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S. V. PAVLENKO

## STUDY OF THE INDUSTRIAL REGION OF THE PYROPHYLLITE SLATE INDUSTRY IN THE SOUTH OF THE SLOVECHNO-OVRUCH RIDGE



*This article presents the results of research on medieval quarries and specialised settlements engaged in the processing of pyrophyllite slate, conducted in the Slovechno-Ovruch ridge. The study characterises the pyrophyllite slate industry sites in the microregion of Prybytky — Cherevky, examines the composition of the cultural layer of settlements and workshop deposits, and describes the methods and approaches used in their investigation. All categories of production artefacts are analysed, including chips, mineral raw material remains, defective blanks, semi-finished products, and production waste from the production of spindle whorls, pectoral crosses, and beads made of pyrophyllite slate. Tool traces on production artefacts are also considered.*

*Key words:* Slovechno-Ovruch mountain ridge, Ovruch medieval industry, pyrophyllite slate, production settlements, quarries, workshops, spindle whorls, crosses, beads.

During the Ancient Rus period (10<sup>th</sup>–13<sup>th</sup> centuries), a specialised system for the extraction and processing of pyrophyllite slate, as well as the distribution of raw materials, semi-finished items, and finished products, was formed and developed in the Slovechno-Ovruch ridge. This took place within a specially established district under the authority of the Grand Prince of Kyiv (Томашевский 2008,

c. 58-59). Among the synchronous branches of the Ancient Rus economy (crafts), the pyrophyllite slate industry held a special place due to such factors as: 1) unique production and aesthetic properties, as well as the availability of locally concentrated mineral raw materials for industrial development; 2) the significant quantity of extracted and utilised raw materials; 3) a high level of technological process development, including tools and equipment; 4) standardisation and quality control of manufactured products; 5) a broad product range (architectural and decorative elements such as wall and floor slabs, capitals, parapets, and cornices; craft tools such as spindle whorls, millstones, crucibles, and casting moulds; jewellery and religious items including beads, pectoral crosses, icons, and religious plaques) and an extensive area of products distribution and trade; 6) the potential high value and possible monetary-accumulative function of certain products, such as spindle whorls (Янин 1956, c. 187-189); 7) direct involvement of princely authority through political and administrative-economic control over the Ovruch district.

Until now, research on the pyrophyllite slate industry — from identifying ancient extraction sites and studying raw material sources to reconstructing production processes, technological tools, mechanisms, and spheres of application and distribution — has been practically non-existent (for a brief overview of industry studies, see: Томашевський, Павленко, Петраускас 2003, c. 132; Томашевський 2017, c. 243, 246, 253, 258-259, 261-262).

Since 1996, the Ovruch Expedition of the Institute of Archaeology of the National Academy of Sciences of Ukraine has been conducting research as part of a separate project on the historical-archaeological and palaeoenvironmental heritage of the Ovruch district in the Slovechno-Ovruch

© PAVLENKO Serhii Vasyliovych, 2025 — Junior Research Fellow, the Institute of Archaeology, the National Academy of Sciences, the Ancient Rus and Medieval Archaeology Department, the Institute of Archaeology, the National Academy of Sciences of Ukraine, ORCID: 0000-0002-3138-5746, [pavlenko@ianam.u.org.ua](mailto:pavlenko@ianam.u.org.ua)

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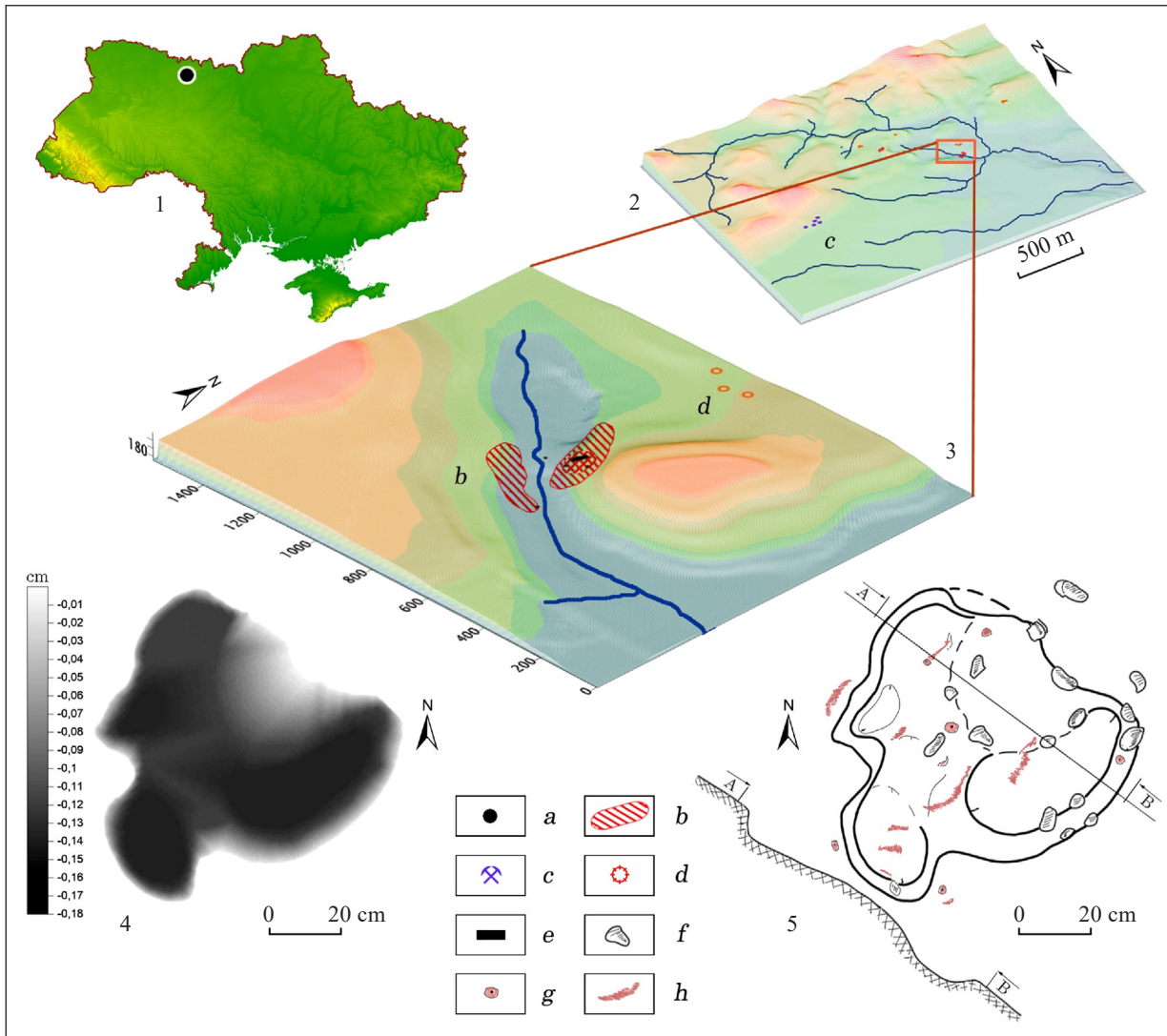


Fig. 1. Prybytky — Cherevky production microregion: 1 — location on the territory of Ukraine; 2 — digital model of the microregion; 3 — digital model of the location of the Prybytky 1 and Prybytky 2 production settlements; 4, 5 — model, plan and section of the collapse spot of the Prybytky 1 production workshop. Symbols: a — location microregion; b — areas of site; c — quarries; d — barrow; e — excavation area; f — stones; g — defective blanks; h — pyrophyllite chips

ridge (Томашевський 1998a, 1998b, 2005). Studies have been carried out on medieval pyrophyllite slate industry sites, including raw material quarries and specialised production settlements. As a result, data on previously known sites have been verified, refined, and supplemented. Several new production settlements have been discovered, and their specialisation within the industry has been determined. Surface outcrops of pyrophyllite slate and quartzite have been localised, ancient quarrying sites have been studied, an archaeological map of industry-related objects has been created, and production microregions within the broader Ancient Rus settlement system of the ridge have been identified (Павленко 2010, с. 157-162, табл. 1; Ивакин, Томашевский, Павленко 2010, с. 391, 392). In the 2002 season, for the first time, the remains of work-

shops for processing pyrophyllite slate were discovered and systematically documented at two production settlements (Томашевський, Павленко 2003; Павленко 2005; 2008).

Among all the sites of the pyrophyllite slate industry studied by the expedition, the most interesting and, in many ways, unique are the sites of the Prybytky — Cherevky production microregion, located on the southern spurs of the Slovechno-Ovruch ridge (fig. 1: 1, 2): the specialised settlements Prybytky 1 and Prybytky 2, the location in the Korchi tract, and the system of medieval quarries in the Yamy tract (fig. 1: 2, 3). The main feature of this microregion is that, alongside the remains of spindle-whorl manufacture, production waste from small ornaments — pendant crosses, beads, religious plaques, and amulets made from

highly decorative varieties of pyrophyllite slate extracted from a quarry near Cherevky village — was found in settlements near Prybytky village.

This article seeks to offer a comprehensive account of a specific micro-region located on the Slovechno-Ovruch ridge, distinguished by its role in the medieval production and processing of pyrophyllite slate.

### *Pyrophyllite Slate of the Slovechno-Ovruch Ridge*

Before turning to the analysis of production settlements and investigated objects, we consider it appropriate to briefly describe the pyrophyllite slate common in this region (cf: Томашевський, Павленко, Петраускас 2003, с. 132; Wołoszyn et al. 2016, s. 600-601).

Pyrophyllite slate is a metamorphic, fine-grained, schistose rock characterized by well-defined foliation. The principal rock-forming minerals are pyrophyllite ( $\text{Al}_2\text{Si}_4\text{O}_{10}(\text{OH})_2$ )<sup>1</sup>, with contents ranging from 52 % to 99 %, and quartz ( $\text{SiO}_2$ ). Pyrophyllite slate may also contain kaolinite, dickite, hematite, goethite, hydromicas (notably illite), muscovite, hydromuscovite, hydrohematite, and hydrogoethite. In rare cases, the presence of halloysite, montmorillonite, and sericite is recorded. Accessory minerals include rutile, zircon, tourmaline, pyrite, apatite, and epidote (ред. Усенко 1975, с. 362; Танкилевич 1978, с. 38-44, 63-65, 74, 164).

Within the Slovechno-Ovruch ridge, pyrophyllite slate exhibits notable variability in mineralogical composition and physico-chemical characteristics, even at the scale of a single deposit. The chemical composition of the slate reveals notable variations in the proportions of key oxides. In particular, a direct correlation has been observed between iron oxide content and the intensity of schist

coloration, ranging from pale pink to dark purple hues (Танкилевич 1978, с. 58, 62, 65, 74).

Among the pyrophyllite slates of the Slovechno-Ovruch ridge, two principal varieties are recognised: those from the Zbranky deposit and those from the Nahoriany deposit. The Zbranky slates are richer in pyrophyllite and are notable for their softness and decorative appearance, particularly due to the presence of spotted varieties. The Nahoriany slates are characterised by a high content of iron oxides and quartz, which makes them harder and darker in colour — from deep pink to purple (Танкилевич 1978, с. 57, 62).

Pyrophyllite slates are spatially and genetically associated with the Upper Proterozoic volcano-genic-sedimentary formations of the Ovruch series, which fill a local platform graben-syncline structure in the northern part of the Ukrainian Shield. They occur interbedded among pink quartzose sandstones and quartzites of the Tovkachi suit as layers ranging in thickness from a few centimetres to several tens of metres, or as lens-shaped bodies (ред. Усенко 1975, с. 363; Танкилевич 1978, с. 12-14, 28, табл. 163; cf.: Полетаєв та ін. 2013, с. 34-35, 38-40).

A range of characteristic properties defines the practical value of pyrophyllite slates. The main ones are as follows: a) mechanical properties: softness and plasticity, with a Mohs hardness of one to two. The rock has a soapy and smooth feel, is easily cleavable, and readily subjected to cutting, grinding, and other mechanical processing methods; b) chemical inertness: resistant to acids, alkalis, and other aggressive chemical environments; c) physical stability: electrically and magnetically neutral, naturally hydrophobic; d) thermophysical characteristics: combine low thermal conductivity, high specific heat capacity, and minimal thermal shrinkage (Танкилевич 1978, с. 148-150). Owing to these properties, pyrophyllite slates have been used since the medieval period. The geologist and archaeologist G. Ossowski was the first to document the association of pyrophyllite slate from the Slovechno-Ovruch ridge with Ancient Rus artefacts (Оссовский 1878).

The system of medieval quarries in the Yamy tract is associated with the deposit near the village of Rudnia-Frankivka. The pyrophyllite slates of this deposit are characterised by a reduced content of aluminium oxide ( $\text{Al}_2\text{O}_3$ ) and an increased content of silicon dioxide ( $\text{SiO}_2$ ). The rock colour varies from pink to burgundy-purple. The slate exhibits medium hardness, a compact structure, and a greasy feel to the touch (Жуковський 1937, с. 26-28).

<sup>1</sup> In archaeological publications, the terms “pyrophyllite” and “pyrophyllite slate” are often used interchangeably. This is evidenced, in particular, by the systematic use of expressions such as “pyrophyllite spindle whorl” or “handiwork of pyrophyllite”. In contrast, geological terminology clearly differentiates between a mineral (pyrophyllite) and a rock (pyrophyllite slate). Pyrophyllite is a mineral — a distinct chemical compound with a defined crystal structure. Pyrophyllite slate is a rock in which pyrophyllite is the principal rock-forming component, although it also contains significant amounts of other minerals. The properties of pyrophyllite slate are not merely those of pure pyrophyllite, but rather the result of the combined effect of its mineral constituents and their spatial arrangement. Moreover, monomineral pyrophyllite formations do not occur in nature. For the products of the Ovruch medieval industry, the correct term is “pyrophyllite slate”.

### ***Characterisation of the Production Microregion***

The Prybytky 1 settlement is located on the north-eastern outskirts of the village, on the western, relatively gentle slopes of the valley on the left bank of the Tatorynka River. The surveyed area of the settlement today is two hectares, a significant part of which is cultivated (fig. 1: 3). The settlement was first discovered and described in 1983 by R. S. Orlov, who, in a small test pit, along with fragments of Ancient Rus ceramics, recorded production waste and blanks of spindle whorls and pendant crosses made of pyrophyllite slate (Орлов, Терпиловский 1983, с. 62-68, рис. 14: 1–14). It is likely that this same settlement, but under a different name, was known to the Director of the Zhytomyr Local History Museum, V. O. Misiats. The researcher's brief archaeological reports mention the discovery of production remnants of crosses at a site near the neighboring Stari Velednyky village (Місяць 1956, с. 3-5). Our many years of searching for an archaeological site with pyrophyllite slate industry artefacts near the specified village failed (see: Томашевський 2017, с. 258-259, 262). Since 1996, work at the Prybytky 1 settlement has been conducted by the Ovruch Archaeological Expedition of the Institute of Archaeology of the NAS of Ukraine (Томашевський 1998b, с. 47).

On the opposite bank of the river, in the backyards of rural homesteads, the Prybytky 2 settlement is located, covering an area of 1.5–2.0 hectares (fig. 1: 3), also associated with pyrophyllite slate and possibly iron processing.

A few hundred meters north of the Prybytky 1 settlement, in the floodplain of the river, we discovered a separate site or production complex (Korchi tract) with a high concentration of cross and bead production remains in the cultural layer.

Approximately 7–8 km to the west, in Quadrat No. 13 of the Velednytske forestry in the Yamy tract (fig. 1: 2c), the expedition discovered and investigated a system of medieval quarry pits, which were industrially connected to the settlement complex near Prybytky village.

During the 2002 season, archaeological work in the microregion was focused on the Prybytky 1 settlement and the Yamy tract. At the Prybytky 1 settlement, an excavation area of 140 m<sup>2</sup> revealed four structures and fifteen household pits. One of the studied structures was most likely the remains of a dwelling, while the second was a workshop for processing pyrophyllite slate (fig. 1: 4, 5). Most

of the investigated objects are dated to the 12<sup>th</sup>–13<sup>th</sup> centuries.

In the Yamy tract, preliminary studies of medieval production quarries were conducted for the first time in 2002. Small-scale excavations were carried out in several of the most representative pits and quarries to study these complexes. Test trenching was conducted around the pits and quarries, samples of possible mineral varieties were collected, and a site plan of the quarries was created.

At the Prybytky 2 settlement, observations were made regarding the nature, thickness, and preservation of the cultural layer, and material was collected for analysis. To determine the characteristics of the cultural layer at the Korchi tract site, a special test trench of 4 m<sup>2</sup> was excavated.

It should be noted that during the work, unprecedented experience was gained in the study of such complexes — both settlements and production objects. Methodological techniques and methods for recording and registering the obtained information were developed.

### ***Characteristics of the Cultural Layer at the Prybytky 1 Settlement***

The cultural layer of production settlements has, for the first time, become the subject of specialised research. A methodology for preliminary differentiated marking and subsequent mapping of production waste, ceramics, and other finds appearing on the surface was applied and tested. Additionally, an algorithm was developed and tested for the disassembly, sorting, counting, and analysis of archaeological material extracted from a control excavation quadrat measuring 2 × 2 m.

The thickness of the cultural layer at the Prybytky 1 settlement is relatively small, not uniform everywhere, and varies within approximately 25–40 cm. The surface of the settlement's subsoil has been significantly disturbed by traces of ploughing from different periods, including very deep reclamation ploughing, which in some areas has affected the deeper parts of archaeological feature fillings.

The composition of the cultural layer, its saturation with pyrophyllite slate processing waste, and other categories of finds can be exemplified by the analysis of Quadrat B2 from the 2002 excavation (table 1). Notably, the cultural layer is dominated by defective remains and waste from spindle whorl production, as well as raw material fragments in various sizes, while ceramic fragments and other finds are relatively scarce.

The settlement layer is mainly composed of ceramics from the 12<sup>th</sup>–13<sup>th</sup> centuries, with a significant number of ceramic fragments from the 10<sup>th</sup> to the early 11<sup>th</sup> centuries and some fragments from the mid-13<sup>th</sup> to 14<sup>th</sup> centuries. During ploughing of the settlement area, residents repeatedly found fragments and even whole slabs of pyrophyllite slate. One such slab, measuring 2.2 × 1.0–1.2 m, was recorded at the threshold of a modern household. The cultural layer and the examined features of the settlements are rich in evidence of ironworking, including fragments of bloomery iron, tuyères, and slags of various types and sizes. These finds indicate the parallel functioning of pyrophyllite- and iron-processing industries at the settlements. It is worth noting that such coexistence has been observed at most specialised settlements in the Slovechno-Ovruch ridge (Томашевский 2008, с. 66; Павленко 2010, с. 161).

### *Characteristics of the Workshop*

The remains of the workshop excavated at the Prybytky 1 settlement represent a slightly sunken area, approximately 12–15 cm deep into the subsoil, with amorphous contours measuring about 2 × 3 m (fig. 1: 4, 5). It is likely that the upper part of the structure, probably a ground-level building, has been destroyed, while the small preserved sunken portion is heavily deformed (fig. 2: 1–3). It is possible that the depth of the foundation pit was influenced by the nature of the moraine subsoil, which consists of extremely hard dark-orange clays saturated with moraine quartzites, breccia-like conglomerates, and flint. The surface of the palaeosoil in the excavated area bears clear traces of ploughing from different periods and in various directions, including deep reclamation ploughing, which destroyed the remains of the structure (fig. 2: 4). The investigated object is filled with production waste, remnants of blanks, semi-finished products, and defective items, all mixed with fine chips and fragments of pink and white-pink varieties of pyrophyllite slate (fig. 2: 5–8).

No structural details of the building were observed, mainly due to the degree of preservation of the object. Based on its shape and parameters, the object does not resemble the storage or waste pits excavated in the area.

On the exposed area of the settlement, specific artefacts — waste and defective remains from the production of pyrophyllite slate spindle whorls and crosses — are concentrated at the location of the object. In all other nearby excavated complex-

es, such artefacts are found only sporadically and are most likely intrusive from the surrounding cultural layer.

Further analysis of all material recovered from the collapse demonstrated that we are dealing with the remains of a single technological unit with its own distinct style. It was also noted that during material processing, certain fragments originating from different parts of the collapse belonged to the same original item — semi-finished products and spindle whorl blanks. The nature and composition of the investigated collapse-filling (its compactness, density, and consolidation) clearly indicate that it resulted from a single, simultaneous event.

Taken together, these observations allow us to reasonably assume that, in this case, the preserved remains (under the specific conditions of the site) represent a production building — a workshop.

Regardless of the interpretation of the object and the origin of its contents — an array of chips, defective products and production waste — whether it represents the workshop itself or, perhaps, an outflow from an object that did not fall within the area of our excavation (which is unlikely), its significance remains unchanged. This uniquely dated, single-phase, essentially sealed production complex — investigated for the first time — is crucial for understanding the mechanisms of the Ovruch pyrophyllite slate industry.

To our knowledge, no prior research has been conducted on similar production sites. Therefore, the entire assemblage of materials from the workshop was of particular interest to us. The need to fully document and classify the contents required the implementation of a specialised program for recording and registering materials, as well as their archaeometric analysis. It's the first time we encountered such a dense, compacted, and highly mineralised filling of complex structure and composition. Its excavation required the development of a specialised methodol-

*Table 1. Composition and intensity of the cultural layer of the Prybytky 1 settlement*

Components of the cultural layer	Amount
Stone fragments and debris of pyrophyllite slate, kg	8.3
Waste and defective blanks of spindle whorl production, items	355
Fragments of ceramics, items	53
Individual finds, items (fragment of glass bracelet)	1
Slags, items	12

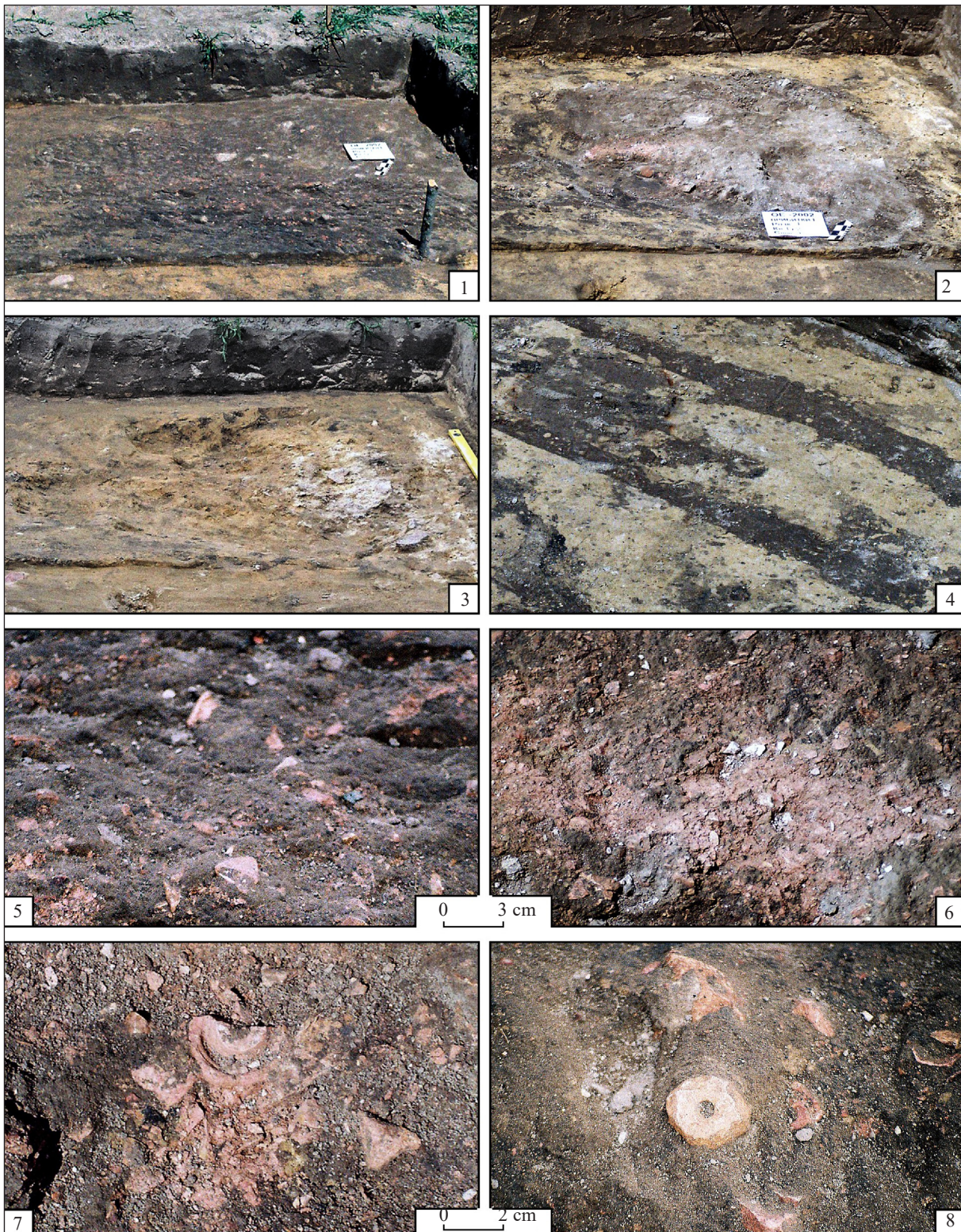


Fig. 2. Prybytky 1, production workshop: 1 — collapse spot at the moment of detection; 2 — collapse spot during sampling; 3 — foundation pit deepening; 4 — traces of ameliorative ploughing on the surface of the palaeosoil; 5–6 — collapse recording, traces of chips; 7–8 — wastes of spindle whorl production in the workshop collapse

ogy and the use of specific tools. The extracted filling was subsequently analysed through sieving and washing, followed by sorting and measurement. This detailed research approach made the excavation pro-

cess extremely labour-intensive and time-consuming. The same applies even more to all subsequent stages of laboratory processing, documentation, archaeometric study, and statistical analysis.

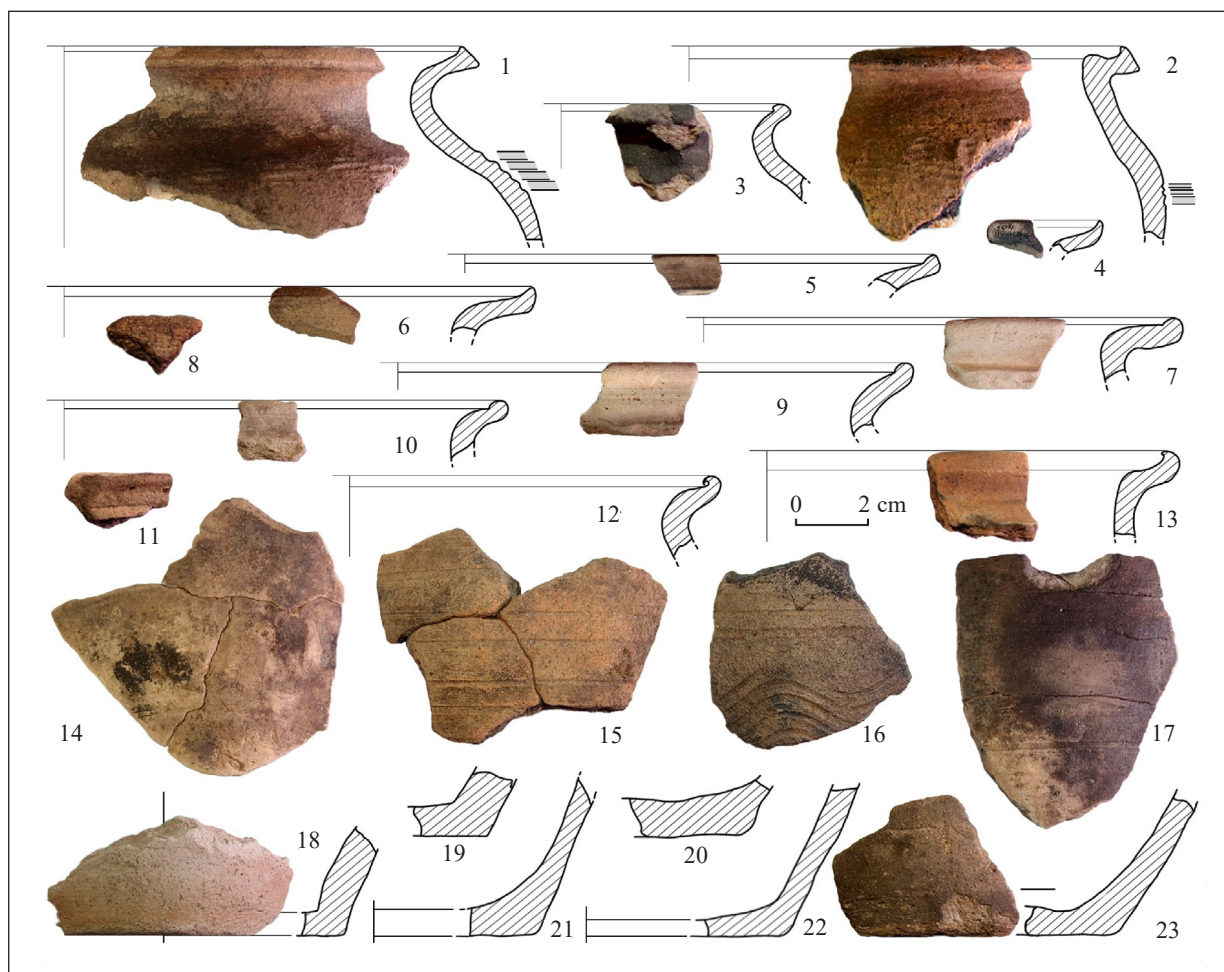


Fig. 3. Prybytky 1, fragments of pottery from the workshop collapse

Within the workshop filling, 2,590 defective remains and waste from spindle whorl production were recorded, along with 49 fragments and blanks of pectoral crosses and beads, 80 small ceramic fragments (including 13 rim sherds), and two fragments of twisted glass bracelets. Various-sized pieces of pyrophyllite slate and chips were separately collected. The main group of profiled upper ceramic fragments found in the filling allows us to date the workshop to the late 12<sup>th</sup> — early 13<sup>th</sup> centuries (fig. 3: 1, 3–13). Some of the recovered rims may belong to a later period (fig. 3: 2).

Below, we briefly examine each category of finds that comprised the workshop's filling.

#### ***Mineral Composition of the Workshop Filling***

The primary mineral component of the workshop filling consists of pyrophyllite chips mixed with unprocessed fragments and pieces of pyrophyllite slate of various sizes, all bearing traces of processing.

#### **Fragments of Pyrophyllite Slate.**

During the excavation, sieving, and sorting process, the entire assemblage of pyrophyllite slate fragments was divided into two size-weight groups: small and medium-sized fragments (fig. 4: 1, 2). Large pieces over 10 × 10 cm in size, which formed the main bulk (3/4 of the filling) of the workshop excavated at the Nahoriany settlement (Павленко 2005, с. 200, табл. 4), were not recorded in the workshop at the Prybytky 1. This can be explained by both the degree of preservation of the workshop and the fine-grained structure of the white-pink variety of pyrophyllite slate found in the quarries of the Yamy tract, which does not form large slabs or blocks of raw material. Additionally, the limited surface exposures of rare slate varieties likely compelled craftsmen to use the more decorative and possibly expensive raw material as efficiently as possible, minimising waste.

The workshop collapse also contained 196 small stones (quartzites, breccia-like conglomerates, pebble-like nodules, and unprocessed

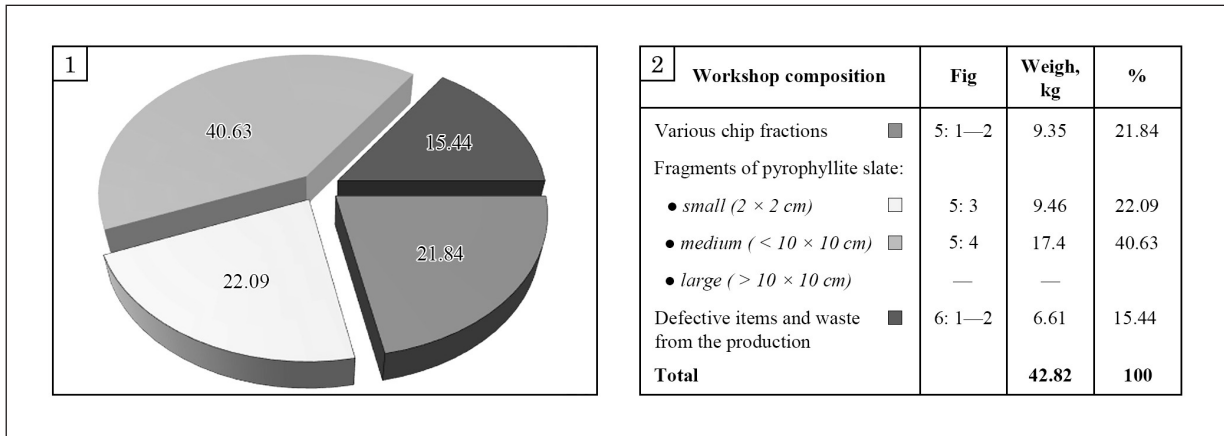


Fig. 4. Prybytky 1: diagram (1) and table (2) showing the distribution of categories of mineral components from the workshop filling

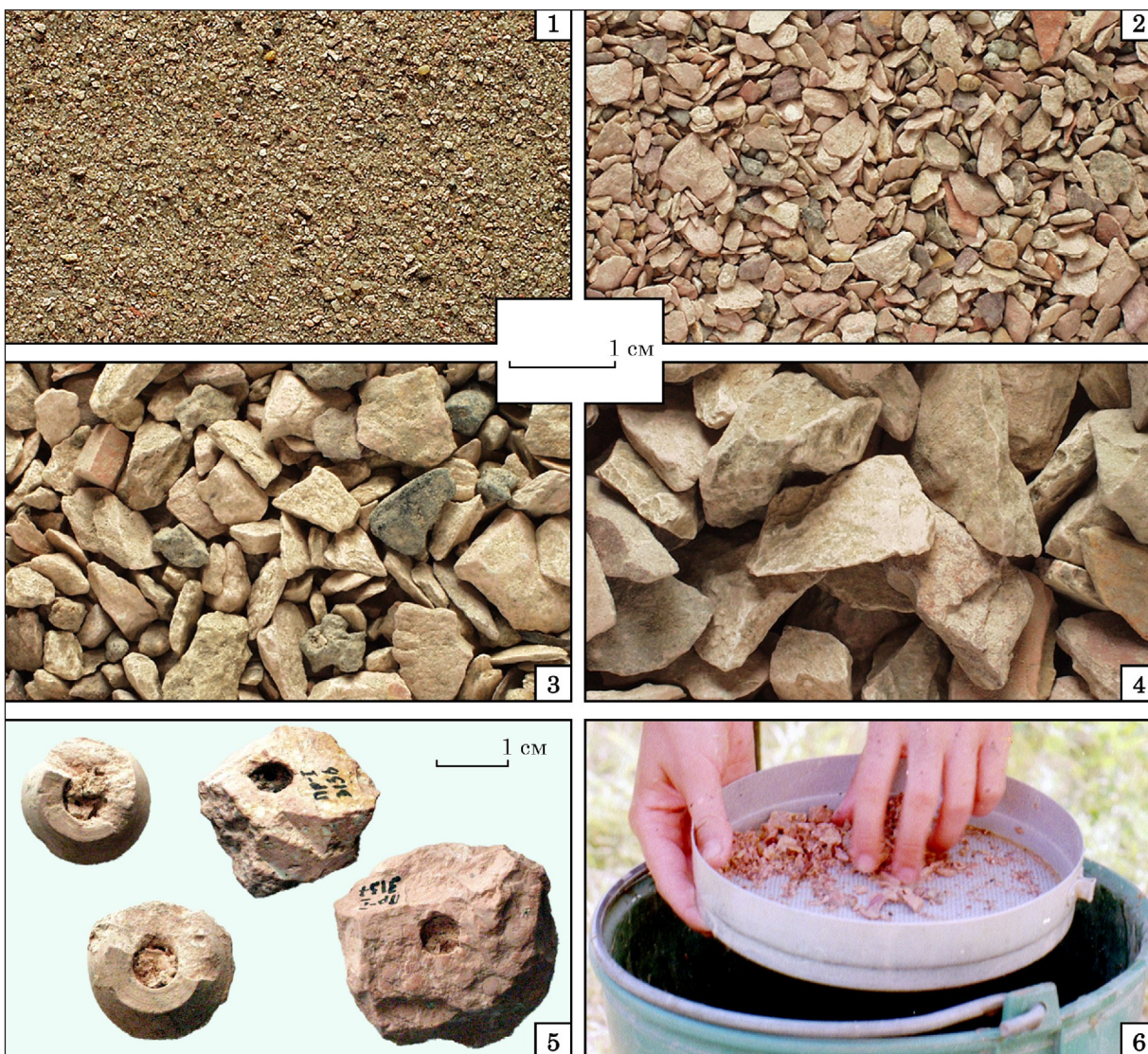


Fig. 5. Prybytky 1, mineral components of the workshop: 1 — fractions of pyrophyllite chips, 2–4 — fragments of pyrophyllite slate of different sizes; 5 — defective items and spindle whorl blanks with chips in the inner channel, 6 — washing process of small fractions of chips from the workshop collapse

flint fragments), with a total weight of approximately 2.5 kg, along with small fragments of fired clay and tiny charcoal particles.

### **Chips.**

For the first time, the pyrophyllite chips were examined as a subject of special scientific interest. In total, more than 9 kg of fine pyrophyllite chips were recovered during the washing and sorting of the filling, accounting for 21.84 % of the total weight of the workshop's mineral content (fig. 4: 1, 2).

To better understand the composition of the chips, a control sample representing 100 % of the total volume was selected and divided into distinct size categories using specialised sieves with various mesh sizes (fig. 5: 6). The following fractions of pyrophyllite chips were identified: fine granular particles, crystals, and flakes up to 1.0–1.5 mm in size; crystalline and granular slate chips ranging from 1 to 7 mm; slate fragments of various shapes up to 15 mm in size (fig. 5: 1–4). Additionally, round, hard, semi-transparent grains — possibly quartz crystals — were identified as a separate category.

### **Waste and Defective Remnants from Spindle Whorl Production.**

The production-related artefacts found in the workshop filling can be divided into defective pieces and manufacturing waste. Defective blanks, depending on the stage of production, distinctive features, and functionality, are categorised into several groups: rectangular or square-shaped blank tiles (“tablets”) (fig. 6: 1–5); blanks with a drilled central hole (fig. 6: 6–17); blanks with a turned cone on one or both sides (fig. 6: 18–29); damaged, nearly finished, and unfinished spindle whorls, as well as their fragments (fig. 6: 33–37, 40). Manufacturing waste includes “corners” — fragments of blanks left over after turning the spindle whorls (fig. 6: 30–32) — and small cone chips from the spindle whorls (fig. 6: 38–39). The previously discussed chips also belong to spindle whorl production waste. For each identified group of defective items and waste, smaller subcategories with specific volume-weight characteristics were distinguished. Graphical representations of the defective finds and the distribution of waste groups in the workshop filling are provided in the table (table 2). Additionally, we attempted to illustrate the technological processes that generated various categories of spindle whorl production waste and to present their characteristic types of defects (table 2).

Without delving into a detailed analysis of each artefact group found in the workshop filling or the spindle whorl manufacturing process (which has

been examined previously, see: Томашевський, Павленко, Петраускас 2003, с. 135), we highlight some of the most interesting observations. Among the production-related artefacts in the workshop filling, manufacturing waste predominates, making up 60 % of the total. A small percentage (1–2 %) of defective remnants and waste from each production stage consists of items that accidentally fell out of the production chain — possibly lost by the craftsman for various reasons. Another portion includes items that were intentionally discarded at different stages of production. The highest percentage of defective pieces in the spindle whorl production process at the Prybytky 1 workshop was observed during the grinding of the whorl cone.

The relatively small percentage of blanks found in the workshop filling at the Prybytky 1 settlement, compared to the excavated workshop in Nahoriany (Павленко 2005, с. 201, табл. 5), is likely due to the need for more efficient use of the rarer raw material.

Additionally, two small fragments of twisted glass bracelets and six slag fragments were discovered in the workshop filling. However, no iron objects, including tool fragments, were recorded in the examined workshop collapse.

### ***Manifestations of Standardisation***

Researchers have long noted the high degree of standardisation in spindle whorls made from pyrophyllite slate (e.g.: Янин 1956, с. 189; Розенфельдт 1964, с. 221). The mass quantity of defective blanks and spindle whorl production waste, observed from the very beginning of our research on production settlements, along with their subsequent measurements and archaeometric analysis, confirm a remarkably high level of standardisation for that time. One of the primary objectives of our study is to reconstruct the final product, which is largely absent from the settlement record. Over the entire course of our research on production settlements of the Slovechno-Ovruch ridge, only a single intact spindle whorl has been discovered that can be considered a finished product. Therefore, we aim to identify the dimensional and proportional standards of pyrophyllite slate spindle whorls by analysing defective items and production waste.

For statistical analysis and classification, we selected artefacts from the final stages (IV–V) of spindle whorl manufacturing — those with a precisely cut (ground) cone to a certain height, free



*Fig. 6. Prybytky 1, workshop. Samples of semi-finished products, defective products and wastes of spindle whorl production: 1–5 — blank tiles, 6–17 — tiles with a drilled hole; 18–29 — blanks rejected in the process of cone grinding; 30–32 — “corners”; 33–40 — defective spindle whorls and their fragments*

from deformation caused by chipping, and with a clearly defined base surface. The ability to measure all key parameters was also considered:  $d$  — the inner hole diameter,  $h$  — cone height,  $D$  base — diameters of the base surface (up/down),  $D_{\max}$  — maximum diameter of the grinded cone, and  $\alpha$  — the angle of the cone surface relative to the base surface (fig. 7). As a result, a sample of 172 blanks was formed for analysis. The parameters of the upper and lower cones of defective spindle whorls and double-sided cone blanks were recorded separately, slightly increasing the sample size.

A correlation-regression analysis confirmed the interrelation between several parameters that determine the spindle whorl's shape: the cone height, the angle of the spindle whorl's cone, the maximum diameter, and/or the diameters of the flat surfaces (bases) of the spindle whorl. However, no correlation was found between the inner hole diameter and the other parameters.

Through statistical classification, all key parameters were grouped into several categories, clearly represented in the graphs as peaks (fig. 8: 1–4). The parameter distribution ranges are quite broad. However, a notable trend is observed: three interrelated parameters (height, maximum diameter, and base diameter) share the same peak frequencies (table 3). We assume that these three groups reflect the existence of three size categories of spindle whorls (fig. 9: 2). At the same time, we acknowledge some variability within these standardised ranges.

Almost all spindle whorls produced in the workshop were of a truncated biconical shape. The production-related material we analysed from the Slovechno-Ovruch ridge provides no evidence of barrel-shaped spindle whorl production. There is no confirmation of an additional technological process (stage) involving the transformation of biconical spindle whorls into oval-barrel-shaped ones within the Ovruch production technology. We assume that the barrel-shaped spindle whorls found in Ancient Rus settlements outside the ridge resulted from functional wear rather than intentional shaping during production.

When determining (or reconstructing) the workshop's spindle whorl standards, it is essential to consider the colour-morphological characteristics of defective blanks and waste (structural and textural features of the raw material). For the workshop materials, we identified seven colour-morphological groups (table 4). Notably, the vast majority of the workshop's blanks and waste are in various shades of pink.

### *On the Issue of Cutter Reconstruction*

The question of tools, particularly cutters, lathes, and machining units, is one of the most intriguing aspects of our research. Solving this issue through modelling requires an in-depth specialised analysis and reconstruction that considers the mineral properties of the rock, the characteristics of the metal, and numerous other significant factors. We are developing various models based on experimental and computer simulations. This work is ongoing, and as it progresses, our understanding of the technological process and tools will be refined and expanded. At present, we can propose a preliminary reconstruction of certain cutter details based on observations of artefacts found in the workshop's filling.

In attempting to reconstruct the cutter, we proceed from the assumption that, given the large-scale production of spindle whorls, the use of a handheld cutter would have been inefficient. We can state with a reasonable degree of certainty that, both in terms of stages and technology, the drilling of the central hole was separate from the cutting of the spindle whorl's cone and preceded it. The cutter likely had a bracket (fig. 9: 1a), which, during the cone-cutting stage, entered the pre-drilled hole to ensure precise centring of the spindle whorl.

Current data suggests that the cutter most likely had a single blade. The cutting edge of the cutter's blade was probably straight, as nearly all blanks from the relevant production stages exhibit a smooth, straight-sided cone (fig. 9: 1b).

Observations of the production waste — specifically the “corner” fragments — suggest that the cutter blade may have been double-edged (fig. 9: 1b–c). Additionally, the opposite side of the cutter might have had a rather complex profile. It is also possible that the cutter featured a horizontal cutting surface (fig. 9: 1d), although we do not rule out the possibility of specialised finishing of the spindle whorl base surfaces. These preliminary observations lead us to reconsider the reconstruction of the cutting tool and the spindle whorl manufacturing process proposed by R. L. Rosenfeld (Розенфельдт 1964, с. 220, 221, рис. 1).

During the measurement of production waste and defective items from the workshop filling, the angle ( $\alpha$ ) of the ground cone's surface relative to the base of the spindle whorl was recorded and measured statistical classification of precisely measured angles (a sample of 187 data points) allowed us to determine both the boundary values

and the most frequently occurring angles. Based on these ranges and distribution peaks, graphical reconstructions were produced, illustrating the most commonly used cutter variations (fig. 10).

### ***Traceological Observations***

Tool marks were recorded on approximately 90 % of all examined spindle whorl remains and production waste. We distinguish several groups of these marks: a) various types of markings at different stages: blank markings (fig. 11: 1), marking and centering (punching) the drilling point (fig. 11: 2), compass markings for the spindle whorl cone diameter (fig. 11: 4); b) traces of breaking, chopping, and possibly sawing the blanks (fig. 11: 3); c) surface treatment traces on blanks and semi-finished products (polishing, grinding, cutting, trimming, and shearing marks) (fig. 11: 5–8); d) drilling traces: concentric marks on the inner hole walls (fig. 11: 10), signs of drill play and vibration, and partially drilled holes in blanks (fig. 11: 9); e) cutter marks on the cone surface of blanks (fig. 11: 12–17) and on the inside of the “corners” — fragments of blanks left over after turning the spindle whorls (fig. 11: 11).

Recording and analysing technological traces on defective blanks and spindle whorl production waste allow for a detailed reconstruction of the manufacturing process, clarification of the sequence of technological operations, identification of tool sets, and examination of their structural features.

### ***Production of Crosses and Beads***

During the analysis of the workshop debris at the Prybytky 1 settlement, 27 defective cross pendants and their fragments were found (fig. 12: 17–41), along with 16 rhomboidal blanks (fig. 12: 1–16), of which six had partially cut rays (fig. 12: 11–16), five bead blanks (fig. 12: 42–46), and other production remnants. Over the course of research at the Prybytky 1 settlement and its surrounding industrial area, the collection of defective products and production waste related to crosses and beads has grown to over 400 items. Archaeometric analysis allowed us to reconstruct the sequence of manufacturing operations for crosses (fig. 13), identify the most common causes of defects, classify cross pendant types and variations, and determine raw material preferences (Павленко 2006).

The primary production stages for cross pendants included: preparation of rhomboidal blanks, marking, cutting of rays, drilling of suspension holes, polishing, and grinding. Several minor intermediate operations might have been employed at various production stages (fig. 13). The most common defects occurred during the cutting of rays, as well as breakage of the upper ray when drilling tiny suspension holes (up to 2 mm in diameter).

The dimensions of rhomboidal blanks varied, with edge lengths ranging from 12 to 44 mm and thicknesses between 5 and 13 mm. The most common sizes were 12–18 × 16–24 mm, with thicknesses of 4–8 mm. Finished crosses also displayed considerable diversity, ranging from 20 × 29 mm in length and 10–14 mm in width.

Among the crosses from the settlement, three main types can be identified. The vast majority are four-pointed crosses, most of which have a horizontal bar shorter than the vertical one. Based on their cross-sections, they can be classified as square, octagonal, round, or oval (fig. 13). The second type consists of four-pointed pendant crosses (five specimens in total), where the horizontal bar is longer than the vertical one, and two suspension holes are drilled on its arms (rays) (fig. 13). These crosses were likely intended for necklaces. The third type — floral crosses (with rays shaped like stylised flowers) — is represented by four broken crosses and nine damaged blanks (fig. 13).

Bead production waste from the workshop is relatively scarce, providing only a general idea of the manufacturing sequence: the creation of prism-shaped (four-, six-, and eight-sided) and cylindrical blanks, drilling of a through-hole along their length, sawing and cutting the blank into separate beads, final shaping, and polishing.

For the manufacture of both crosses and beads, highly decorative varieties of pyrophyllite slate were selected (fig. 12; 13). These included pink, lilac, dark red, and sealing-wax-coloured varieties with a layered structure and round, hard grain-like inclusions ranging in colour from white-cream to bluish-grey (fig. 12: 1–2, 15–16, 25, 42; 13; 14: 2, 3). No direct correlation has been identified between the structural and textural properties of the raw material and the size or shape of the crosses.

In the workshop debris (four specimens) and the cultural layer of the settlement (16 specimens), grey crosses with white veins, bands, and granu-

lar inclusions (fig. 12: 36–38) were discovered. These resemble marble in appearance. It is possible that some of these items underwent deliberate exposure to high temperatures and/or specific thermochemical or organic reactions (fig. 13). Such treatment might have been used to create a marble-like effect<sup>2</sup>. Pyrophyllite slate crosses found at Ancient Rus sites outside the range have been

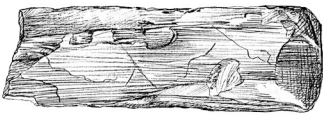


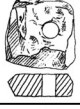






referred to in archaeological literature as “korsunchyk crosses”<sup>3</sup>.

To our knowledge, no comprehensive study has been conducted on known stone cross pendants (“korsunchyk crosses”) in terms of typology or mineralogical composition using specialised analyses. The issue of “korsunchyk crosses” requires further research based on our findings, allowing for a more systematic distinction between

<sup>2</sup> R. Spirģis published two crosses made of natural asphalt (a mixture of bitumen and quartz grains), found in Riga and visually very similar to products made of pyrophyllite slate. The researcher interpreted these artefacts as evidence of pilgrimage to the Holy Land. He suggested that the grey marble-like crosses produced in the Ovruch workshops were imitations of valuable pilgrimage souvenirs (Спирģис 2017, с. 576-577, рис. 13; Spirģis 2018, pp. 497-498). A. E. Musin likewise did not rule out the possibility of similar imitations of pilgrimage insignia: he proposed that some of the dark green crosses with light green inclusions found in Novgorod were made from local minerals and imitated pilgrim crosses carved from crocoite (Мусин 2003, с. 149-150; 2009, с. 233-234). However, it has been suggested that small stone pectoral crosses (so-called “korsunchyks”) were not perceived as pilgrim eulogies in Ancient Rus. The association with the “relics of holy places” emerged only in the 18<sup>th</sup>–19<sup>th</sup> centuries (Беляев 2017, с. 539, 541). It should also be noted that there are doubts regarding the existence of a developed production and wide distribution of marble crosses in Byzantium, Asia Minor, and the Levant in the 12<sup>th</sup>–13<sup>th</sup> centuries (Беляев 2017, с. 538).

<sup>3</sup> The term “korsunchyk” is used to refer to a certain type of crosses, both stone and metal, worn on the body. It is quadrangular in shape, equilateral or with an elongated vertical arm, with straight or slightly widened ends. In the Ancient Rus period, the word “korsunchyk” was not used. The widespread use of the term has been recorded since the end of the 19<sup>th</sup> century in the works of antiquity collectors, archaeologists, and art historians. The earliest written mention of the term dates back to the mid-19<sup>th</sup> century, in a description of the life of the Old Believers community in Kyiv. The spread of the term is associated with the authority of N. P. Kondakov, who suggests that the word “korsunchyk” indicates the place of production or import of such artefacts (more details, see: Беляев 2017, с. 531-533, 540-542). In the scientific literature and among archaeologists, the term is used in at least three meanings known to the author: 1) to all small body crosses, regardless of material, 2) only to body crosses made of stone, 3) to body crosses made of decorative varieties of stone (marble, steatite, porphyry, jadeite, etc.). It is in the latter sense that the term is used in the text of the article.

**Table 2. Prybytky 1, workshop. Distribution of production artefacts, defective products and spindle whorl manufacturing waste by production stage**

Production stage	Technological operation	Final product	Defective artefacts		Varieties and causes of defects	Production waste		
			Amt	Figure		Type	Amt	Figure
I	Preparation of raw materials for making blanks: sawing or splitting blocks, clumps, pieces of pyrophyllitic slate into smaller ones	<ul style="list-style-type: none"> <li>• Tiles, not less than 10 × 10 cm;</li> <li>• Elongated bars 10 × 2–3 cm</li> </ul>	152			Slate remnants		
II	Cutting (punching) blanks for a spindle whorl	Blank, rectangular or square tile			<ul style="list-style-type: none"> <li>• Chips and breakage of blanks;</li> <li>• Possible size mismatch</li> </ul>			
III	Drilling the inner hole	Blank with a drilled hole	280		<ul style="list-style-type: none"> <li>• Inaccurate hole centering;</li> <li>• Drill wobble and runout;</li> <li>• Blank fractures</li> </ul>	<ul style="list-style-type: none"> <li>• Blank chipping</li> <li>• Small chips</li> </ul>		
IV	Grinding the spindle whorl cone on one side of the blank	Blank with a chiselled cone on one side	283		<ul style="list-style-type: none"> <li>• Blank breakage;</li> <li>• Chipping of the chiselled cone of the whorl</li> </ul>	<ul style="list-style-type: none"> <li>• “Corners” — remnants of tile blank</li> <li>• Chips</li> <li>• Cone chipping</li> </ul>	1398	
	Grinding the spindle whorl cone on the opposite side of the blank	Blank with a chiselled cone on both sides	228					
V	Separation of the spindle whorl from the blank, trimming and grinding of surfaces	Spindle whorl (finished product) faulty	97		<ul style="list-style-type: none"> <li>• Surface chipping on the spindle whorl cone</li> <li>• Spindle whorl breakage</li> </ul>	Spindle whorl cone chipping	84	

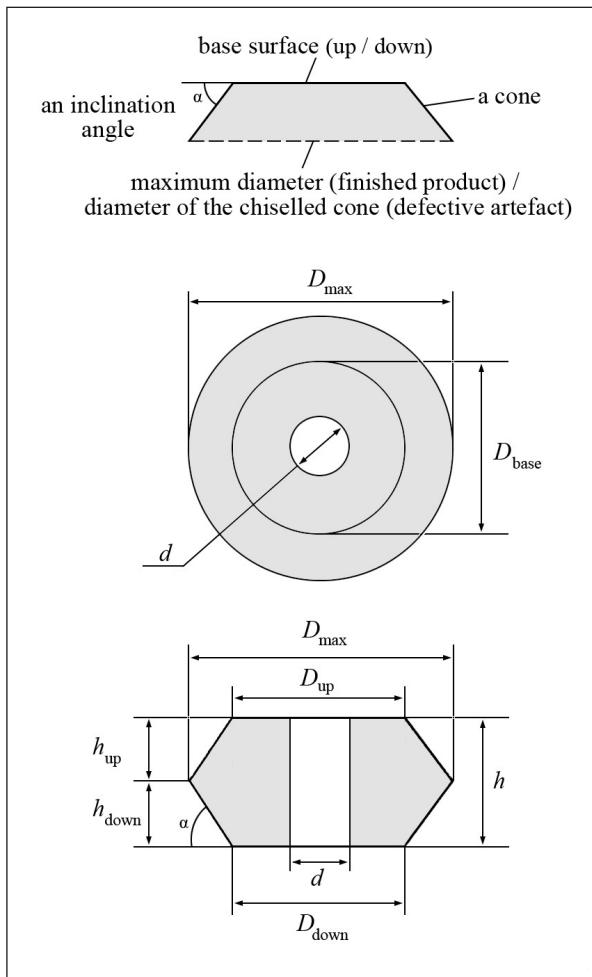


Fig. 7. Measurement scheme of pyrophyllite slate spindle whorl parameters.

products made within the pyrophyllite slate industry and similar items produced from other minerals and regions.

The discovery of “marble-like” pectoral crosses within the same production complex as spindle whorl and pyrophyllite slate cross manufacturing waste suggests the possibility of reattributing some known “korsunchyk crosses” based on future mineralogical analysis. This calls for a reassessment of existing collections, especially those formed outside the Slovechno-Ovruch ridge.

In addition to cross and bead production waste, a fragment (1/4) of a pyrophyllite slate tile blank was found in the workshop filling, possibly intended as an icon or devotional plaque. One surface of this blank features an engraved cross, while the opposite side bears an incised halo outline of a saint’s face (fig. 14: 2). Other finds include a tile fragment with a dashed drawing in the form of a ship or trident (fig. 14: 4), a blank (fig. 14: 6) and a spindle

whorl (fig. 14: 5) with a grid-like marking, fragments of a rectangular tile (fig. 14: 1) and a spindle whorl (fig. 14: 5) with notches on both surfaces.

From the microregion near Prybytky, two amulets bearing highly intriguing signs and symbols are also known; they are currently preserved by local historians.

### *Study of Surface Exposures of Pyrophyllite Slate and Medieval Quarries*

The quarries in the Yamy tract represent a system of spoil heaps and pits of various sizes, ranging from 1.0–1.5 to 8–12 m in diameter, with depths of 0.3 to 2.7 m. Large and deep pits are evidently associated with extraction activities, whereas smaller ones are linked to prospecting and exploration of raw materials. The area containing the quarries, situated on an elevated rocky oak forest with relic vegetation, covers 300 m<sup>2</sup>.

On this site, trial excavations were conducted in five quarry pits, two elevated spoil heaps, and several areas presumed to contain a cultural layer outside the pit-spoil complex. The fillings and spoil heaps consist of a dense, compacted mixture of mineral fragments of various sizes (quartzites, pyrophyllite slate), mineralised loamy podzolic soil, and an extensive root system of the forest vegetation. These conditions significantly complicated standard archaeological excavation procedures, necessitating the use of specialised tools and techniques. Despite these challenges, it was possible to determine the typical structure of fillings and the stratigraphy of such objects.

In the investigated quarries, all possible varieties of pyrophyllite slate were sampled. Alongside rock fragments (a total of 1,150 specimens collected), 250 artefacts (18 % of the total) were found, exhibiting clear traces of primary processing, surface polishing, and cutting of ends and

Table 3. Ranges and peaks of distribution of main dimensional parameters of blanks

Parameters	Distribution peaks, mm			Distribution range, mm
	4	5	6	
Cone height (h)	14	16	18	2.5–12
Base diameter (D base)	19	22	25	12–22
Max. cone diameter (D max)	6–7			17–31
Hole diameter (d)				5–8

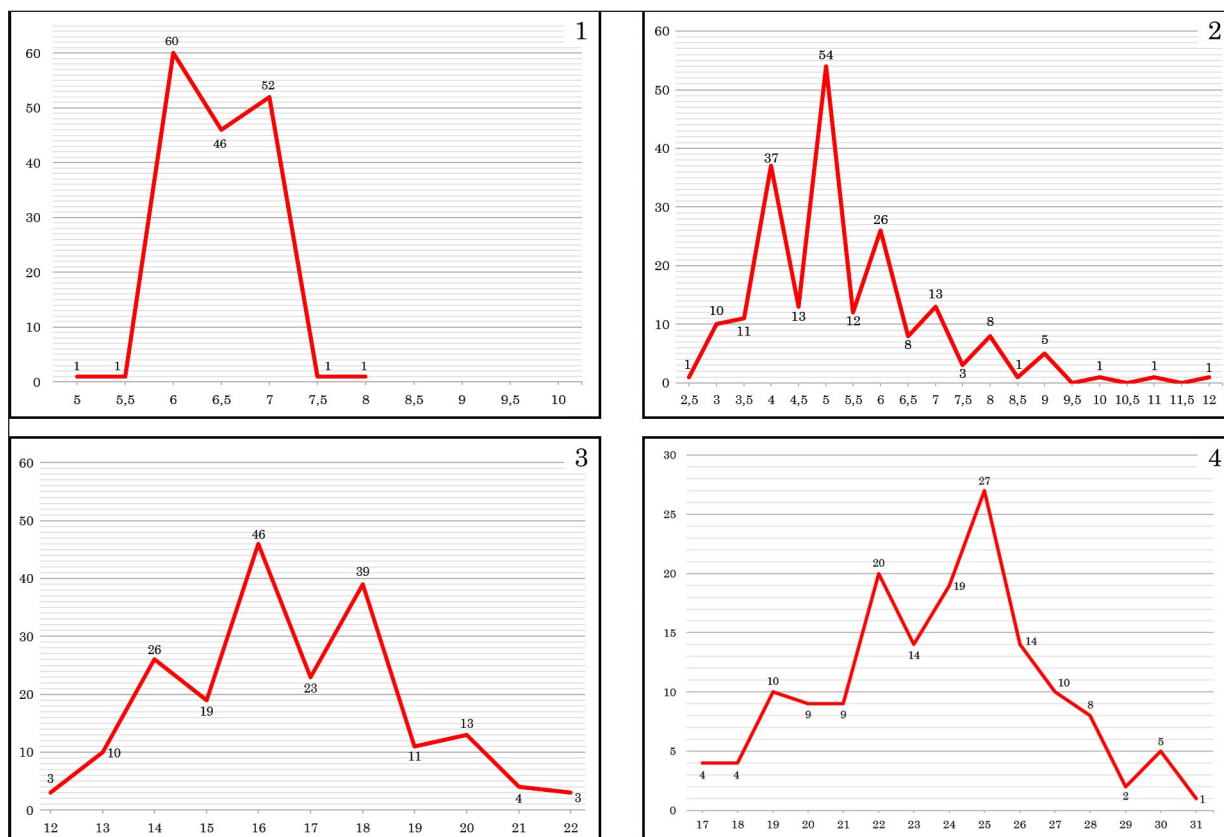


Fig. 8. Prybytky 1, workshop. Frequency diagrams showing distribution of values for the main parameters of defective blanks: 1 — diameter of the inner hole; 2 — height of the chiselled cone; 3 — diameter of the base surface; 4 — maximum diameter of the chiselled cone. On the x-axis — value of parameters, on the y-axis — frequency of distribution

edges. In the cultural layer surrounding the quarry pits, tiles were discovered that, in form and processing technique, resembled spindle whorl blanks found at production settlements (fig. 15). This suggests that, in addition to extraction, some initial processing of raw materials may have taken place on-site.

Research confirmed that surface exposures of pyrophyllite slate are often accompanied by boulders of red Ovruch quartzite.

The system of medieval quarries in the Yamy tract is associated with a pyrophyllite slate

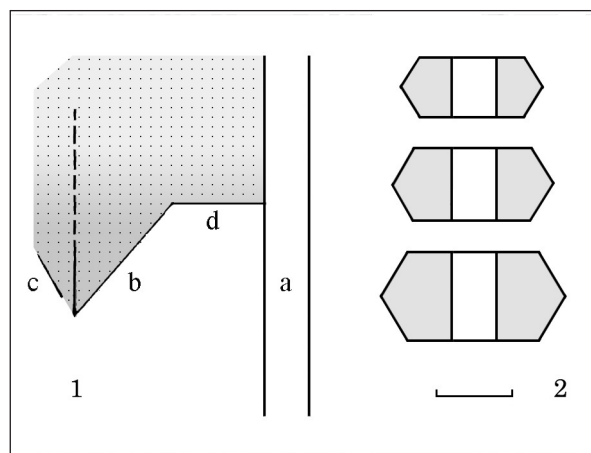


Fig. 9. Graphical reconstructions: 1 — variant of a cutter: a — a bracket, b–d — cutting surfaces (internal, external, horizontal respectively); 2 — variants of dimension groups (standards) of finished products

Table 4. Colour-morphological and structural-textural features of raw materials

Groups	%
White-light pink, different structure	4.6
Pink, all shades, monotonous	62.8
Pink, all shades, granular inclusions	22.4
Pink, all shades, thinly layered	2.5
Lilac, all shades, different structure	1.2
Violet, all shades, different structure	0.4
'Jewel-like', different structure	6.1

deposit explored by a geological field party in the 1930s, 1950s, and 1970s near the village of Rudnia-Frankivka. The deposit is located to the south and west of the village, in the Kamiana Hora tract — a hill with gentle slopes. Here, pyrophyllite slates lie close to the surface, beneath a thin layer of alluvial sands. Geological reports mention small pits from

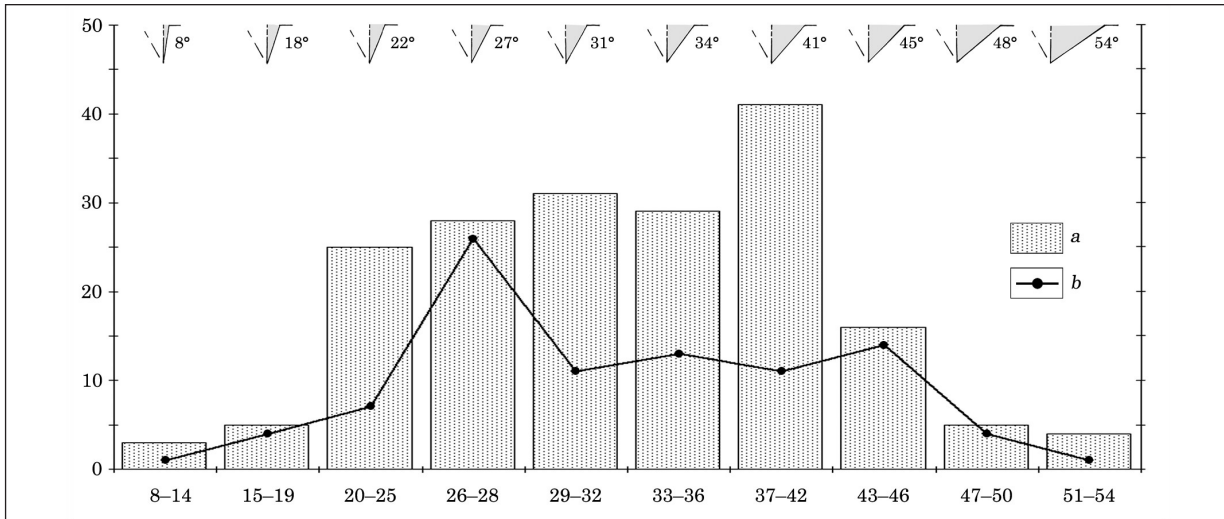


Fig. 10. Graphical reconstructions of cutter variants based on the distribution of values of the angle ( $\alpha$ ) of inclination of the chiselled cone surface relative to the spindle whorl's base surface :  $a$  — range of values;  $b$  — number of cases

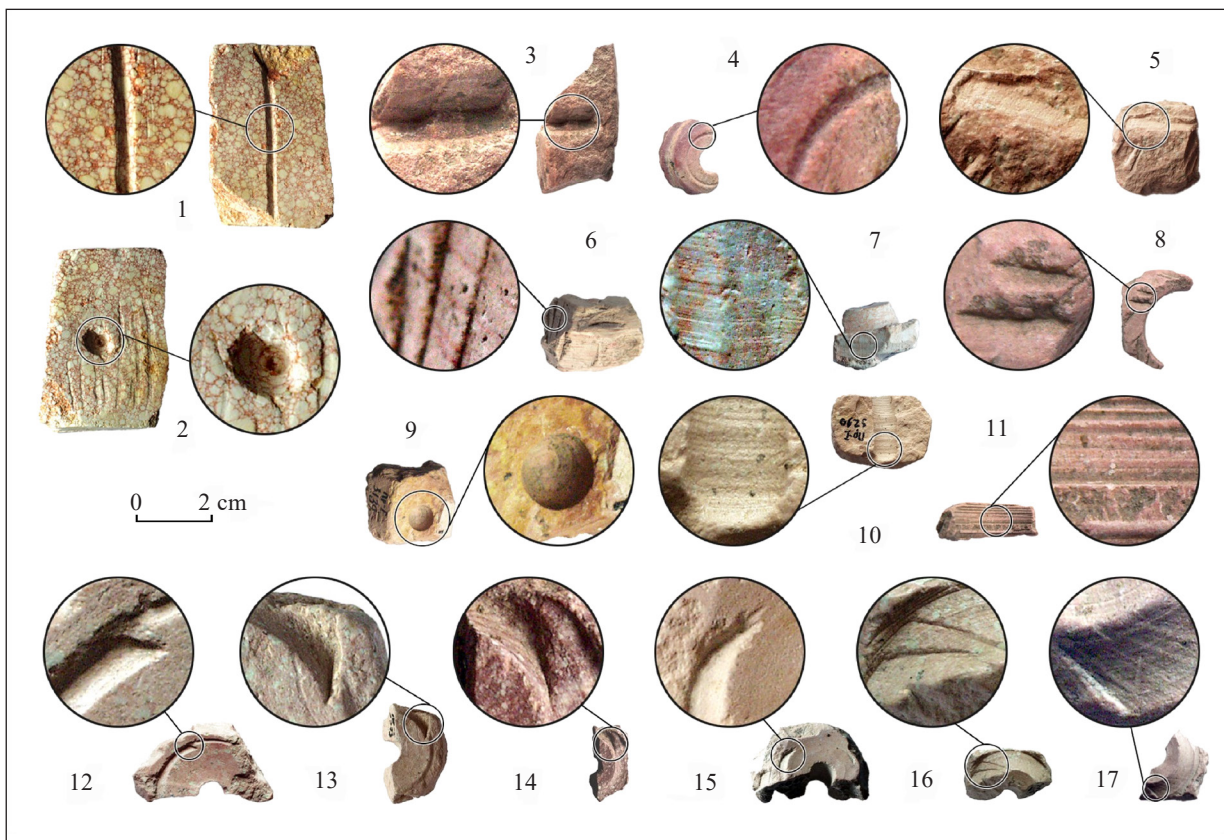


Fig. 11. Prybytky 1, workshop and site. Tool marks on waste and blanks

which the local population extracted slate for their own use throughout the 20<sup>th</sup> century (Жуковський 1937, с. 26-28; Воробьёва, Костенко 1955, с. 10-11; Поданев, Дадей 1976, с. 71-72). The medieval workings we discovered in the Yamy tract may not be the only ones. This area requires an additional detailed archaeological survey.

***Programme for Collecting Information on Artefacts of Pyrophyllite Slate in Ancient Rus and Europe***

In parallel with processing field materials from the specialised workshop settlements of the Slovechno-Ovruch ridge, we are systematically gathering data on workshop finds and evi-

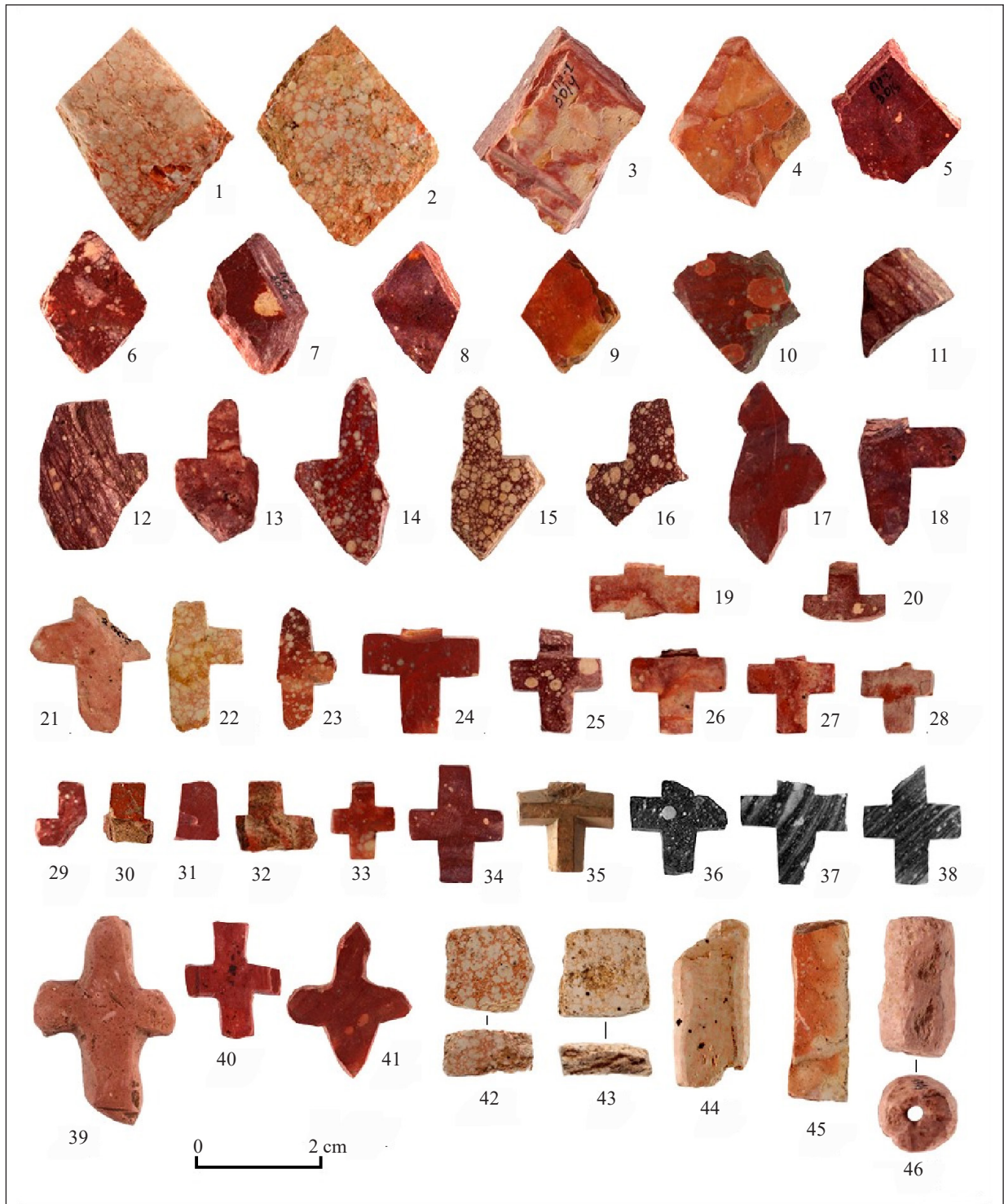


Fig. 12. Prybytky 1, workshop. Samples of blanks and waste from the production of crosses and beads: 1–11 — diamond-shaped blanks; 12–18 — blanks at the stage of cutting out cross beams (rays); 19–41 — defective crosses; 36–38 — marble-like crosses (“korsunchyks”); 42–46 — remnants of bead production

dence of production (defective items, waste, and semi-finished products) of pyrophyllite slate spindle whorls in Ancient Rus settlements beyond the ridge. A programme is also being carried out to collect information on the concentration of pyrophyllite slate spindle whorls in major settlement

centres of Ancient Rus and Europe, as well as on their discovery in monetary-hoard complexes and burial sites.

As a subject of scientific interest, spindle whorl production is self-sufficient; its primary artefacts (waste and defective items) require clas-

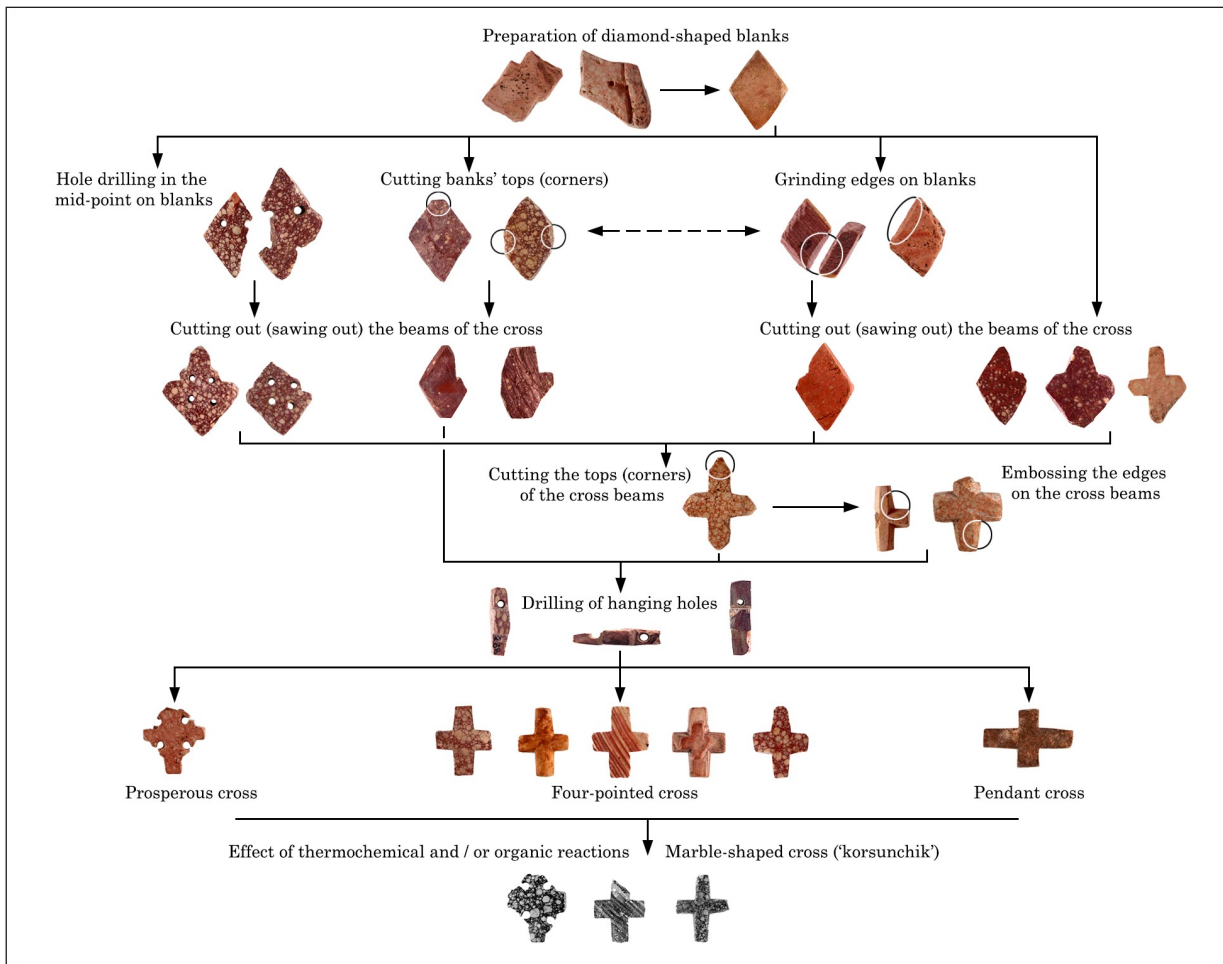


Fig. 13. Prybytky microregion. Scheme of the sequence of production operations, stages in the manufacturing of crosses from pyrophyllite slate

sification and typology, as we have previously noted. Since the layers of specialised settlements and workshop fillings predominantly contain defective, damaged, and broken items, it is difficult to define clear production settlement standards based on them. However, we have reason to believe that the analysis and archaeometric study of a large series of finished products — taking into account probable changes in spindle whorl shape and size during use — will allow identification and examination of standard groups with reasonable accuracy.

By comparing these size-proportional groups and mineral-raw material characteristics while considering the specific technological signatures of workshops, we can distinguish items produced in particular specialised settlements among collections of finished spindle whorls. This approach enables us to reliably trace the path of an item from the quarry through a specialised settlement workshop to the end user. The materials from the production microregion of Prybyt-

ky — Cherevky (Yamy), due to their unique mineral characteristics, offer a rare opportunity for such archaeological analysis.

To illustrate the correlation possibilities arising from the study of series of finished products, we refer to the results of analysing a collection of pyrophyllite slate spindle whorls from the city and surrounding areas of medieval Pereiaslavl Ruskyi (modern-day Pereiaslav in Kyiv Oblast), which we have previously introduced into scientific circulation (Павленко 2001, 2003).

The examined collection consists of 189 pyrophyllite slate spindle whorls, of which 163 (86.2 %) were suitable for analysis. Biconical spindle whorls account for 55.8 % of these (91 specimens). Among them, a subgroup of whole, undamaged artefacts with clear parameters was selected, comprising 60 specimens. As a result of the analysis, six spindle whorls (10 % of those examined) were identified as matching the size and colour-morphological features (raw material characteristics) of the standard types tentative-

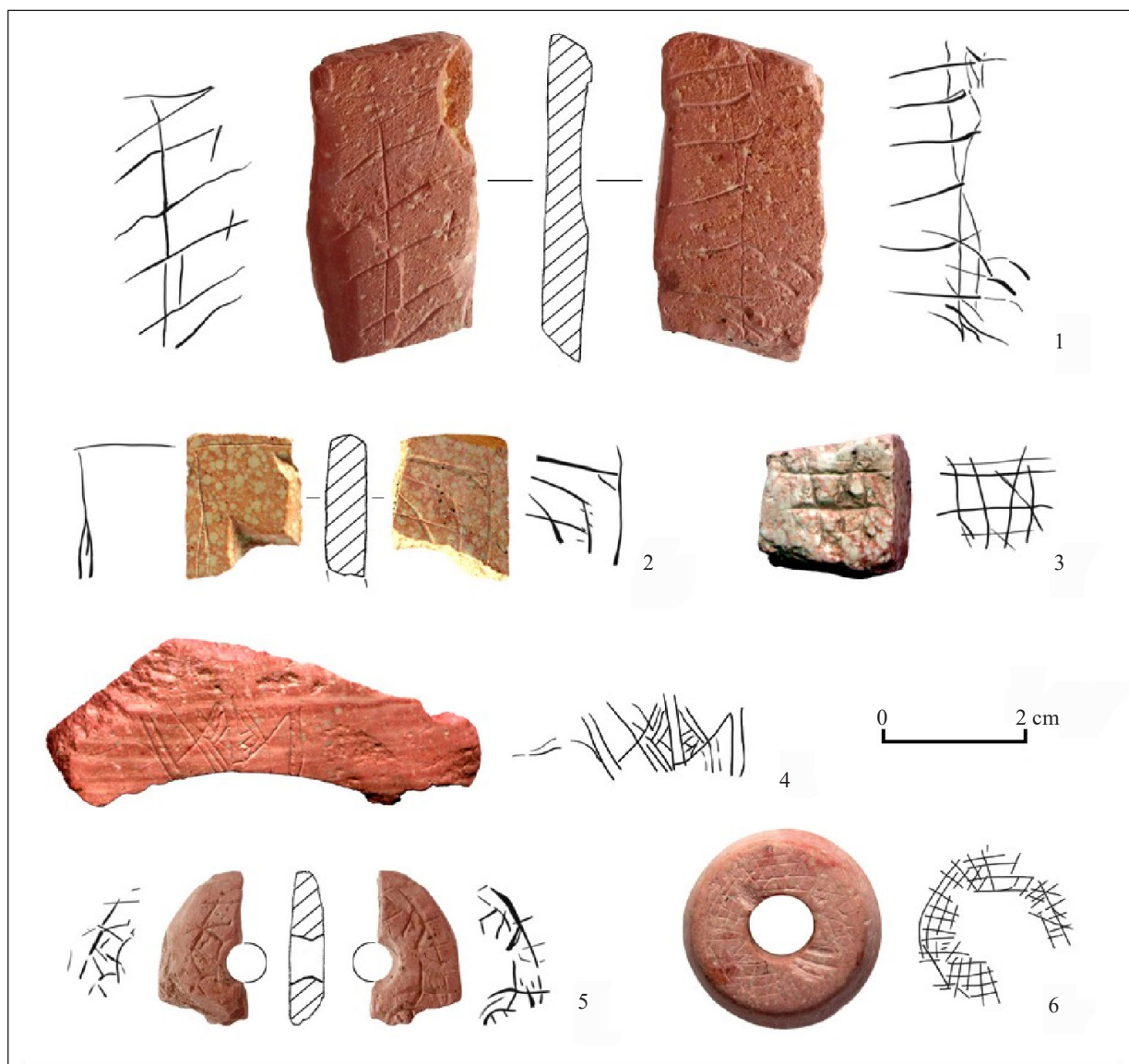


Fig. 14. Prybytky 1, site: 1, 3–6 — fragments of waste and defective blanks with graffiti; 2 — a fragment of an icon-image

ly established in our study of materials from the Prybytky 1 workshop settlement.

Using our proposed methodology, collections of spindle whorls from Kyiv's Podil (Черновол 2008) and rural settlements of Chernihiv Polissia (Веремейчик 2008) have been analysed and introduced into scientific discourse.

Unfortunately, most researchers limit their publications to merely listing the number of pyrophyllite slate spindle whorls found during excavations, occasionally noting their shapes and individual dimensions. Although recent publications on Ancient Rus cities provide some data on the stratigraphic distribution of pyrophyllite slate spindle whorls, this information is often insufficient for compiling complete collections, conducting comprehensive analyses, or comparing them with finds

from other Ancient Rus settlements and materials from the specialised workshops of the Slovechno-Ovruch ridge.

Given our experience and the wide distribution of medieval settlements where pyrophyllite slate spindle whorls are found (Western Europe — White Sea — Ural region — Black Sea — Balkan Peninsula), we deemed it appropriate to propose a simplified, publication-adapted tabular version of an electronic database (fig. 16). This allows for the comparison of collected observations on a standardised basis.

It should be noted that a number of specialised studies have addressed the distribution of pyrophyllite slate products — primarily spindle whorls — across a vast area that includes Scandinavia (Андрощук 1999, с. 160-161; Sjöbeck



Fig. 15. Yamy tract, quarries. Fragments of pyrophyllite slate blanks with traces of surface and facet treatment

2016, pp. 40-44), the Baltic region (Антоневич 1960; Мугуревич 1965, с. 35-42; Shiroukhov 2024), Germany (Herrmann 1963; Gabriel 1977, pp. 124-129; 1988, pp. 199-203; Biermann, Pust, Ansoerge 2007), the Czech Republic (Sláma 1990; Kouřil, Přichystal 2022), Poland (Wołoszyn 2003, mapa 37; 2007, s. 185-187, рис. 6; Lisowska 2013, s. 136-138, 221-224), the Lower Danube area (Комша 1987; Перхавко 1999; Йотов 2017, 2022, с. 64-68), Chersonesus-Korsun (Якобсон 1985, с. 118-119, 126; Колесникова 2006, с. 129-130, 132, 140), and Volga Bulgaria (Якимов 1992). The list of authors and publications is far from exhaustive. These studies explore the chemical and mineralogical characteristics of the artefacts and their correspondence to pyrophyllite slate sourced from the Slovechno-Ovruch ridge. They also analyse the presumed routes of spindle whorl distribution, the chronological framework of their arrival in various regions, and the socio-economic context in which the exchange took place, including international trade networks and the transformation of the status of such objects within new cultural and social settings. However, no comprehensive study has yet examined spindle whorls using a unified archaeometric approach and within an integrated methodological framework for investigating the distribution and consumption of pyrophyllite slate products.

### Conclusion

The Prybytky — Cherevky industrial microregion occupies an exceptional place among the monuments of the Ovruch pyrophyllite slate industry as well as in the settlement system and economic structure of the medieval Ovruch region. Its uniqueness is determined by the deposits and surface outcrops of highly decorative varieties of pyrophyllite slate in the vicinity of Cherevky village. This quarry, containing rare and exquisite types of mineral raw materials, was explored and developed by the medieval population and has no analogues among similar sites on the Slovechno-Ovruch ridge. The exclusivity of the raw material defined the specialisation of synchronous

Андрощук, Ф. А. 1999. Древнерусские вещи Швеции (попытка предварительной оценки). В: Канторович, А. Р. (ред.). *60 лет кафедре археологии МГУ им. М. В. Ломоносова. Тезисы докладов юбилейной конференции* (Москва, 20–24 декабря 1999 г.). Москва: МГУ, с. 160-162.

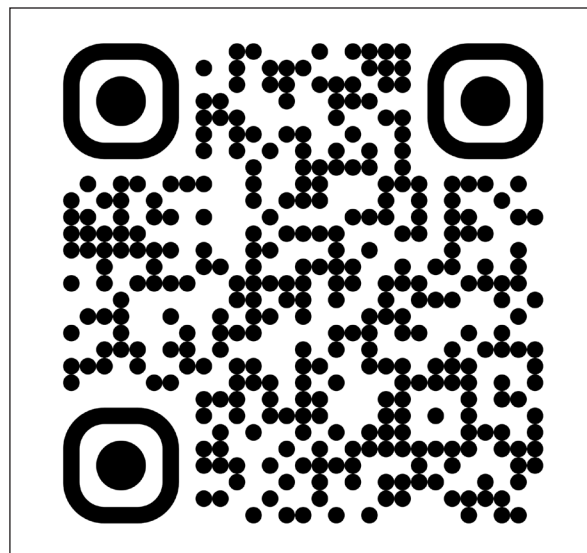


Fig. 16. Online access (QR code) to the electronic database

industrial settlements, which focused on the production of small pyrophyllite slate ornaments — pendant crosses, beads, icons, and amulets. Notably, the settlement complex near Prybytky is currently the only known site where mass production of crosses and icons has been documented. The preserved extraction and production complexes of the Prybytky — Cherevky microregion are monuments of global significance in the fields of nature, geology, history, archaeology, and technology. They require further study and the implementation of measures for their protection.

The materials obtained from the conducted research on medieval pyrophyllite slate quarries, production settlements, and workshops — covering the full production cycle from raw material extraction to the creation of finished products — offer fundamentally new insights into the manufacturing process of pyrophyllite slate spindle whorls and crosses. These findings provide a solid foundation for reconstructing the technology, organisation, and functioning of the medieval Ovruch pyrophyllite slate industry. Further fieldwork and analytical studies will allow for refinement and detailed elaboration of our observations and conclusions.

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### Сергій В. Павленко

Молодший науковий співробітник відділу давньоруської та середньовічної археології, Інститут археології НАН України, ORCID: 0000-0002-3138-5746, [pavlenko@iananu.org.ua](mailto:pavlenko@iananu.org.ua)

## ДОСЛІДЖЕННЯ ВИРОБНИЧОГО РЕГІОНУ ІНДУСТРІЇ ПІРОФІЛІТОВОГО СЛАНЦЮ НА ПІВДНІ СЛОВЕЧАНСЬКО-ОВРУЧСЬКОГО КРЯЖУ

У статті подано результати досліджень спеціалізованих пам'яток та комплексів виробничого осередку індустрії пірофілітового сланцю, розташованого на південних відрогах Словечансько-Овруцького кряжу в мікрорегіоні сіл Прибитки та Черевки. Схарактеризовані видобувні та виробничі пам'ятки мікрорегіону, їх топографічне положення, коротко подана історія досліджень. Особлива увага зосереджена на характеристиці специфічного культурного шару виробничих пам'яток, його складу та насиченості. Відображені результати перших археологічних досліджень середньовічних кар'єрів із видобутку пірофілітового сланцю в урочищі Ями, описана структура копалень, особливості стратиграфії, розглянуті різновиди мінералів, підтверджена попередня обробка сировини на місці видобутку.

Основна увага приділена виробничому поселенню Прибитки I, на якому археологічними розкопками досліджена площа 140 м<sup>2</sup>, виявлені залишки майстерні з обробки пірофілітового сланцю та виготовленню пряслиць для прядіння, натільних хрестиків і намистин. Заповнення майстерні містило велику кількість відходів виробництва, що дало змогу детально простежити послідовність етапів і технологію процесу виготовлення пряслиць та інших виробів. Запропонований алгоритм розбору, сортування, підрахунку й аналізу заповнення своєрідного комплексу. Проаналізовані всі категорії мінеральної складової заповнення майстерні: стружка, мінеральні-сировинні відходи, браковані заготовки, напівфабрикати та відходи виробництва. На основі аналізу розмірних та кольорово-морфологічних параметрів бракованих виробів та відходів, зроблені спостереження щодо існування уніфікованих типів пряслиць із виразними пропорційними характеристиками. Це свідчить про певний прояв стандартизації готової продукції. Спостереження за транологічними слідами на артефактах дали змогу визначити набір інструментів, запропонувати реконструкцію різця та розглянути його конструктивні особливості. Коротко висвітлено виробництво натільних хрестиків. порушено питання переатрибутації мармуроподібних хрестиків, традиційно відомих як «корсунчики», як виробів із пірофілітового сланцю.

Запропонована програма збору інформації про артефакти з пірофілітового сланцю на пам'ятках Середньовічної Європи, що створить можливість простежити географію поширення продукції та її зв'язок із конкретними майстернями Словечансько-Овруцького кряжу.

*Ключові слова:* Словечансько-Овруцький кряж, овруцька середньовічна індустрія, пірофілітовий сланець, кар'єри, виробничі поселення, майстерні, пряслиця, хрестики, намистини.

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