACT

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The article explores stone disks discovered at medieval sites in Rus'. A total of eight pyrophyllite slate objects, sourced from outcrops near Ovruch (Ukraine), were analysed. These disks have been previously interpreted as various items, including calendars, craft tools such as needle sharpeners and polishing stones, as well as components of hand-operated bow drills. Through measurements and surface analysis, three stone disks (Kyiv, Listven, Liubech) exhibit similarities to Vikings' sun compasses, with a limited number of examples found in Greenland and the Baltic Sea region. The analysed objects were dated to the period between the late 12th and mid-13th centuries. The origin of the raw material suggests local manufacturing. At the same time, the form and function may have been influenced by Scandinavian traders and sailors, aligning with the presence of these disks along rivers within the trade route 'from the Varangians to the Greeks.' Further studies and archaeological experiments are necessary to confirm whether these disks had a practical navigational purpose.

Keywords: sun compass, Ovruch pyrophyllite slate, stone disk, Rus', navigation
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INTRODUCTION

One distinctive cultural trait in medieval Central and Eastern Europe is manifested through the prevalence of diverse artefacts crafted from red pyrophyllite slate, exhibiting hues ranging from light pink to purple. This raw material found application in various contexts, including tombstones, sizable decorative elements intricately carved within places of worship in Old Rus', as well as icons, querns, whetstones, weights, casting moulds, spindle whorls, crosses, beads, and other items.

A notable concentration of these artefacts has been identified within the territory of southern Rus'; however, spindle whorls originating from abroad are also documented in this region. Despite an exhaustive exploration encompassing diverse categories of pyrophyllite items, the examination of associated workshops, distribution routes, and chronological aspects (Rozenfeldt 1964, 220-224; Rybakov 1948, 188-195), numerous unresolved questions persist within this domain.

Recently, the investigation into products derived from the pyrophyllite industry has undergone a heightened focus, primarily catalysed by the implementation of a scientific project aimed at the exploration and preservation of a medieval outcrop named Ovrutskoykras. This initiative, spearheaded by A. P. Tomashevskyi (Tomashevskyi 1998, 151-155; 2005, 186-194; Pavlenko 2005), has not only intensified research outcomes related to pyrophyllite deposits, settlements, and workshops in proximity to Ovruch – where pyrophyllite items were processed – but has also extended its purview to encompass diverse categories of pyrophyllite discoveries from other regions within southern Rus' (Pavlenko 2001). This surge in focus has further stimulated a comprehensive investigation of pyrophyllite artefacts within the Chernikhiv Polissia territory (Veremeychyk 2008; 2013; Sytyi and Skorokhod 2012).

The escalating volume of studies and publications dedicated to these materials has facilitated the identification of a collection of stone disks featuring concentric rings and dimensions that significantly deviate from conventional spindle whorls. These distinctive characteristics form the foundation for the research presented in this paper. An effort has been made to establish connections between some of these disks and artefacts previously documented in scientific literature, where they have been denoted as compasses (see Sølver 1953; Thirlsund 1987; 1999; Stanisławski 2000).

THE MATERIALS – DISKS OF PYROPHYLLITE SLATE

Within the diverse array of pyrophyllite artefacts, attention is drawn to objects of an unclear function. Of particular interest are relatively uncommon discoveries of disks adorned with concentric rings on their surfaces, occasionally featuring radial lines or notches.

We have successfully compiled information regarding the sizes and appearances of nine such disks. However, a detailed description was available for only four of them (from Listven, Liubech, Kyiv, and Gubin). As for the remaining disks, their documentation is limited to published photographs, lacking comprehensive descriptions or containing only scant information, which will be elucidated in the subsequent discussion.

1. Malyi Listven, Chernikhiv region

Two such artefacts are known from the Chernikhiv district. The first originates from a settlement adjacent to the Stronghold II near Malyi Listven village. Researchers interpret the archaeological sites near Malyi Listven as correlating with the Listven mentioned in chronicles (so-called letopises), quoted in the year 1024 AD. This settlement is situated along a water trade route on the Bilous River, connecting Chernikhiv and Liubech between the 10th and 13th centuries (Kovalenko and Shekun 1984).

A pyrophyllite slate disk was discovered within the remains of a two-storey dwelling (Trench 1, Structure 1), dated to the end of the 12th and mid-13th centuries (Shekun and Veremeychyk 1986, 328). The find, circular and pink in shape, had a diameter of 6.5 cm, a thickness of 1.3 cm, and a hole diameter of 1.7 cm (Fig. 1). Its surface exhibited a polished, shining, and smoothed texture, with a rounded side edge. An irregular undulating line was carved on the lateral surface, approximately in the middle. The disk's surface was well-preserved, with minimal damage. On one side, four deep concentric rings were present, with irregular spacing between them. The first outermost circle was located 0.5 cm from the edge, the second at the same distance from the first. The third and fourth circles were carved 0.3 cm from each other. The distance between the irregular fourth internal circle and the central hole was 0.7 cm. This side of the disk featured twelve radial lines outlining irregular sectors. Most lines were deeply carved, radiating from the hole towards the outermost circle but not crossing

Fig. 1. The disk of pyrophyllite slate from Listven, Ukraine (Photo by O. Veremeychyk)

Fig. 2. The disk of pyrophyllite slate from Liubech, the Castle Hill, Ukraine (Photo by O. Veremeychyk)

it. On the back side, six concentric rings were observed, with a part showing seven. It is plausible that during the carving of lines near the hole, the distance between the rings was reduced, leading to variations in measurements. The first outer ring on this side was carved 0.5 cm from the edge, with the distances between the first, second, third, and fourth circles being almost identical at 0.3 cm.

Upon further observation, a disrupted arrangement of concentric rings becomes apparent on the disk. The internal ring was carved 0.5 cm from the hole. On this side, the disk is also segmented into irregular sectors with lines radiating from the hole towards the outer circle. Additionally, around the hole, additional diagonal notches are visible. The radial lines on both sides were carved onto the existing concentric rings.

2. Liubech, Chernikhiv region

Another fragment of a pyrophyllite disk was documented in Liubech on Castle Hill (Trench 1) in 2010 (Veremeychyk and Bondar 2010, 185, fig. 209). This artefact originates from a cultural layer dated to the end of the 12th-13th centuries.

Only a quarter of the original object remains intact (Fig. 2). The slate disk has delaminated, leaving only a fragment of one of its surfaces. The estimated diameter of the item was approximately 7.5 cm, with a hole measuring 1.8 cm in diameter. Four concentric rings are still clearly visible on the disk, with the first one situated 0.5 cm from the external edge. The distance between the other circles is roughly the same, around 0.3 cm. Because some circles have nearly vanished, determining the original number or their original spacing is challenging. Additionally, the disk features three irregular, notched radial lines.

3. Kyiv

During excavations in the area of Gonchari and Kozhumiaki in Kyiv, a pink pyrophyllite slate disk was unearthed in a cultural layer dating to the Old Rus period (Kozubovskyi *et al.* 1993, 251-253). The disk had a diameter of 6.5 cm, with a hole diameter of 2 cm. On one side of the disk, the authors of the publication noted four concentric rings, each at an approximately equal distance (0.4-0.5 cm). One of the internal circles featured characteristic diagonal notches. Unfortunately, the photograph provided in the publication is of low quality, preventing an accurate determination of the number of notches.

Furthermore, the clearly visible rings on this side are intersected by radial lines, forming distinct sectors. On the severely damaged reverse side of the disk, an inscription remains: И...ОАНАКИЛО, which, according to S.O. Vysotskyi, may signify 'the circle of John'.

4. Gubin, Khmelnytskyi region

The disk discovered in Gubin has been dated to the 12th-13th centuries, featuring a diameter of approximately 10 cm and a hole diameter of 2.3 cm. On both sides of the disk, three concentric rings were carved, although no radii were documented (Fig. 3). The author of the publication of the disk interprets the artefact as a polishing stone. In the Cyrillic alphabet, three words are inscribed: Jesus, Amen, Yarilo. This inscription is accompanied by a solar symbol (Yakubovskyi 2020, 120, fig. 103: 3).

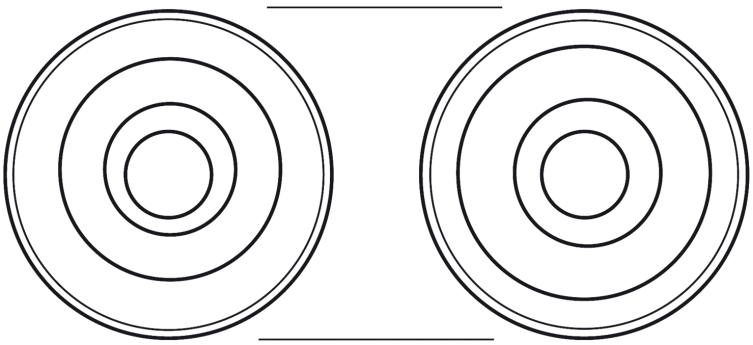

Fig. 3. Drawing of radial lines on the disk in the published photo
(No scale – illustrated by O. Antowska-Gorączniak after Yakubovskyi 2020, fig. 103:3)

5. Others

Similar discoveries have also been documented in Kyiv Podol (four items) and Mstislav' in Belarus, although precise information about them is unavailable (Kozubovskyi *et al.* 1993, 253).

An analysis of photographs depicting fragments of the disks from Kyiv suggests that the disks had external diameters ranging from 6.6 to 10 cm, with central holes varying from 1 to 2.2 cm. In one instance, the hole was square-shaped with a side length of 1.4 cm. However, publications lack detailed descriptions and chronological information regarding these items.

Consequently, concentric circles have been identified on the discussed disks, accompanied by either inscriptions (two items) or radial lines (three items).

FUNCTIONS OF THE DISKS

Various interpretations regarding the function of these disks have been proposed. O.V. Shekun suggested, based on the division of the item into twelve sections, that the disk from Listven might have served as a calendar. The authors of the publication on the disk from

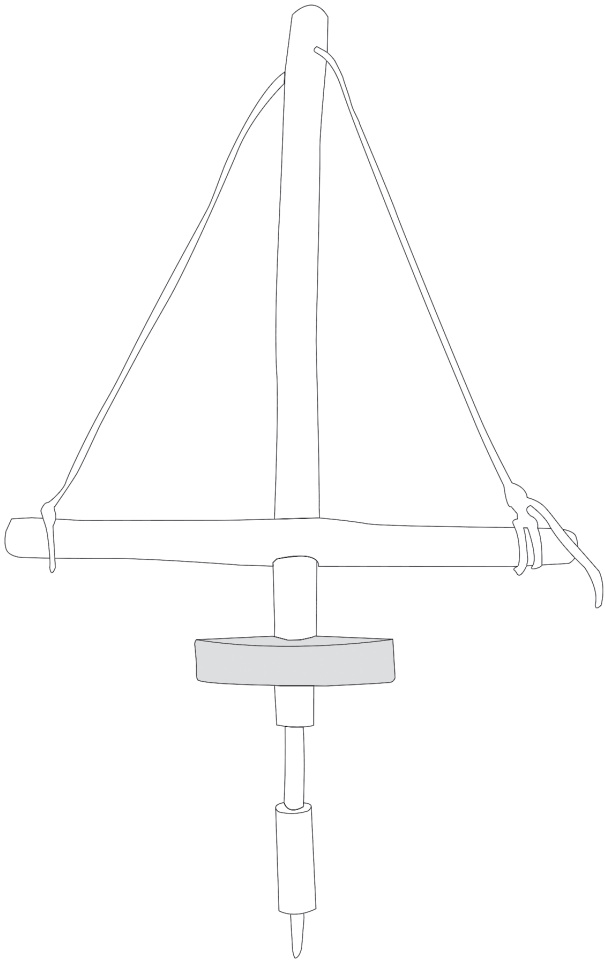

Fig. 4. A bow drill with a stone disk-base
(Illustrated by O. Antowska-Gorączniak after Popkiewicz 2012)

Gonchari and Kozhumiaki also allowed for such an interpretation while additionally suggesting their potential use as needle-sharpening devices (Kozubovskyi *et al.* 1993, 253). In contrast, the discoverers of the artefact from Gubin interpreted the disk as a polishing stone (Yakubovskyi 2020, 120). Being a relatively soft rock, pyrophyllite slate was easy to process. The polished surfaces of the disks, however, lack visible traces of wear that would be expected if they had been used as polishing stones, suggesting a different function.

A. P. Tomashevskyi and A.A. Chekanovskyi have suggested (in personal communication), that these objects might have served as flywheels for manual bow drills used in jewellery production (Fig. 4). In such an interpretation, the main axis of the tool would pass

through the central hole and have at its end a sharp drill for boring holes. Similar tools, for instance, might have been utilised to drill holes in amber (Popkiewicz 2012, 565). Thus, one possible function of the pyrophyllite slate disks appears to be connected with crafts, although this does not preclude a secondary use for other purposes.

The division into sectors observed on three of them (Listven, Kyiv – the area of Gonchari and Kozhumiaki, Liubech) allows for the assumption of another potential function. Recent discussions among Polish researchers regarding similar disks found in Greenland and Poland, made from wood, bone, or stone in one case, have led to the hypothesis that these objects could be compasses – navigational instruments used by Vikings (Stanisławski 2000, with further references therein, 2002, Jagodziński 2015, 46-51). Carl S¸lver was the first to propose such an interpretation of the disk from Greenland in 1953. The pros and cons of this hypothesis are presented below.

SUN COMPASSES

The hypothesis of Vikings employing navigational instruments, including sun compasses, is a widely debated idea with both proponents (*e.g.*, Stanisławski 2000; Indruszewski and Godal 2006) and critics (*e.g.*, Roslund *et al.* 2003; Filipowiak 2020, critically assessing data and prior discussions; 2022).

To date, several artefacts from early medieval Europe have been identified and interpreted as navigational instruments:

1. A wooden disk discovered in Greenland – unearthed in 1948 by Danish archaeologist Christen Leif Vebćk near the Uunartoq fjord, in the southern part of the island within the Narsarsuaq settlement (Fig. 5: a). Preserved is half of the object with a diameter of approximately 7 cm, about 1 cm thick, and features a hole around 1.5 cm in diameter. On one side of the dial, around its perimeter, there are 32 triangular notches and two lines – one straight and the other curved – interpreted as gnomonic lines (Sølver 1953, 294). The remnants of the structure where the disk was discovered were initially dated, using the ^{14}C method, to approximately 1000 AD (Thirslund 1987). However, recent verifications of the site have raised concerns about its stratigraphy, and the relics above the layer containing the disk were dated to the 14th-15th centuries (Arneborg *et al.* 2012, 23, 24, fig. 9). Consequently, the dating of this specific object, the wooden disk, remains far from unequivocal.

2. A second disk from Greenland was located in the Uunartoq fjord – detailed information about this object is not available (Thirslund 1987; Stanisławski 2000, 159).

3. A triangular stone from Greenland, situated in the eastern part of the island at Vatnahverfi farm – features a gnomonic line indicating 61°N latitude (Thirslund 1987; Stanisławski 2000, 159).

4. A semicircular stone from Denmark, discovered on the Albuen peninsula by Aase Hansen – likely constitutes half of an artefact with one damaged surface (Fig. 5: b). It ex-

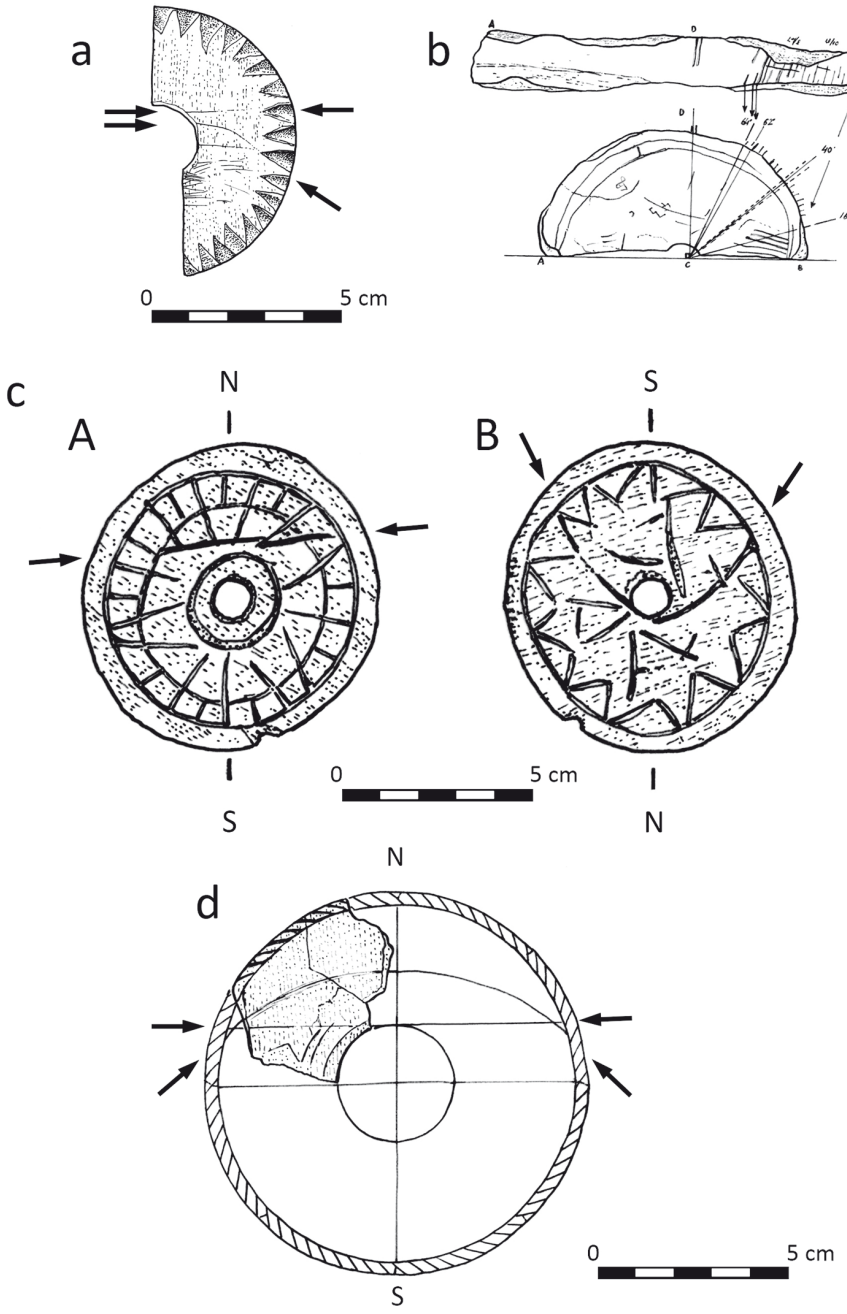

Fig. 5. The disks recognised hitherto: wooden (a, c), stone (b – no scale) and of whale bone (d) (Illustrated by O. Antowska-Gorączniak after: a – Jagodziński 2015, fig. 37; b – Thrislund 1987, 27; c – Stanisławski 2000, fig. 4, 5; d – Jagodziński 2015, fig. 39)

hibits notched lines on its side and radial lines on the surface (four remaining), along with a clearly recognisable fragment of the edge of its hole (Thirslund 1987, 21; Stanisławski 2000, 159).

5. A wooden disk from Wolin was discovered in the year 2000 during excavations led by Władysław Filipowiak at Site 4, specifically in Trench 2, within wooden structures found in Layer IV (Fig. 5: c). Crafted from oak wood, it measures 8.1 cm in diameter when measured along the growth rings but 8.6 cm across them, approximately 0.9 cm thick, with a central hole diameter of around 1 cm. On side A of the disk, the radii on the dial were marked following a 12/24-part system, albeit with some inaccuracies. These markings were incised with a sharp knife to 1-2 mm depth. Side A also featured three concentric rings and 24 incised lines extending from the last circle towards the middle of the dial, more or less perpendicular to the outermost ring. The shorter notches terminated on the second circle, while the longer ones almost reached the third circle. On the opposite side of the artefact, side B, only one circle was incised around its perimeter, along with twelve irregular triangles oriented with their apices facing the centre of the dial and four semicircular incised lines with a side rectangular notch. However, a different interpretation of these ornaments has been proposed by W. Filipowiak, suggesting that there were no semicircular notches, and instead, the lines formed a pattern of eight circular ornaments on the disk and around its hole, five of which were almost L-shaped (Filipowiak 2020, 321, fig. 4: A). The artefact has been dated based on dendrochronological dates obtained from samples taken from the construction of the wharf and a house, along with stratigraphical data, to the first half of the 11th century, likely its final stage (Stanisławski 2000). However, a more recent publication raises some doubts about such a narrow dating, as archaeological data from the layers may have been mixed (Filipowiak 2020, 321).

6. Fragments of a bone disk and a square bone object from Truso (Janów Pomorski) were unearthed by Marek Jagodziński during excavations conducted between 2001 and 2003 within the port settlement area, specifically in Building No. 8 (Fig. 5: d). The discovery included 17 strongly fragmented whale bones. Among them, some originated from a disk adorned with a decorated frame featuring diagonal notches along its perimeter, alongside straight and curved lines – interpreted as gnomonic lines. Additional fragments were identified as part of a tetragonal object, assumed to be a dial base. Considering the find's location, technology, and decoration, both objects were deemed components of the same instrument. According to Páll Bergţórsson, an Icelandic specialist in navigational instruments, this ensemble might have served as an astrolabe, representing a more sophisticated implement. The reconstructed dimensions of the disk were determined to be 10 cm in diameter and 1.7 cm in thickness. The dating of the area where Building No. 8 was recorded corresponds to the second and third phases of the settlement's occupation, commencing at the turn of the 10th century (Jagodziński 2012, 326-328; 2015, 49-51; 2017).

OPERATION MODE OF A SUN COMPASS

Captain Carl Sølver was the pioneer in suggesting, based on the wooden disk from Greenland, that such artefacts might have functioned as sun compasses (Sølver 1953). This proposition gained further support from subsequent archaeological discoveries and insights from various disciplines, notably astronomy and experimental sailing experiences with similar objects as compasses (Thirslund 1987; 1999, 8; Stanisławski 2000, 159). Expertise in criminology also played a crucial role, confirming the deliberate creation of the lines on the dials of the compasses found in Greenland and Wolin (Thirslund 1999, 7; Stanisławski 2000, 174).

All these disks feature a hole, a characteristic utilised in sun compasses where a gnomon was placed to cast a shadow on the dial. However, no such component was discovered alongside any of the disks. This missing part could have been a wooden stick, cut to the appropriate height and sharpened, or a purposefully processed piece of wood. The gnomon facilitated the determination of the time of day based on the Sun's apparent position in the sky (akin to a sundial) or, in the case of a compass, latitude alone. The key elements in the interpretation of the disks as sundial-compasses were the divisions and markings on the dials. These included diverse combinations of radial lines, rings, perimeter notches, and straight and curved lines traversing the dial.

A significant breakthrough occurred when the Swedish astronomer Curt Roslund determined the function of lines on the dial of the disk from Greenland: a straight line corresponding to the declination of the vernal and autumnal equinoxes and a curved one indicating the summer solstice at 61˚N latitude (Thirslund 1987, 14, 15). Similar lines were identified on the bone dial from Truso, assumed to have served a comparable purpose but for 54°N latitude (Jagodziński 2015, 50). The interpretation of notches on the best-preserved disk from Wolin also supported a similar hypothesis: the straight line on side A marked the equinox, while the curved line on side B denoted the end of April or mid-summer at 60˚N latitude (Stanisławski 2000, 171). The gnomonic line's shape resulted from three factors: latitude, the gnomon's height, and the Sun's declination. For extended sea voyages, multiple gnomonic lines were essential to account for latitude changes during the voyage and variations in the Sun's declination throughout the day (Thirslund 1987, 16; Stanisławski 2000, 169). The divisions marked by radial lines or triangular notches probably represented directional indicators.

The wooden disk from Greenland distinguished itself with a notable feature: a series of 32 triangular notches around its perimeter, implying that Scandinavians might have been cognizant of up to 32 directions. This stands in contrast to other known sun compasses, which typically follow the 12/24 system – a division method associated with the Mediterranean region. The employment of the 32-system in Northern Europe is suggested (Stanisławski 2000, 171). In the 12-division system, the distance between incised lines is generally 30°, though deviations and inaccuracies have been observed in compasses.

Extensive discussions on medieval navigation methods, detailed in the literature (Thirslund 1987), and the multifaceted functions and operational modes of these devices, particularly those derived from the disk from Greenland, have been proposed. These interpretations include viewing them as instruments for coordinating latitude and local south (Bernáth *et al.* 2013a), compasses based on the rule of a reversed solar disk (Bernáth *et al.* 2013b), or twilight boards (Bernáth *et al.* 2014).

COMPARATIVE STUDY

The pyrophyllite items under discussion, along with previously published artefacts linked to sun compasses, share the characteristic shape of a flat disk featuring a central hole. This aperture appears to be a pivotal element essential for the device's functionality, designed to house the gnomon – a sharpened stick casting a shadow on sunny days. Additionally, we consider that some form of marking on the dial – be it triangular notches along the edge or engraved rays – is necessary to categorise the disk as a navigational instrument. Consequently, in our further analysis, we exclude the disk from Gubin, characterised by only three circles, irregularly cut in relation to the hole.

The distinctive feature that sets the pyrophyllite disks apart from those identified as sun compasses is the absence of gnomonic lines, both the straight line for an equinox (either vernal or autumnal) and the hyperbolic one. These lines were not engraved on the stone surfaces, although they could have been temporarily applied using erasable dyes, such as charcoal or chalk.

When hypothetically considering the use of a temporally-determined gnomon curve, attention should be directed to the inland location where the stone disks from Rus' were discovered. The utilisation of such a temporal genomic curved line might have been crucial when moving along the N-S axis, where latitude changed relatively rapidly, impacting the angle of incidence of the shadow. In such cases, the ability to easily adjust the curve could have been significant for achieving more precise directional measurements. W. Filipowiak has suggested that the limitation imposed by permanent gnomon shadow lines may hinder the prolonged and widespread use of instruments interpreted as navigational tools (Filipowiak 2020, 318, 319).

Despite the absence of genomic lines, the objects share numerous common features. The wooden disks from Greenland and Wolin are of similar sizes: 7 cm and 8.6 cm in diameter, corresponding to the dimensions of the items from Rus'. Two of them have diameters of 6.5 cm (Kyiv and Listven), while the one from Liubech measures 7.5 cm. The estimated thickness of the disks varies from 0.9 cm (Wolin) to 1 cm (Greenland) and up to 1.3 cm (Listven).

The diameters of the holes in the stone disks from Ukraine (ranging from 1.7 cm to 2 cm) are slightly larger than those known from other sites (from 1 cm in Wolin to about 1.5 cm in Greenland).

Excluding the triangular object from Greenland and the wooden disk without a description, based on the available writings, the authors are aware of four disks, including the well-preserved one from Wolin. If hypothetically considering that the three pyrophyllite slate disks also served as sun compasses, their potential differentiation over time may be suggested, taking into account factors such as size, marking elements, and the shape of the notches.

Thus, the disks from Greenland (although their chronology is still unclear) and from Truso lack concentric rings, which, on the contrary, were incised on the disk from Wolin (three circles) and the objects made of pyrophyllite slate from Kyiv (four), Listven (four and six or seven), and Liubech (four). This suggests that the earlier, older ones (9th to 10th centuries) did not feature concentric rings, which appeared only on the wooden item from Wolin, dated to the end of the first half of the 11th century. Towards the end of the 12th and up to the mid-13th centuries, the rings were confirmed on the disks from the territory of Kyivan Rus.

The older navigational instruments (Greenland, Truso) do not have the division of the dials with radial lines. Such a division was observed on the item dated to the end of the mid-11 th century from Wolin – with a 12/24 division system, having only 12 triangles marked on the opposite side of the disk, facing their apices towards the centre of the disk and based on the outermost ring. This division might have referred to the cardinal directions of the world. The marking of the navigational instrument from Wolin and the division into 12 radii of the stone disk from Listven, and possibly that from Kyiv (the fragment of the disk from Liubech is unfortunately too small), refer to the southern marking system from the Mediterranean region. On the reconstructed compass from Greenland, triangular notches were marked around its perimeter in the 32-system, which was used in Northern Europe (Stanisławski 2000, 174).

CONCLUSIONS

The analysis of the disks of pyrophyllite slate from the territory of Ukraine presented here allows for the assumption that the items had a particular utilitarian function. In addition to previously proposed interpretations found in publications, a new hypothesis suggests they could have functioned as sun compasses. This interpretation applies to a subset of items featuring concentric circles and radii, with a central hole intended for a gnomon. Hypothetically, it might have been possible to mark a curved gnomonic line on the surface using erasable dyes. Making such corrections could have been crucial when changing latitude, accompanied by a shift in the angle of incidence. It may be presumed that one supporting element for this interpretation is a dial with radial divisions and a hole suitable for a gnomon, notably found on two disks (Kyiv, Listven). Moreover, the division into 12 parts on these two disks allows us to relate this measuring system to that applied to compasses

in the Mediterranean region. The significance of concentric rings on the stone disks, seemingly similar to the wooden sun compass from Wolin, adds weight to this interpretation. Changes in the appearance of known examples of navigational instruments over time have also been observed, particularly in the youngest specimens.

In the early medieval period, the utilisation and advancement of navigational instruments were ascribed to Scandinavians, who were believed to have been able to use such tools not only in coastal sailing but also undertake long voyages across open seas, eliminating the need to constantly observe the shoreline. Both constellations and the Sun played crucial roles in sea navigation during this era. Compasses utilising sunlight have been recognised as a significant technological advancement of the time. Scandinavians, with their vessel construction, navigational skills, and compass usage, successfully reached distant islands in the northern Atlantic, such as Greenland, Newfoundland, and the shores of present-day Canada. The sagas also provide limited information on sea voyages and directional settings, indirectly suggesting the use of navigational instruments. In favourable weather conditions, a navigator 'could then discern the quarters of heaven', indicating the ability to find direction, and the radial lines on the disks might have facilitated such quarter division, aiding in staying on course. In 1984, a reconstruction of the disk from Greenland was conducted, accompanied by a sailing experiment that demonstrated the potential use of such an item as a compass (Stanisławski 2000, 159). However, some researchers criticise this experiment, pointing out that the disk used was not an accurate replica of the original archaeological find. While the experiment confirmed the possibility of sailing using a solar compass, it did not conclusively prove that the Narsarsuaq disk was initially utilised for this purpose (Filipowiak 2020, 323).

Recent critical publications challenging the function of the wooden disks from Greenland and Wolin as navigational instruments propose alternative uses for the Narsarsuaq object. While the exact purpose is not specified, suggested functions include a piece of furniture, a 'butter-stamp', a top for a small keg, a component of a fish trap, or a spindle whorl. The disk from Wolin might have served as a fishing float or a potter's bat, intended for stamping vessel bottoms (Filipowiak 2020, 326). In the case of stone disks from Rus', their use as a fragment of furniture decoration or a float is deemed implausible due to the chosen raw material for their production. Additionally, the shallow incisions of concentric circles and radii make them unsuitable for use as 'butter stamps' or potter's stamps. The presentation of similar stone objects within a different context by the authors sheds light on potential interpretations of future discoveries and contributes to the ongoing discussion about evolving study concepts regarding their purpose.

The pyrophyllite slate disks, as discussed above, likely originated as a local product, manufactured in the territories of southern Rus' given the proximity of the raw material outcrops. However, if their function as compasses is acknowledged (a plausible scenario), it can be speculated that the inhabitants of the region acquired knowledge about such instruments from the Scandinavians, who had a presence in the area from the early 10th

century (Duczko 2007). Considering the locations where these stone disks were discovered, particularly Kyiv, Listven, and Liubech situated along the significant communication and trade route 'from the Varangians to the Greeks' (*Povist vremennykh lit – Powieść minionych lat* 1999, 6), it is conceivable that the skill of using navigational instruments, such as sun compasses, in this part of Europe might have been imparted by Scandinavian traders and sailors.

The understanding of how navigational instruments might have been utilized in the Middle Ages has been substantiated through experiments conducted by archaeologists. A faithful replica of the compass from Greenland demonstrated its effectiveness during a voyage from Reykjavik to Nuuk in Greenland (Stanisławski 2000, 159). Consequently, it is proposed that further experiments be conducted with other objects, including those made of pyrophyllite slate.

In general, the pyrophyllite slate disks necessitate further comprehensive investigation, encompassing precise determination of their size and weight, macro- and microscopic analysis of both surfaces (including the measurement of the position and depth of the rings, radial carvings, notches, and potential mechanical wear on the surface), involving macro-scale photographs, and other laboratory analyses aimed at verifying the function and chronology of these artefacts.

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