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V. O. KRYZHANOVSKIY**NON-FERROUS METALWORKING
IN KYIVAN PODIL (10th — FIRST HALF OF THE 13th CENTURY)**

The article focuses on the archaeological features and artefacts associated with the processing of non-ferrous metals discovered in the Podil district of Kyiv, highlighting the development of this craft during the period of Kyivan Rus. Specialised structures are presented, including bronze-casting workshops, jewellery workshops, metalworking workshops, domestic workshops, and cultural layers related to such activities. The identification and classification of these structures were made possible through the analysis of specialised artefacts, including metals intended for trade, semi-finished products, casting vessels, casting moulds, tools, and production waste. As a result, craft centres were discovered, indicating that non-ferrous metalworking was a widespread craft in one of the largest medieval cities of Rus.

Key words: Kyivan Rus, Kyivan Podil, non-ferrous metals, bronze-casting and jewellery workshops, metalworking workshops, raw materials and production wastes, crucibles and smelting ladles, casting moulds and tools.

The Kyivan Podil (also known as Podol, Podolie, or Lower City) (fig. 1) is the lower part of the city. It is an urban area located along the right bank of the Dni-pro River in the coastal lowlands (Сагайдак 1991, с. 3). The annals repeatedly mention it as one of Kyiv's oldest districts. Along with the “Upper City,” it played a significant role in the city's socio-economic and political life (Тараненко 2017, с. 7, 9-11). In the days of Kyivan Rus, Podil resembled a trading city. It was a relatively independent settlement (Тараненко 2017, с. 28) that occupied an area of about 180 hectares with dense development. Various production centres emerged there, including those specialising in processing non-ferrous metals (Сагайдак 2010, с. 402, 425; Тараненко 2017, с. 110-114).

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At different times, the territory of the Kyivan Podil was researched by such scholars as P. P. Tolochko, F. O. Androshchuk, D. V. Bibikov, V. I. Bidzilia, T. A. Bobrovskiy, V. A. Bohusevych, K. M. Hupalo, A. B. Zankin, V. M. Zotsenko, I. V. Zotsenko, H. Yu. Ivakin, V. H. Ivakin, O. P. Kaliuk, M. A. Sahaidak, I. M. Samoiloivskiy, M. S. Serhieieva, S. P. Taranenko, and others. The most recent work on the study of Kyivan Rus monuments is S. P. Taranenko's monograph, *The Planning Structure of the Ancient Rus Podil of Kyiv: Formation and Development* (Тараненко 2017), which substantially expanded upon M. A. Sahaidak's earlier work, *Ancient Kyivan Podil: Problems of Topography, Stratigraphy, Chronology* (Сагайдак 1991). The latter listed and described production workshops related to the processing of non-ferrous metals known at the time. Since then, many similar features have been investigated in the Podil area, contributing to the further study of this craft tradition.

The core of this article is a catalogue of archaeological features and artefacts related to non-ferrous metalworking, including specialised finds from cultural layers and from features in which such items occurred intrusively. The primary objectives of this study are to provide the first comprehensive synthesis of archaeological evidence concerning non-ferrous metalworking in the Kyivan Podil and to propose a model for reconstructing the spatial organisation of this craft industry. The chronological scope of the study spans the period from the 10th to the first half of the 13th century.

For the first time, the contents of the sites and materials from the cultural layers have been collated, and all known features and artefacts have been systematically catalogued. In addition, criteria for distinguishing between bronze-casting, jewellery-making, blacksmithing, and locksmithing workshops are proposed, and four craft centres have been identified.

Materials and Methods

This article analyses 109 archaeological features, including materials from the cultural layers of the Kyivan Rus period, originating from 43 ex-

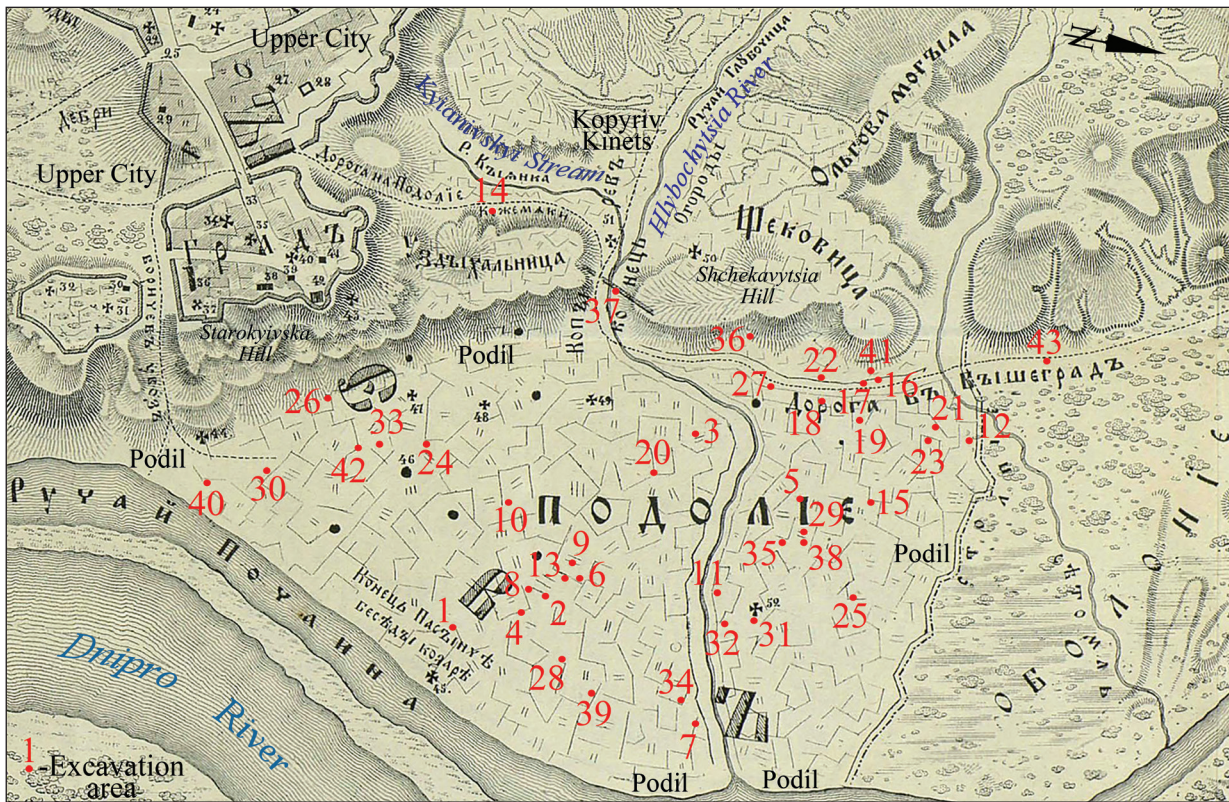


Fig. 1. Location of the Podil excavation areas on the reconstruction plan of Kyiv (from 988 to 1240), after: Zakrevskii 1868, p. 922, drawing annotations by the author

cavation sites in Kyiv’s Podil district (figs. 1–3, tables 1–2). The excavations are presented in chronological order, from the earliest to the most recent. The level of detail in the description of features and artefacts varies according to the quality of fieldwork and desk-based research. Some of these materials are published here for the first time.

The following criteria were used to classify different production features (structures). Workshops engaged in bronze-casting, specialising in foundry processes, are identifiable through characteristic finds, including metal raw materials and casting vessels such as crucibles, casting moulds, and copper alloy slag. Their production focused on copper-based alloys (leaded bronze, tin bronze, and brass) and on the manufacture of finished products derived from these materials. Jewellery workshops produced decorative ornaments, attire fittings, sacred items, and equestrian harness elements from non-ferrous and precious metals. The workshops used specialised tools, casting moulds and small-volume casting vessels (including crucibles, moulds, micro-tools, remnants of precious metals and stones). Blacksmith and locksmith workshops constituted distinct functional spaces that could be combined. Blacksmith workshops produced non-ferrous metal items through hot or cold forging,

while locksmith workshops were primarily used to repair existing objects. However, due to the similarity of the artefacts recovered from these sites, clear differentiation is often difficult. Therefore, the general term “metalworking workshops” is used. These workshops differ from other production spaces in their lack of casting moulds and vessels, limited quantities of metal raw materials, and evidence of semi-finished or broken items (including ferrous slag, blacksmith’s scale, and specialised ironworking tools). Founders and jewellers could operate domestic workshops within typical residential spaces. A production space integrated into a residential structure may be distinguished from occasional repair activity by the presence of several thermal engineering structures (one of which was used for cooking), together with a large number of vessels, moulds, tools, raw materials, and waste. Universal workshops accommodated various types of manufacturing, using shared facilities and thermal engineering structures. Owing to similar technological processes, the processing of non-ferrous metals could have been combined with iron or glassworking through the use of shared casting vessels or tools. Workshops or domestic workshops featured a variety of thermal engineering structures, ranging from production

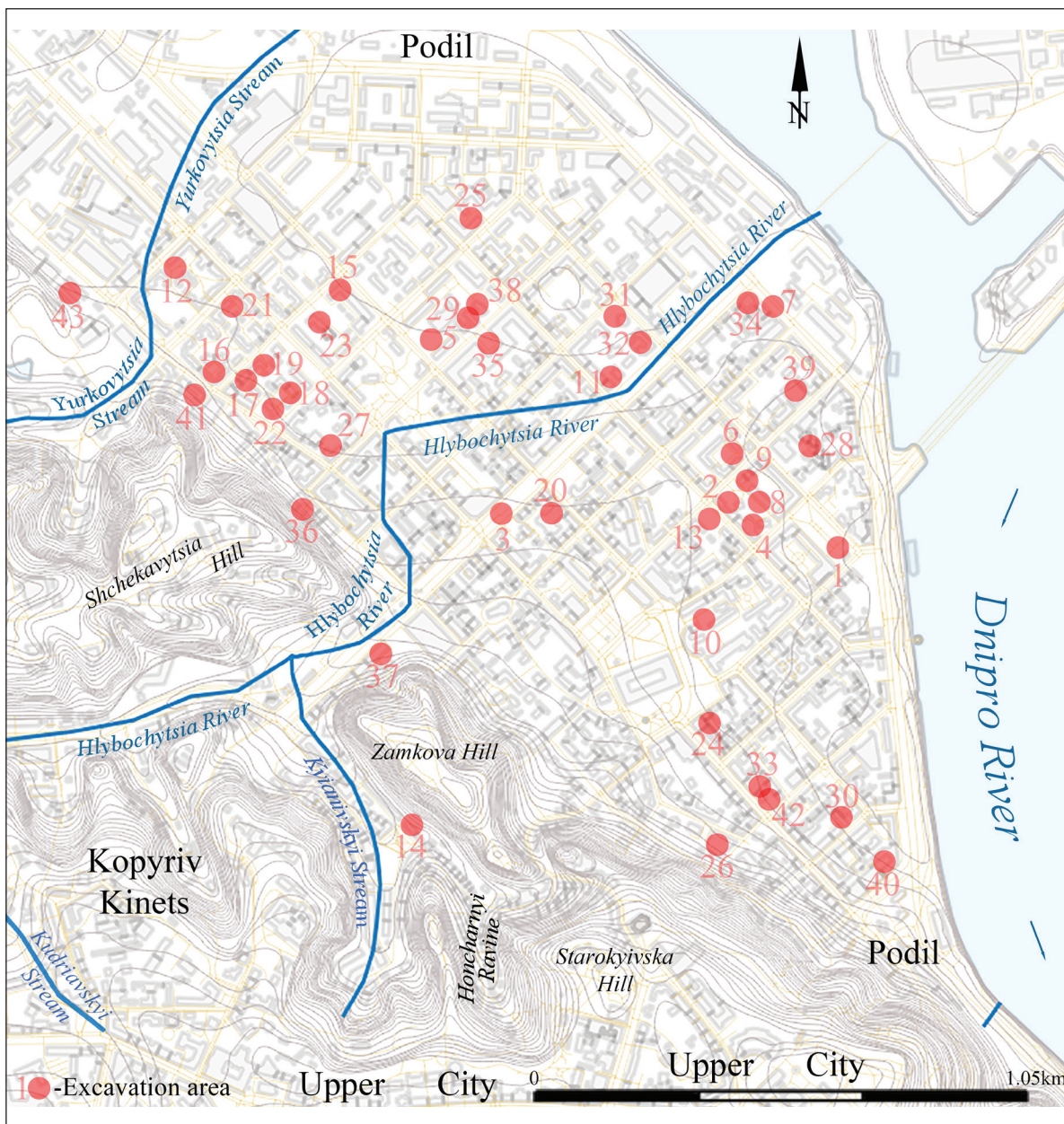


Fig. 2. Location of the Kyivan Podil excavation areas on a modern topographic map

kilns to ordinary cooking ovens and open hearths, all capable of reaching temperatures high enough to melt some metals. In the article, this general term is used because of the limited possibilities for interpreting such structures. Warehouses, pits, and cellars are regarded as workshop components used for storing raw materials, finished products, and production waste. Owing to preservation conditions affected by modern urban development, the planning and stratigraphic measurements of archaeological features may not accurately reflect their original dimensions.

Artefacts from the Kyivan Rus cultural layers were also analysed. These finds may indicate the possible presence of specialised non-ferrous metal

production within a given territory. However, their occurrence does not always provide clear evidence of such activity. Natural processes (such as landslides) and anthropogenic factors (including modern construction activities) may account for their displacement (fig. 3, table 1–2).

These features were distinguished from others according to the totality of their characteristics and classified by levels of interpretive certainty. High certainty refers to production structures containing thermal engineering installations together with casting vessels, moulds, tools, and production waste. Moderate certainty applied to production structures, which combined several categories of specialised artefacts. Low certainty refers to

Table 1. The excavation areas that contain features related to the processing of non-ferrous metals, including workshops, their components, and cultural layers

Excavation areas: numbers (years of research) and locations	Feature numbers					Total
	Bronze-casting workshops	Jewellery workshops	Metalworking workshops	Domestic workshops	Cultural layers	
1 (1955) Pochainynska St., 1					1	1
2 (1956) Voloska St., 20		2				1
3 (1975) Verkhni Val St., 30		3				1
4 (1981–1982, 1988) Voloska St., 16	8	6	5, 7	4		5
5 (1981–1982) Shchekavytska St., 25–27		10		9, 11	12, 13	5
6 (1983) Spaska St., 25–39			14			1
7 (1983) Naberezhno-Khreshchatytska St., 37–39					15*	1
8 (1985) Hryhoriia Skovorody St., 11					16*	1
9 (1985) Spaska St., 20	18, 19			17	20	4
10 (1987) Kontraktova Ploshcha Sq., 4	21, 22, 23, 24				25*	5
11 (1987) Nyzhnii Val St., 41			26**, 27**, 28		29*, 30, 31	6
12 (1988) Kostiantynivska St., 61		32			33	2
13 (1988–1989) Spaska St., 14		34, 35, 37		36		4
14 (1988–1989) Vozdvyzhenska St., 23–25	38					1
15 (1989) Mezhyhirska St., 43					39*, 40	2
16 (1989) Obolonska St., 1					41	1
17 (1989) Obolonska St., 4	43, 44, 46, 47, 49			42, 45	48*, 50, 51	10
18 (1990) Vvedenska St., 3A			52, 53			2
19 (1990) Obolonska St., 16/6	55, 56, 57, 58, 59		54		60, 61	8
20 (1991–1992) Mezhyhirska St., 11	62, 63				64	3
21 (1992) Yurkivska St., 12/59					65	1
22 (1992–1993) Kyrylivska St., 26/2A, B					66	1
23 (1993) Obolonska St., 12	67					1
24 (1996) Kontraktova Ploshcha Sq., 2		68				1
25 (1996) Voloska St., 58/29					69	1
26 (1997) Andriivska St., 1					70	1
27 (1998) Shchekavytska St., 7/10		71			72	2
28 (1998–1999) Spaska St., 30					73*	1
29 (2002) Shchekavytska St., 27–29	74					1
30 (2002) Ihorivska St., 7					75	1
31 (2003) Pochainynska St., 27/44	76				77	2
32 (2003–2004) Pochainynska St., 25/49		78			79	2
33 (2004) Sahaidachnoho St., 16–18					80	1
34 (2004) Verkhni Val St., 68					81	1
35 (2004) Shchekavytska St., 30/39					82	1
36 (2005) Yaroslavskiy Ln., 7/9				83		1
37 (2005–2006) Verkhni Val St., 8					84*	1
38 (2006) Shchekavytska St., 29	85, 86, 87, 88				89, 90	6

* — materials that accidentally entered the features from the cultural layers;

** — it could also be metallurgical workshops.

Excavation areas: numbers (years of research) and locations	Feature numbers					Total
	Bronze-casting workshops	Jewellery workshops	Metalworking workshops	Domestic workshops	Cultural layers	
39 (2007–2008, 2011) Spaska St., 35	91	92			93*, 94*, 95*, 96*, 97*, 98*, 99, 100, 101	11
40 (2007) Naberezhno-Khreshchatytska St., 1A					102	1
41 (2008) Kyrylivska St., 23–25					103*	1
42 (2011–2012) Petra Sahaidachnoho St., 16					104	1
43 (2016) Kyrylivska St., 37	105, 106, 107				108, 109	5
Total	31	12	9	8	49	109

Table 2. Artefacts related to non-ferrous metal processing

Excavation area numbers	Feature numbers	Dating (centuries)	Materials of processing of non-ferrous metals					Trimblings/ Spatters (Melts)/Slag
			Metals intended for trade	Semi-finished products	Casting vessels	Casting moulds	Tools	
1	1	10 th –13 th			6			
2	2	13 th						–/–/+*
3	3	10 th				3		
4	4	12 th –13 th				1	1	
	5	12 th –13 th						
	6	12 th –13 th		1		1		
	7	12 th –13 th		1	+			
5	8	12 th	+		30		+	
	9	12 th –13 th						
	10	12 th –13 th				5	1	+/–/–
	11	12 th –13 th			3			
	12	12 th			241	+		
6	13	12 th –13 th						+/–/–
	14	12 th –13 th						–/+/–
7	15	12 th			1			
8	16	11 th			1			
9	17	12 th	1		12			
	18	11 th			2			
	19	11 th						–/–/2
	20	11 th –12 th			2			
10	21	12 th			2			–/+/+
	22	11 th						–/–/+
	23	11 th			1			
	24	12 th			1			–/+/+
	25	11 th			1			
11	26	11 th	2**		2			–/+/+
	27	11 th			1			–/–/+
	28	11 th						–/–/+
	29	11 th –12 th			1			
	30	11 th			1			

* Here and after: certain artefacts were found here, but no specific quantitative data are available; ** copper ore.

Excavation area numbers	Feature numbers	Dating (centuries)	Materials of processing of non-ferrous metals					Trimblings/ Spatters (Melts)/Slag
			Metals intended for trade	Semi-finished products	Casting vessels	Casting moulds	Tools	
	31	12 th				1		
12	32 33	10 th -13 th 12 th	+		1			
13	34 35 36 37	11 th 11 th -12 th 11 th 11 th				1 1 1		-/-/+
14	38	12 th -13 th		1		1		
15	39 40	12 th -13 th 12 th -13 th			2 137			-/-/+
16	41	12 th -13 th				1		
17	42 43 44 45 46 47 48 49 50 51	12 th 12 th -13 th 12 th -13 th 12 th -13 th 12 th -13 th 12 th -13 th 12 th -13 th 12 th -13 th 12 th -13 th 11 th			2 2 4 1 1 5 3 1	1		-/-/2 -/+/ -/-/+
18	52 53	11 th -12 th 11 th -12 th			1 2			-/-/2
19	54 55 56 57 58 59 60 61	12 th -13 th 11 th -12 th 11 th -12 th 11 th -12 th 11 th 11 th 11 th -13 th 12 th -13 th		1	1 1 6 1 17		2	-/1/ -/-/+
20	62 63 64	12 th 12 th 12 th			1 2			-/-/+
21	65	13 th		1			1	
22	66	11 th -13 th			1			
23	67	12 th -13 th		26	206			-/+/-
24	68	12 th			1			
25	69	12 th		1				-/-/2
26	70	11 th			1	1		
27	71 72	11 th -12 th 12 th				1		-/+/-
28	73	12 th -13 th			1			
29	74	12 th		+				-/+/-

Excavation area numbers	Feature numbers	Dating (centuries)	Materials of processing of non-ferrous metals					Trimmings/ Spatters (Melts)/Slag
			Metals intended for trade	Semi-finished products	Casting vessels	Casting moulds	Tools	
30	75	12 th				1		
31	76	11 th -12 th			74	15		-/-/+
	77	12 th			10			
32	78	11 th						-/+/+
	79	12 th -13 th						-/-/33
33	80	11 th -13 th			+			
34	81	11 th -12 th				1		-/-/+
35	82	11 th -12 th				+		
36	83	12 th			2			
37	84	12 th -13 th			1		2	-/-/6
38	85	12 th		+				
	86	12 th						
	87	12 th			2			
	88	12 th			1	1		
	89	12 th			138			-/-/5
	90	11 th			3			-/-/1
39	91	12 th			+			-/+/43
	92	12 th	+	+	+			-/+/+
	93	11 th -13 th			3			-/-/3
	94	11 th -13 th						-/-/2
	95	11 th -13 th			1			
	96	11 th -13 th						-/-/2
	97	11 th -13 th						-/-/1
	98	11 th -13 th						-/-/1
	99	11 th -13 th			1			-/-/5
	100	11 th -13 th					1	-/-/1
	101	11 th -13 th			+			-/-/+
40	102	11 th			1			-/-/5
41	103	11 th -12 th			4			
42	104	12 th -13 th			17			
43	105	10 th -11 th						-/(1)/-
	106	11 th			1			
	107	11 th			1			
	108	12 th -13 th	4	1	9		3	-/(44)/18
	109	10 th -11 th		1	11		1	11/(11)/32
Total			9	35	990	38	11	11/1(56)/165

isolated artefacts indicating metalworking activity but lacking clear workshop infrastructure. Very low certainty (indirect evidence of metalworking) applies to finds from cultural layers or non-production structures that may suggest craft activity nearby.

The identification of workshops was made possible through the discovery of specialised artefacts within the fills of archaeological features.

These artefacts (table 2) included metal raw materials (ore and metals intended for trade), semi-finished products (blanks and unfinished items), tools (casting vessels, such as crucibles and smelting ladles, casting moulds, and production tools), and production waste (metal scraps, spatters, and slag). The documented quantities of various artefacts are provided where possible, although they might differ from the original amounts, since

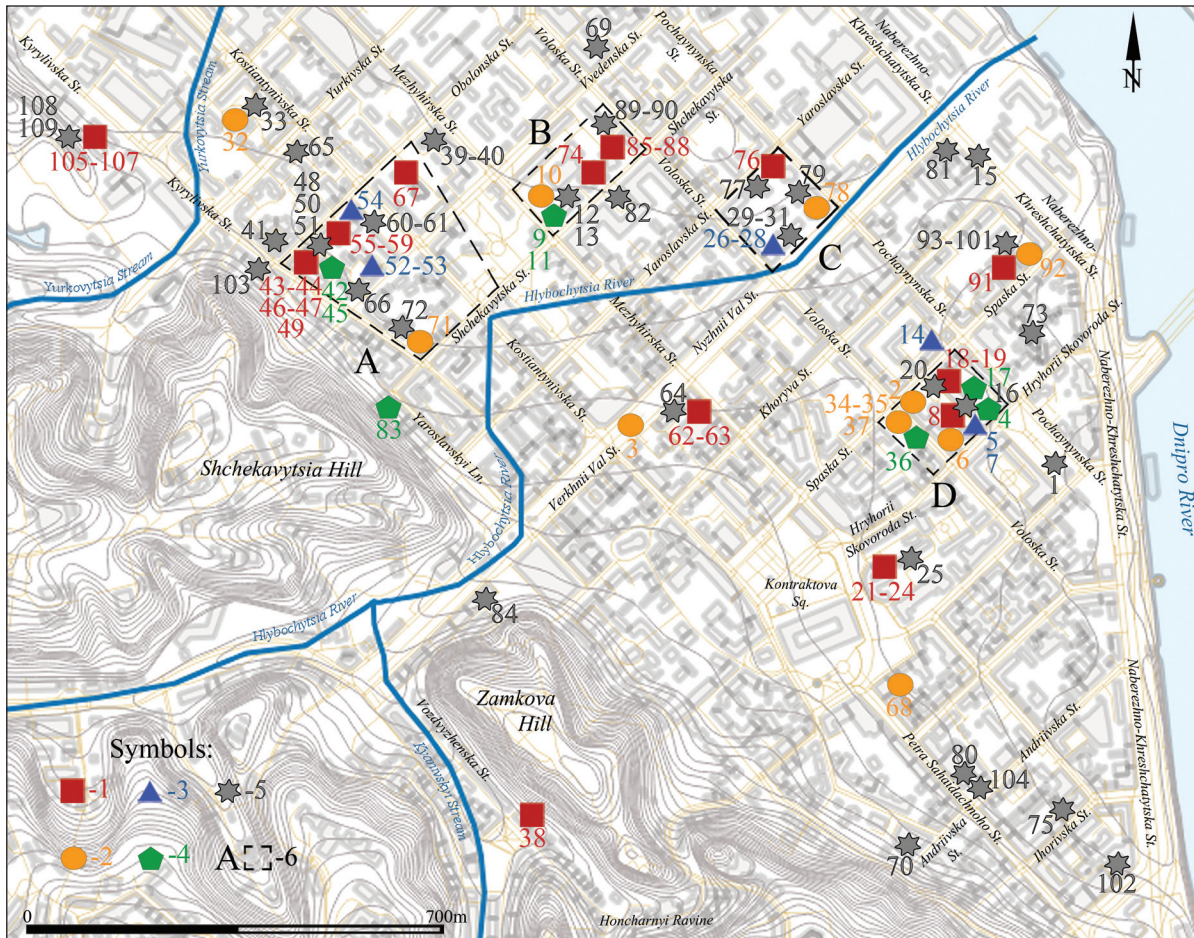


Fig. 3. Location of features and craft centres related to the processing of non-ferrous metals in the Kyivan Podil on a modern topographic map: 1 — bronze-casting workshops; 2 — jewellery workshops; 3 — metalworking workshops; 4 — domestic workshops; 5 — cultural layers; 6 — areas of the production centres

many scientific reports and documentation lack precise numerical data. In the absence of laboratory analyses of the non-ferrous metal artefacts described in the article, the metals were provisionally classified using paired name variants: “copper/bronze” and “tin/lead.” The paired term “crucible/smelting ladle” is used to refer to casting vessels, whose exact type could not be determined.

Artefacts similar to those found in Kyiv have also been discovered in other Rus cities and settlements.

The research methodology was based on typological, statistical, cartographic, and chronological methods. The dating of the archaeological features was based on the analysis of the ceramics found in the fills. The artefacts discussed in the article are currently preserved in the collections of the Archaeological Museum of the Institute of Archaeology of the National Academy of Sciences of Ukraine, the National Museum of the History of Ukraine, and the Kyiv History Museum.

Results

The research resulted in the following list of specialised artefacts related to non-ferrous metalworking discovered in the fills of archaeological features and cultural layers of Kyivan Podil (10th — first half of the 13th century)

Area 1¹ (figs. 2–3, tables 1–2)

1.² Cultural layer contained crucibles with traces of melted copper/bronze inside (Самойловський 1955, с. 3).

Area 2 (figs. 2–3, tables 1–2)

2. Jewellery workshop contained clumps of oxidised copper/bronze, slag, and fragments of melted smalt or enamel (L = 2 m; H = 1.2 m) (Копилов 1956, с. 21; Толочко 1965, с. 17–18).

Area 3 (figs. 2–3, tables 1–2)

¹ Numbering of excavation areas where features and finds related to non-ferrous metalworking were located.

² Numbering of the archaeological features, including the Kyivan Rus cultural layers, related to non-ferrous metalworking.

3. Jewellery workshop contained casting moulds (fig. 5: 3–4, 7) and a fragment of a grinding bar, which was probably used for mould correction (Гупало, Ивакин, Сагайдак 1976, с. 2, 9–11; Гупало, Ивакин, Сагайдак 1979, с. 47–53, 48–51, рис. 7–10; Гупало 1981, с. 302–308; Орлов 1983, с. 31–34; Сагайдак 1991, с. 36–37, 92–94; Зоценко, Брайчевська 1993, с. 43).

Area 4 (figs. 2–3, tables 1–2)

4. Domestic workshop contained a fragment of a casting mould (fig. 5: 2) and a feather-shaped drill (Сагайдак, Чернов 1982, с. 1–8, 15; Сагайдак 1991, с. 43–44, 46, рис. 25).

5. Metalworking workshop contained a thermal engineering structure.

6. Jewellery workshop contained a thermal engineering structure (dimensions (dim.) = 1,0 × 1.1 m): a bronze jewellery tweezer with a fixing ring and a significant number of copper/bronze products, mainly jewellery, as well as a pin intended for repair with a broken end that was covered with cloisonné enamel (Сагайдак, Чернов 1982, с. 6–11).

7. Metalworking workshop contained a thermal engineering structure (L = > 2 m): fragments of ceramics with traces of copper/bronze, and gold alloys on the walls, wholes and fragments of smelting ladles (fig. 4: 9–17), and a gold three-bead earring intended for repair, with one of the beads slightly flattened and the earring's eyehole bent (Сагайдак, Чернов 1982, с. 1–12).

8. Bronze casting workshop contained small weights, numerous fragments of crucibles, and pieces of copper/bronze (Сагайдак, Сергеева 1990; Сагайдак 1991, с. 45).

Area 5 (figs. 2–3, tables 1–2)

9. Domestic workshop (dim. ≈ 4 × 3 m).

10. Jewellery workshop contained a canopy, and a thermal engineering structure (diam. = 0.9 m); several spots of the small thermal engineering structures (diam. = 0.3–0.4 m): scraps of copper/bronze, melted copper/bronze small balls, casting moulds, scraps of slate (probably waste from the manufacture of casting moulds), and a fragment of scales (Ивакин, Степаненко 1982, с. 15–16; 1985, с. 101, рис. 25; Сагайдак 1991, с. 38, 125).

11. Domestic workshop contained a thermal engineering structure: numerous fragments of crucibles and smelting ladles, small ceramic fragments covered by copper/bronze slag, and slate fragments — waste from local casting mould manufacturing (Ивакин, Степаненко 1982, с. 7–11).

12. Cultural layer contained casting moulds and two small, fragmented, semi-deep dishes

covered by a slag crust on the inside and outside (Ивакин, Степаненко 1982, с. 16; 1985, с. 79, рис. 1).

13. Cultural layer contained scraps of copper/bronze, numerous fragments of crucibles and smelting ladles, and a sprue with gold droplets (Ивакин, Степаненко 1982, с. 2–7; 1985, с. 81, рис. 2).

Both 12 and 13 also contained small crucibles and smelting ladles, 12 of which were either mostly complete or fragmented (with handles), together with 26 detached handles; a miniature ceramic pot, probably used as a smelting ladle (covered with a slag crust on the inside and a glass-like mass on the outside, and half-filled with this material); and numerous small fragments of slagged ceramics (Ивакин, Степаненко 1982, с. 16, 26).

Area 6 (figs. 2–3, tables 1–2)

14. Metalworking workshop contained numerous highly oxidised copper/bronze items, together with splashes of copper/bronze, were concentrated nearby (Сагайдак 1984, с. 9–10).

Area 7 (figs. 2–3, tables 1–2)

15. Non-production structure (artefacts originated from the cultural layer) contained a fragment of a crucible covered on both sides with a continuous layer of glass-like mass (Сагайдак 2003, с. 2–3).

Area 8 (figs. 2–3, tables 1–2)

16. Non-production structure (artefacts originated from the cultural layer) contained a fragment of the bottom of the crucible covered with a pellicle of a porous, glass-like mass on the outside (Занкин, Сагайдак, Тимошук 1985, с. 44–46).

Area 9 (figs. 2–3, tables 1–2)

17. Domestic workshop (dim. = 3.4 × 3.4 m) contained a thermal engineering structure (dim. = 0.8 × 0.6 m): a copper/bronze ingot of a rod-shaped, flat-convex shape with uneven edges and a back, weighing 315 g, as well as fragments of crucible walls covered by copper/bronze slag.

18. Bronze casting workshop (dim. = 3.00 × 2.25 m; contained a thermal engineering structure measuring 0.86 × 0.51 m) contained a fragment of a crucible wall, covered on both sides with a thin layer of copper/bronze slag. A small fragment of a thick-walled crucible was found in the fill of a thermal engineering structure.

19. Boundaries and orientation of the bronze casting workshop almost coincided with the boundaries of the previous feature: contained fragments of copper/bronze slag.

20. Cultural layer contained fragments of crucibles (Зоценко и др. 1985, с. 7, 16, 25–30).

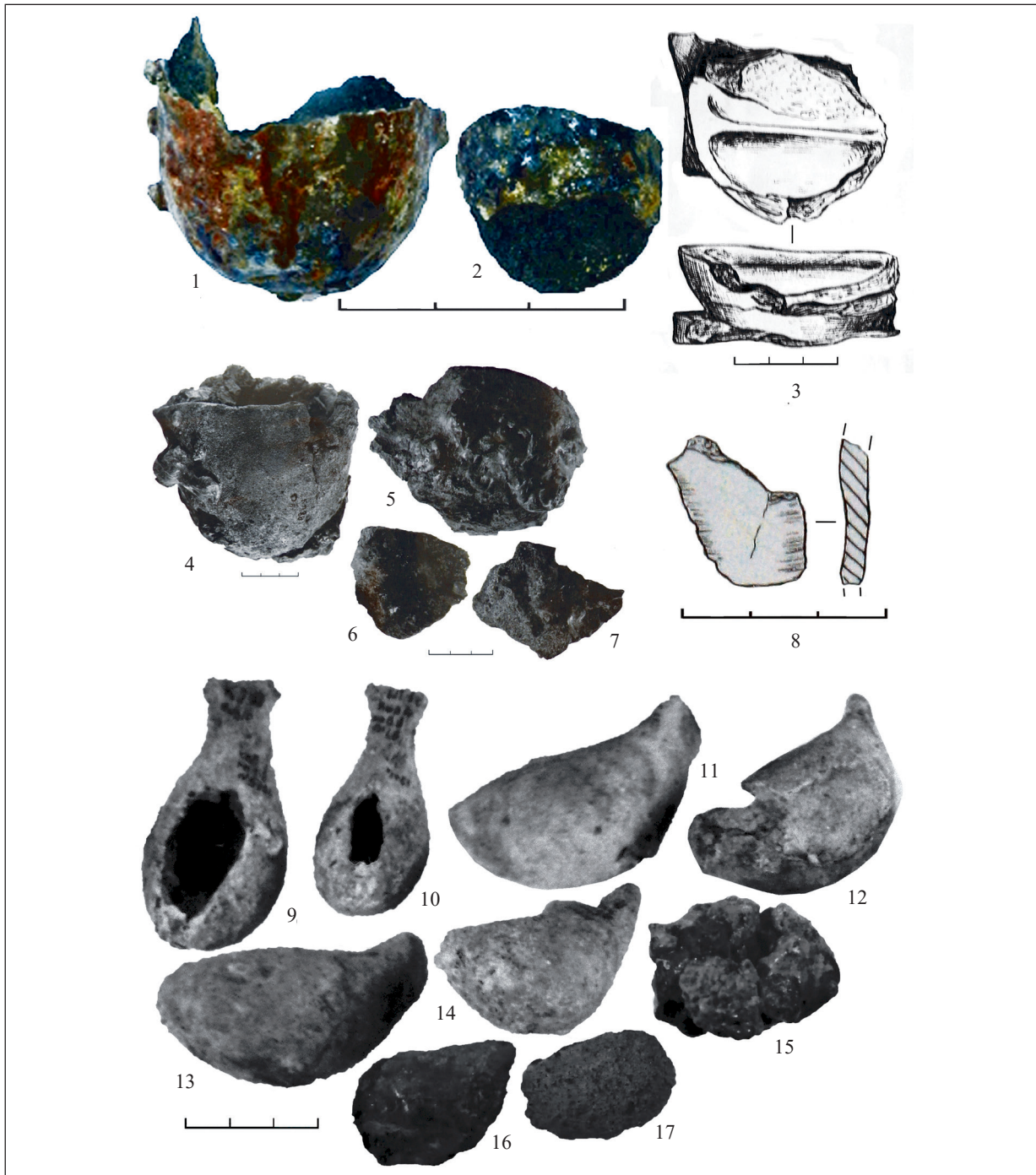


Fig. 4. Casting vessels: 1–2 — from feature 104, after: Сагайдак та ін. 2012а; 3 — from feature 68, after: Сагайдак, Сергеева 1996; 4–7 — from feature 49, after: Бидзиля, Тимошук, Фридман 1990; Fig. 5 Casting moulds: 1 — from feature 34, after: Сагайдак и др. 1988; 2 — from feature 4, after: Сагайдак, Чернов 1982; 3–4, 7 — from feature 3, after: Гупало, Івакін, Сагайдак 1979; 5 — from feature 81, after: Хамайко 2006; 6 — from feature 31, after: Зоценко, Брайчевська 1993 — from feature 84, after: Сагайдак, Черновол, Пєфтіць 2006; 9–17 — from feature 7, after: Сагайдак, Чернов 1982

Area 10 (figs. 2–3, tables 1–2)

21. Bronze casting workshop (wall L = 2.5 m and 1.25 m; contained a thermal engineering structure) contained a vertical rim of a slagged crucible with a drip of copper/bronze on the inner surface and a fragment of a slagged crucible wall. Numerous splashes of molten copper/bronze and pie-

ces of slagged clay with copper/bronze inclusions were found in the fill of the feature pit.

22. Bronze casting workshop (dim. = 2.90 × 1.37 m) contained fragments of clay coating covered by glass-like slag and numerous pieces of glass-like slag.

23. Bronze casting workshop (dim. = 2.15 × 1.00 m) contained a slagged crucible.



Fig. 5. Casting moulds: 1 — from feature 34, after: Сагайдак и др. 1988; 2 — from feature 4, after: Сагайдак, Чернов 1982; 3-4, 7 — from feature 3, after: Гупало, Івакін, Сагайдак 1979; 5 — from feature 81, after: Хамайко 2006; 6 — from feature 31, after: Зоценко, Брайчевська 1993

24. Bronze casting workshop (dim. = 2.5 × 1.6 m) contained splashes of copper and bronze, glass-like slag, fragments of clay coated with glass-like slag, traces of copper and bronze, and a thick-walled casting vessel with no traces of use; a discarded thermal engineering structure was also present.

25. Non-production structure (dim. = 2.00 × 0.75 m; artefacts originated from the cultural layer) contained a small, slagged fragment of a crucible (Сагайдак, Занкин, Тимошук 1988, с. 5-11, 13-14, 16-18, 22-23).

Area 11 (figs. 2–3, tables 1–2)

26. Metalworking workshop (with clay-coated walls, dim. = 4.35 × 4.00 × 4.37 m) contained a significant number of splashes of crucible bronze and copper, weighing about 10 g, and fragments of the slagged crucibles were found, as well as two thermal engineering structures used for metal casting (Зоценко, Брайчевська 1993, с. 49-53, рис. 5–6). The first thermal engineering structure (dim. = 1.40 × 0.74 × 0.38 m) contained small pieces of glass-like slag in its fill. Beneath, two pieces of chalcosine ore weighing 270 and 125 grams were found, both with traces of cutting on one side. There was a fragment of a crucible, slagged on the outside, but lacking a glass-like crust on top. On the inside, a heavy, dense slag-metal mass adhered to the crucible wall (Зоценко, Брайчевська 1993, с. 90-95, рис. 23). The second thermal engineering structure had a height of 0.4 m (Зоценко, Брайчевська 1993, с. 94, рис. 24). Numerous glass-like slags were found near these thermal engineering structures, some of which adhered to ceramic fragments.

27. Metalworking workshop (dim. = 4.40 × 2.00 × 1.75 m; contained a thermal engineering structure measuring 1.15 × 1.10 m, H = 0.35 m): a fragment of a crucible covered by a slag crust was found nearby (Зоценко, Брайчевська 1993, с. 55, рис. 9).

28. Metalworking workshop (dim. = 1.60 × 1.05 × 0.50 m, located in the open air and probably covered by a canopy) contained fragments of burnt clay with adhering copper and bronze oxides — probably the remains of its frame — together with a significant amount of glass-like slag were found around it (Зоценко, Брайчевська 1993, с. 55-56, 96).

29. Non-production structure (artefacts originated from the cultural layer) contained a small bowl with a flat bottom used as a crucible, its inner surface covered by crust, while the outer surface was coated by dense slag.

30. Cultural layer contained an almost complete crucible with an outer surface covered with a crust and a droplet-like patch of oxide copper/bronze on the bottom.

31. Cultural layer contained a casting mould (fig. 5: 6) (Зоценко, Брайчевская 1987; Зоценко, Брайчевська 1993, с. 46-47, 97-98, рис. 3–4, 25: 5).

Area 12 (figs. 2–3, tables 1–2)

32. Jewellery workshop (diam. ≈ 1 m) contained copper/bronze fragments of wire blanks twisted into rings.

33. Cultural layer contained a small fragment of a slagged crucible wall (Андрощук, Бобровский, Зоценко 1988, с. 5-6, 13-14).

Area 13 (figs. 2–3, tables 1–2)

34. Jewellery workshop contained a casting mould (fig. 5: 1).

35. Jewellery workshop (dim. = 2.7 × 2.5 m) contained several pieces of copper/bronze slag (Сагайдак и др. 1988, с. 13-15; Сагайдак, Брайчевская, Михайлов 1990, с. 7-8).

36. Domestic workshop (dim. = 3.75 × 3 m) contained a fragment of a pyrophyllite casting mould (Сагайдак и др. 1988, с. 15-16; Сагайдак, Брайчевская, Михайлов 1990, с. 6-7, ф. 28).

37. Jewellery workshop (dim. = 2.12 × 1.63 m) contained a fragment of a crucible (Сагайдак, Брайчевская, Михайлов 1990, с. 10).

Area 14 (figs. 2–3, tables 1–2)

38. Bronze casting workshop (dim. = 4.5 × 3.5 m) contained a fragment of a stone casting mould and a significant number of copper/bronze alloy products, including a large fragment of a copper/bronze sheet from a large dish and several small fragments of metal sheets (unfinished products, products requiring repair, and metal scrap intended for remelting) (Івакін та ін. 1990, с. 1-2).

Area 15 (figs. 2–3, tables 1–2)

39. Non-production structure (dim. ≈ 3 × 3 m; artefacts originated from the cultural layer) contained two closed-type smelting ladles without openings for loading raw materials (Занкин, Полин, Калюк 1990, с. 29-30).

40. Cultural layer contained fragments of crucibles, including one complete crucible; small copper/bronze ingots; casting pellicle; and glass “threads,” which could have been used in jewellery production (Занкин, Полин, Калюк 1990, с. 36, 41-42).

Area 16 (figs. 2–3, tables 1–2)

41. Cultural layer contained a casting mould (Сагайдак, Сергеева, Тимошук, 1989, с. 18).

Area 17 (figs. 2–3, tables 1–2).

42. Domestic workshop (dim. = 3.5 × 3.5 m; contained a thermal engineering structure measuring 1.10 × 1.05 m, which had been rebuilt four

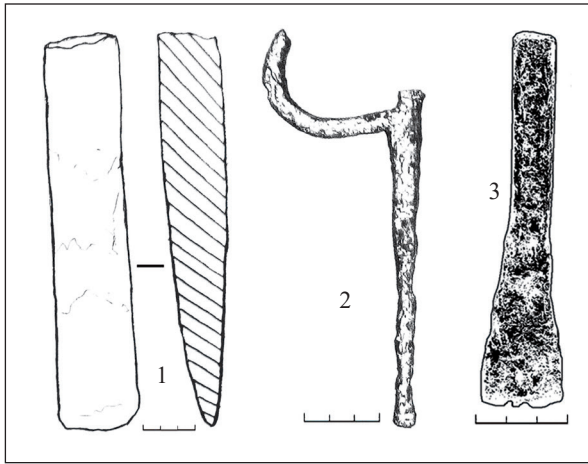


Fig. 6 Tools: 1–2 — from feature 84, after: Сагайдак, Черновол, Пєфтіць 2006; 3 — from feature 108, after: Івакін та ін. 2016

times, with a pit measuring 0.85×0.75 m located in front of it) contained fragments of thick-walled crucibles which were covered by glass-like slag on the outside, and a broken iron hand punch.

43. Bronze casting workshop (dim. = 2.35×2.00 m) contained fragments of crucibles covered by glass-like slag on the outside.

44. Bronze casting workshop (dim. = 1.85×1.15 m; contained a thermal engineering structure) contained fragments of crucible walls, the inner and outer sides of which were covered by glass-like slag, together with pieces of porous slag containing copper/bronze inclusions.

45. Domestic workshop (dim. = 3.5×2.00 m; contained a thermal engineering structure) contained a thin, trapezoidal-shaped plate of pyrophyllite with evenly ground faces, similar to a blank for a casting mould panel.

46. Bronze casting workshop contained a fragment of a thick-walled crucible wall covered by glass-like slag.

47. Bronze casting workshop contained a rectangular tin/lead plate bearing chopping marks, that could have been used as raw material for bronze production.

48. Non-production structure (dim. = $3.00 \times 2.50 \times 2.10 \times 1.25$ m; artefacts originated from the cultural layer) contained a round bottom of a thick-walled, wide-open, conical crucible (outside covered with glass-like slag).

49. Bronze casting workshop (dim. = 0.65×0.50 m, a massive glass-like mass occupied half of its working volume with inclusions of copper/bronze): from above, there was a crucible with adhered inclusions of oxidation copper/bronze, and its inner surface was clean (fig. 4: 4). Splashes

of copper and bronze covered the surrounding ground surface, as well as fragments of crucibles (fig. 4: 5–7) and small pieces of glass-like slag containing copper and bronze inclusions. Nearby, a fragment of marketable bronze was found: a short rod with chopped ends and a triangular cut-away weighing 60.2 g. Also, a twisted, thin copper/bronze plate that could have been a coin or a pendant blank was found. Several small lenticular pits filled with charcoal, pieces of slag, and copper/bronze were identified near the feature.

50. Cultural layer contained the base of a flat-bottomed crucible slagged on both sides; a crucible wall fragment with glass-like slag on the outside; and the massive bottom of the crucible also covered by the glass-like mass on the outside.

51. Cultural layer contained a fragment of the wall of a large crucible, the outer side of which is covered by glass-like slag (Бидзиля, Тимошук, Фридман 1990, с. 22–25, 27–30, 39–40, 42, 52, 62–66).

Area 18 (figs. 2–3, tables 1–2)

52. Metalworking workshop (dim. = 4.25×3.50 m; contained a thermal engineering structure and five pits) contained an iron nozzle, glass-like slag, and two pieces of glass-like slag with copper inclusions. Pieces of copper/bronze and glass-like slag were found in the fill of pit 3 (dim. = 1.63×0.75 m). A smelting ladle with a side hole was found in the fill of pit 5 (diam. = 0.4 m).

53. Metalworking workshop (dim. = 3.63×2.10 m) contained fragments of a crucible with a bumpy, slagged outer surface and a smelting ladle fragment (Калюк, Фридман 1990, с. 77–80, 88–89).

Area 19 (figs. 2–3, tables 1–2)

54. Metalworking workshop (dim. = 3.0×2.3 m; contained a thermal engineering structure) contained a rim of a crucible.

55. Bronze casting workshop (dim. = 3.3×3.2 m; contained the thermal engineering structure measuring 1.1×1.1 m) contained an iron chisel.

56. Bronze casting workshop (dim. = 4.2×2.3 m) contained a fragment of a crucible.

57. Bronze casting workshop (dim. = 2.5×1.2 m) contained a copper/bronze rod composed of a thread of balls (a blank or unfinished product), fragments of crucible walls, a fragment of the rear part of the crucible/smelting ladle with a side opening for loading metal, and a fragment of the crown of a crucible with a pouring spout.

58. Bronze casting workshop (dim. = 3.25×3.25 m) contained a small piece of a crucible wall, a drop of oxidized copper or bronze, and pieces of copper/bronze slag.

59. Bronze casting workshop (dim. = 2.2 × 0.7 m; contained a thermal engineering structure) contained a considerable quantity of copper/bronze slag.

60. Cultural layer contained casting moulds (dim. = 7.5 × 5.5 cm; th. = 3.5 cm; dim. = 7 × 6 cm; th. = 37–45 mm).

61. Cultural layer contained fragments of crucibles (Калюк, Фридман 1990, с. 29-31, 42, 46, 49-52, 55-56, 61-64).

Area 20 (figs. 2–3, tables 1–2)

62. Bronze casting workshop (dim. = 5 × 4.25 m) contained ceramic slag covered by glass-like slag and a fragment of burnt granite, which may have been part of the thermal engineering structure, with traces of copper/bronze oxidation on one of its faces.

63. Bronze casting workshop (dim. = 5.5 × 1.5 m) contained a fragment of a crucible wall covered with an oxidation crust resulting from non-ferrous metal melting.

64. Cultural layer contained a fragment of a crucible wall, the outer side of which was covered with a dense crust (also extending over one of the crucible's faces), and a part of the smelting ladle with a dense layer of copper/bronze oxides covering both its inner and outer surfaces (Башкатов, Зоценко, Тимошук 1992, с. 22, 32, 37-38, 45).

Area 21 (figs. 2–3, tables 1–2)

65. Cultural layer contained a copper/bronze matrix for embossing lily-shaped pendants, with poorly removed sprues on the branches (Занкин, Калюк 1992, с. 16-17; Калюк, Занкин 1993, с. 68).

Area 22 (figs. 2–3, tables 1–2)

66. Cultural layer contained a crucible bottom (Бидзиля, Занкин, Калюк 1993, с. 35).

Area 23 (figs. 2–3, tables 1–2)

67. Bronze casting workshop (remains of a canopy) contained five small thermal engineering structures located 0.80–1.25 m apart; one preserved the lower part (diam. = 0.15 m, wall th. ≈ 0.1 m). Blanks of small cloisonné enamel crosses were found within the feature. A total of 26 crosses were found, 17 of which had fused into a single mass due to strong oxidation. The blanks of the crosses were of two types: three-blade-ended and oval-ended. The surrounding surface was covered in drop-like splashes of copper/bronze, as well as numerous small fragments of crucibles/smelting ladles. Five whole specimens were found among these fragments. The discovery of a fragment of an unburned crucible may indicate local manufacturing (Сагайдак, Сергеева, Михайлов 1997; Сагайдак, Сергеева, Михайлов 2004, с. 15-16, 19-21).

Area 24 (figs. 2–3, tables 1–2)

68. Jewellery workshop (dim. = 2.3 × 2.0 m) contained a fragment of a crucible with partitions used in the production of cloisonné enamel products (fig. 4: 3), as well as several ceramic floor tiles covered with glass-like slag (Сагайдак, Сергеева 1996, с. 10-12).

Area 25 (figs. 2–3, tables 1–2)

69. Cultural layer contained a fragment of twisted copper or bronze wire and several small pieces of non-ferrous metal slag (Сагайдак, Сергеева 2002, с. 5).

Area 26 (figs. 2–3, tables 1–2)

70. Cultural layer contained a fragment of a crucible wall covered by glass-like slag on the outside and a casting mould (Сагайдак и др. 1997, с. 18-19).

Area 27 (figs. 2–3, tables 1–2)

71. Jewellery workshop (dim. = 1 × 1 m) contained numerous copper/bronze splashes.

72. Cultural layer contained a casting mould (Сагайдак, Башкатов, Михайлов 1998, с. 11, 19).

Area 28 (figs. 2–3, tables 1–2).

73. Non-production structure (artefacts originated from the cultural layer) contained a fragment of a crucible (Сагайдак, Сергеева 1999, с. 20, 30).

Area 29 (figs. 2–3, tables 1–2)

74. Bronze casting workshop (contained a thermal engineering structure with a two-level base showing traces of repair) contained numerous copper/bronze splashes, and fragments of copper/bronze items, possibly non-ferrous metal scrap (Сергеева, Шевченко 2007, с. 25-27).

Area 30 (figs. 2–3, tables 1–2)

75. Cultural layer contained a casting mould (Сагайдак, Сергеева, Горбаненко 2002; Сагайдак, Сергеева, Горбаненко 2003, с. 246-247, рис. 4: 3).

Area 31 (figs. 2–3, tables 1–2)

76. Bronze casting workshop (dim. = 2.5 × 2.0 m; contained a thermal engineering structure) contained fragments of crucibles, crucible walls covered with glass-like slag, fragments of glass-like masses, and stone casting moulds for casting ingots of metal intended for trade.

77. Cultural layer contained fragments of crucibles and ceramic vessel walls covered with glass-like slag (Сергеева, Тараненко, Журухина 2003; Сергеева, Тараненко, Журухина 2005).

Area 32 (figs. 2–3, tables 1–2)

78. Jewellery workshop (dim. = 0.12 × 0.07 m, H ≈ 0.50 m, wall th. = 0.07–0.10 m): traces of non-ferrous splashes and a significant amount of glass-like slag were found nearby.

79. Cultural layer contained pieces of copper/bronze, pieces of glass-like mass, pieces of glass-like slag, and a piece of smalt (Сагайдак, Башкатов, Хамайко 2004, с. 7).

Area 33 (figs. 2–3, tables 1–2)

80. Cultural layer contained numerous fragments of crucibles (Сагайдак, Башкатов 2004, с. 5–11).

Area 34 (figs. 2–3, tables 1–2)

81. Cultural layer contained numerous pieces of copper/bronze slag, a casting mould (fig. 5: 5) (Сагайдак, Хамайко 2005, с. 16–18; Хамайко 2006; 2010, рис. 1).

Area 35 (figs. 2–3, tables 1–2)

82. Cultural layer contained numerous crucibles, including complete forms (Тараненко 2017, с. 149, табл. 10).

Area 36 (figs. 2–3, tables 1–2)

83. Domestic workshop (dim. = 6.6–8.6 × 2.15 × 0.25 m; contained a thermal engineering structure measuring 2 × 1.25 m) contained fragments of crucibles (Сагайдак, Тараненко, Івакін 2005; 2006, с. 328).

Area 37 (figs. 2–3, tables 1–2)

84. Non-production structure (L ≈ 15.0 m, W = 1.5–2.0 m; artefacts originated from the cultural layer) contained pieces of glass-like slag, a fragment of iron scales (fig. 6: 2), an iron chisel (fig. 6: 1), and a fragment of a crucible (fig. 4: 8). These may represent redeposited material from the cultural layers of Zamkova Hill (Сагайдак, Черновол, Пефтіць 2006, с. 12–13, 16–17, 19, рис. 13: 1; 14: 3; 37: 1).

Area 38 (figs. 2–3, tables 1–2)

85. Bronze casting workshop (dim. = 1.18 × 0.65 m, laid out of raw bricks, and lowered into a pit measuring 1.55 × 0.83 m) contained some copper/bronze items represent scrap collected for remelting.

86. Bronze casting workshop (related to the thermal engineering structure nearby) contained charcoal.

87. Bronze casting workshop contained fragments of crucibles.

88. Bronze casting workshop (dim. = 1.25 × 0.80 m) contained a casting mould and a crucible fragment.

89. Cultural layer contained numerous fragments of crucibles and pieces of glass-like slag.

90. Cultural layer contained fragments of crucibles, and a piece of glass-like slag (Сереєва, Шевченко 2007а, с. 337–339; 2007б, с. 9–10, 14–15, 21).

Area 39 (figs. 2–3, tables 1–2)

91. Bronze casting workshop (dim. = 6.0 × 1.5 m) contained fragments of crucibles, copper/bronze splashes and slag, glass-like slag (Сагайдак, Хамайко, Вергун 2007, с. 14).

92. Jewellery workshop (dim. = 7 × 5 m) contained fragments of crucibles; a fragment of a crucible with gold droplets on the inner side of the rim; copper and bronze scrap; irregularly shaped flattened copper and bronze ingots; copper and bronze splashes; gold splashes (0.3–0.6 cm); bullion wire; fragments of charred fabric embroidered with it; pieces of copper and bronze slag; amber; and rock crystal showing traces of working (Сагайдак, Хамайко, Вергун 2009, с. 264–265, рис. 1–2; Сагайдак, Хамайко, Комар 2015, с. 28–29).

93. Non-production structure (artefacts originated from the cultural layer) contained fragments of a crucible and pieces of copper/bronze slag.

94. Non-production structure (artefacts originated from the cultural layer) contained pieces of copper/bronze slag.

95. Non-production structure (artefacts originated from the cultural layer) contained a fragment of a crucible.

96. Non-production structure (artefacts originated from the cultural layer) contained pieces of glass-like slag and a piece of tin/lead.

97. Non-production structure (artefacts originated from the cultural layer) contained a piece of copper/bronze slag.

98. Non-production structure (artefacts originated from the cultural layer) contained a piece of glass-like slag.

99. Cultural layer contained a fragment of a crucible, fragments of non-ferrous wire (one of yellow metal and the other of copper/bronze), pieces of tin/lead, a fragment of smalt, pieces of glass-like slag, and copper/bronze slag.

100. Cultural layer contained iron jeweller's tweezers and a piece of glass-like slag.

101. Cultural layer contained fragments of crucibles, copper/bronze slag (Сагайдак, Хамайко, Вергун 2007; Сагайдак та ін. 2012b, с. 267).

Area 40 (figs. 2–3, tables 1–2)

102. Cultural layer contained a fragment of a crucible and pieces of copper/bronze slag (Сагайдак та ін. 2007, с. 18).

Area 41 (figs. 2–3, tables 1–2)

103. Non-production structure (dim. = 4.5 × 4.5 m, contained a thermal engineering structure measuring 1.5 × 1.5 m; artefacts originated

from the cultural layer) contained fragments of crucibles (Сагайдак та ін. 2008, с. 20, 24).

Area 42 (figs. 2–3, tables 1–2)

104. Cultural layer contained fragments of crucibles (fig. 4: 1–2) (Сагайдак та ін. 2012а, с. 29–30).

Area 43 (figs. 2–3, tables 1–2)

105. Bronze casting workshop (W = 1.1 m) contained a lot of small copper/bronze melts on its surface.

106. Bronze casting workshop (L = 0.53 m, W = 0.88 m, H = 0.24 m) contained a crucible wall.

107. Bronze casting workshop (dim. = 1.9 × 0.4 m) contained a fragment of the crucible bottom.

108. Cultural layer contained an iron chisel (fig. 6: 3), metal casting tools (non-ferrous metal pushers), fragments of crucibles, a copper/bronze washer blank, a tin/lead ingot, pieces of sheet tin/lead, a tin/lead bundle, pieces of copper/bronze slag, pieces of glass-like slag, and copper/bronze melts and tin/lead melts.

109. Cultural layer contained fragments of crucibles, pieces of glass-like slag, copper/bronze melts, tin/lead melts, pieces of copper/bronze slag, a non-ferrous metal casting pusher, a workpiece for a copper/bronze ring, copper/bronze scrap, several small pieces of copper/bronze scrap, semi-finished products of twisted copper/bronze wire (Івакін та ін. 2016, с. 39, 43–44, 57; 2018).

Casting Moulds (Brief Descriptions of Selected Examples)

The casting moulds are among the most informative artefacts found in the above-described features, providing insights into the variety of products manufactured by medieval Kyiv craftsmen.

3³. Mould 1 (fig. 5: 3) — (pyrophyllite; dim. = 7.2 × 6.5 × 5.9 cm; th. = 1.4 cm and 0.9 cm) was intended for casting belt-set plaques. An Arabic inscription was found on one of the side faces. Mould 2 (fig. 5: 7) (pyrophyllite; dim. = 8.0 × 6.2 cm; th. = 0.4–0.8 cm) was intended for casting round, segment-shaped, and pentagonal plaques for a belt set on one side and wire for suspending kolts, etc., on the other side. Mould 3 (fig. 5: 4) — (slatestone; dim. = 5.5 × 3.5 cm; th. = 1.3 cm) preserves only one intact working side. The side bears impressions of three pads, three sprues, and channels for removing gases. The reverse side shows an image of a heart-shaped

plaque or pendant with dentiform ledges along the rim (Гупало, Івакін, Сагайдак 1979, с. 48–51, рис. 7–10; Орлов 1983, с. 31–34).

4. Mould (pyrophyllite; dim. = 27 × 21 mm; th. = 7–8 mm) was intended for casting rings (diam. = 18 mm) (fig. 5: 2). One side shows a longitudinal cleavage face, while the other preserves the working surfaces. One surface was flat for grinding, and the other was cone-shaped with a sprue (Сагайдак, Чернов 1982, с. 1–8, 15; Сагайдак 1991, с. 43–44).

10. Moulds (pyrophyllite). Two fragments were intended for casting shield rings with inserts in the centre and imitation granulation along the edges. Another fragment was intended for a hollow suspension (an unsuccessful attempt was made on its back to cut out a mould for casting a small icon) (Івакін, Степаненко 1985, с. 101, рис. 25).

31. Mould (pyrophyllite; dim. = 49 × 48 × 48 × 44 mm; th. = 11–15 mm). A panel of a two-sided mould (fig. 5: 6) intended for casting a trapezoid-shaped pendant (Зоценко, Брайчевська 1987; Зоценко, Брайчевська 1993, с. 46–47, 97–98, рис. 3–4, 25: 5).

34. Mould (pyrophyllite; th. = 9 mm). A rectangular mould fragment with a ground front face and a roughly finished reverse (Сагайдак и др. 1988, с. 13–15; Сагайдак, Брайчевська, Михайлов 1990, с. 7–8).

41. Mould (clay). Intended for casting small bells with a slit-like opening (Сагайдак, Сергеева, Тимошук 1989, с. 18).

60. Mould 1 (plinth brick; dim. = 7.5 × 5.5 cm; th. = 3.5 cm) has a conical hole on one side (diam. = 28 mm; depth = 18 mm). The surface of the cone is decorated with eight radial lines interconnected by X-shaped crosses. Two of the lines include deep, rounded depressions (approx. 1.5 mm deep). Mould 2 (plinth brick; dim. = 7 × 6 cm; th. = 37–45 mm) has a conical recess (diam. = 22 mm; depth = 11). Eleven radial lines intersected by two radial circles are mortised into the recessed surface. No traces of heat exposure or soot were found. These moulds were probably intended for casting so-called weight seals (Калюк, Фридман 1990, с. 61–64).

70. Mould (clay; dim. = 53 × 51 mm; th. = 14 mm). Recesses in the form of a wire with a two-horned end and balls at the ends are carved on the working surface (Сагайдак и др. 1997, с. 18–19).

72. Mould (pyrophyllite; dim. = 24 × 14 mm). A double-panel mould intended for casting small crosses with a ball-shaped completion of rays (Сагайдак, Башкатов, Михайлов 1998, с. 11).

³ Numbering of the archaeological features, including the Kyivan Rus cultural layers, related to non-ferrous metalworking.

75. Mould (stone; dim. $\approx 4 \times 3$ cm). Oval-shaped mould intended for casting buttons or small jewellery items (Сагайдак, Сергеева, Горбаненко 2002; Сагайдак, Сергеева, Горбаненко 2003, с. 246-247, рис. 4: 3).

81. Mould (copper/bronze; dim. = $4.0 \times 3.2 \times 0.5$ cm). Intended for casting small crosses with extended arms (dim. = 1.7×1.7 cm; 1.6×1.7 cm) (fig. 5: 5) (Хамайко 2010, рис. 1).

88. Mould intended for casting pads for a chain (Сергеева, Шевченко 2007b, с. 9-10).

Discussion

From 1955 to 2016, 109 features and 1316 artefacts associated with the processing of non-ferrous metals were discovered and studied during archaeological excavations conducted across 43 areas in the Kyivan Podil (tables 1–2, figs. 2–6).

Bronze casting workshops and their components — features 8, 18–19, 21–24, 38, 43–44, 46–47, 49, 55–59, 62–63, 67, 74, 76, 85–88, 91, and 105–107 (a total of 31) — were identified within the excavation areas 4, 9–10, 14, 17, 19–20, 23, 29, 31, 38–39, and 43 (a total of 13).

Jewellery workshops and their components — features 2–3, 6, 10, 32, 34–35, 37, 68, 71, 78, and 92 (a total of 12) — were identified within the excavation areas 2–5, 12–13, 24, 27, 32, and 39 (a total of 10).

Metalworking workshops and their components — features 5, 7, 14, 26–28, and 52–54 (a total of 9) — were identified within the excavation areas 4, 6, 11, and 18–19 (a total of 5). Features 26 and 27 may represent metallurgical workshops.

Domestic workshops and their components — features 4, 9, 11, 17, 36, 42, 45, and 83 (a total of 8) — were identified within the excavation areas 4–5, 9, 13, 17, and 36 (a total of 6). Features 17, 45, and 83 likely belonged to founder-smiths, while features 4, 9, 11, 36, and 42 likely belonged to jewellers.

One or more workshops could feature multi-disciplinary production, combining non-ferrous metalworking with ironmaking/ironworking and glassmaking/glassworking (Тараненко 2017, с. 118). Features 5, 7, 11, 26–27, and 52–54 (a total of 8) likely functioned as universal workshops or their components. These combined the processing of non-ferrous metals with ironmaking and ironworking operations (Паньков 2012, с. 42-51). Features 5, 7, and 11 (a total of 3) ad-

ditionally specialised in glassmaking and glassworking operations (Журухіна 2021, с. 128-145).

In the cultural layers of Kyivan Rus — features 1, 12–13, 15–16, 20, 25, 29–31, 33, 39–41, 48, 50–51, 60–61, 64–66, 69–70, 72–73, 75, 77, 79–82, 84, 89–90, 93–104, and 108–109 (a total of 49) — specialised artefacts related to non-ferrous metal processing were identified within the excavation areas 1, 5, 7–12, 15–17, 19–22, 25–28, 30–35, and 37–43 (a total of 32). It's possible that production workshops were located near those features. Certain artefacts were also recovered in non-production structures and originated from cultural layers — features 15–16, 25, 29, 39, 48, 73, 84, 93–98, and 103 (a total of 15).

These features can be conventionally divided into the following chronological periods based on their duration (table 2).

Feature 3 dates to the 10th century. Features 105 and 109 (a total of 2) date to the second half of the 10th century — first half of the 11th century. Features 16, 18–19, 22–23, 25–28, 30, 34, 36–37, 51, 58–59, 70, 78, 90, 102, and 106–107 (a total of 22) date to the 11th century. Features 20, 29, 35, 52–53, 55–57, 71, 76, 81–82, and 103 (a total of 13) date to the end of the 11th century — first half of the 12th century. Features 8, 12, 15, 17, 21, 24, 31, 33, 42, 62–64, 68–69, 72, 74–75, 77, 83, 85–89, and 91–92 (a total of 26) date to the 12th century. Features 4–7, 9–11, 13–14, 38–41, 43–50, 54, 61, 67, 73, 79, 84, 104, and 108 (a total of 29) date to the second half of the 12th century — early 13th century. Features 2 and 65 (a total of 2) date to the first half of the 13th century. Features 1, 32, 60, 66, 80, and 93–101 (a total of 14) have a broad dating range from the 10th or 11th century to the 13th century because it was impossible to determine their exact time of existence (table 1–2).

Most features date to the 11th and 12th — early 13th centuries. During those periods, Kyiv experienced its greatest economic prosperity due to numerous trade connections, which is reflected in the development of non-ferrous metal craft.

The following finds were identified in the fills of features: nine metals intended for trade, 35 semi-products, 990 casting vessels, 38 casting moulds, 11 tools, and 233 production waste items (figs. 4–6, table 2). Analogous artefacts have been found in Vyshhorod (Бібіков 2018, с. 119-120, 122, 136, рис. 42б: 2–5, 46), Voin (Довженок, Гончаров, Юра 1966, с. 74-75), Chernihiv (Моця, Казаков 2011, с. 73, 126-128, 179), Raikovetske hillfort (Гончаров 1950, с. 102-107), Novhorod (Рындина 1963, с. 214-219, 224-225, 267-268, рис. 7: 4–6,

8–10; 12: 4–5, 7, 9), Staraia Ladoga (Рябинин 1994, с. 31), Pskov (Закурина 2006, с. 113), Vi-loozero (Голубева 1973, с. 122-124, 135-138, рис. 41: 7, 10–11, 13–17; 12: 9; 47: 2–12; 50: 7, 10; табл. 12–13), Novogrudok (Гуревич 1981, с. 39, 51, 57, 74, 76, 82, рис. 28: 11; 30: 1; 40: 6; 58: 4, 6–7; 67: 1; табл. 18), at the Serensk (Зайцева 2001, с. 375) and Bilsk (Халиков 1985, с. 74-75, 78, 86-100) hillforts.

The concentration of bronze casting, jewellery, and metalworking workshops in certain districts of the city led to the formation of craft centres where non-ferrous metals were processed. Several factors may explain their location in certain territories. First, dense urban development, which included the main buildings of the workshops and their components, such as additional production structures, thermal engineering structures, warehouses, pits, etc. Second, proximity to water resources that would ensure production needs and fire safety. Third, the coexistence of several crafts within the same centres sharing technological operations to optimise production processes (universal workshops).

In general, the identification of craft centres depends on the scope of the archaeological research. Since excavations in Podil are unevenly distributed, it cannot be said with certainty that the identified craft centres existed within the territorial and chronological boundaries outlined in this article. The quality of work performed on adjacent excavation areas often differs due to natural and anthropogenic factors. However, it should be noted that some centres are located in areas where local groups of production complexes have already been identified (Тараненко 2017, с. 113). Consequently, the reliability of their localisation is quite high.

Thus, four craft centres (fig. 3) were identified in the Kyivan Podil during the 10th — early 13th centuries (Сагайдак 1991, с. 31-51, рис. 10; Тараненко 2017, с. 113, 149, табл. 10).

Centre A, with a total area of approximately six hectares, was located in the northwestern part of the district. Here, in five excavation areas (17–19, 23, and 27), 17 specialised archaeological features (42–47, 49, 52–59, 67, and 71) were discovered and researched, 11 of which relate to bronze casting, two to jewellery production, and four to metalworking (fig. 3, table 1). Most workshops specialised in the processing of copper/bronze (Тараненко 2017, с. 36-40, рис. 15, 19–22).

Centre B was located east of Centre A, and covered about two hectares. Here, in three excavation areas (5, 29, and 38), eight specialised archaeological features (9–11, 74, and 85–88) were discovered and researched, five related to bronze casting and three to jewellery businesses (fig. 3, table 1). The workshops specialised in copper/bronze processing and jewellery production (Ивакин, Степаненко 1982, с. 12-14).

Centre C was located east of Centre B, and its total area was about two hectares. Here, in three excavation areas (11 and 31–32), five specialised archaeological features (26–28, 76, and 78) were discovered and researched, three of which related to metalworking, one to bronze casting and one to jewellery craft (fig. 3, table 1). The workshops specialised in copper/bronze processing and jewellery production (Зоценко, Брайчевська 1993).

Centre D was located southeast of Centres A, B, and C, and covered about two hectares. In three excavation areas (4, 9, and 13), 13 specialised archaeological features (2, 4–8, 17–19, and 34–37) were discovered and researched, three of which related to bronze casting, seven to jewellery and three to metalworking craft (fig. 3, table 1). Most of the workshops specialised in processing non-ferrous metals for jewellery production (Тараненко 2017, с. 89-91).

Conclusions

Forty-three excavation areas in the Kyivan Podil were analysed, and 109 features and 1316 specialised artefacts dating from the 10th century to the first half of the 13th century were identified within their fills. The following were discovered: 31 bronze-casting workshops, 12 jewellery workshops, nine metalworking workshops, eight domestic workshops, as well as specialised artefacts from 49 cultural layers, some of which may have originated from nearby workshops. In some cases, they were combined with ironmaking and/or glassmaking crafts, which used similar equipment, tools, and technologies for processing raw materials. Most of the features date to the 11th century, and the 12th to the early 13th century, reflecting the political, socio-economic, and cultural development of Kyiv during those periods.

The emergence of these features was influenced by several factors, including proximity to the Hlybochytzia and Dnipro rivers and the Yurkovytzia and Kyianivskyi streams, since such produc-

tion activities involved a high risk of fire; opportunities to sell products at marketplaces such as Torhovyshe (in the area of modern Kontraktova Square), and access to the port on the Dnipro River, which allowed for the import of raw materials and the export of finished goods via waterways (Сагайдак 1991, с. 27-30, 126; Тараненко 2017, с. 89-91).

Some of these features formed four craft centres that specialised in processing non-ferrous metals. The territory of each centre may have covered from two to six hectares.

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ОБРОБКА КОЛЬОРОВИХ МЕТАЛІВ НА КИЇВСЬКОМУ ПОДОЛІ (X — ПЕРША ПОЛОВИНА XIII ст.)

Київський Поділ розташований уздовж правого берега Дніпра, в прибережній низовині, що за часів Київської Русі займав площу близько 180 га зі щільною забудовою, де виникли різноманітні майстерні, зокрема й такі, що спеціалізувалися на обробці кольорових металів.

За період з 1955 по 2016 рр. на території 43 ділянок розкопів виявлено й досліджено 109 спеціалізованих об'єктів та 1316 артефактів, серед яких матеріали з 49 культурних шарів, які могли потрапити туди з найближчих виробничих споруд. Серед об'єктів виділено 31 бронзоліварну майстерню, 12 ювелірних майстерень, дев'ять ковальських / слюсарних майстерень, вісім жител-майстерень. Більшість об'єктів датуються XI та XII — початком XIII ст. Деякі з них поєднувалися із залізобробним / залізобробним та / або скловарним / склоробним ремеслами.

У їх заповненнях зафіксовано 9 товарних металів, 35 напівфабрикатів, 990 ливарних посудин, 38 ливарних форм, 11 інструментів та 233 екземпляри виробничих відходів. Низка виробничих об'єктів утворювали чотири спеціалізовані ремісничі осередки Подолу площею від 2 до 6 га, які спеціалізувалися на обробці кольорових металів.

Поява значної кількості об'єктів кольорової металообробки на території київського Подолу була зумовлена близькістю до річок і струмків, оскільки така діяльність пов'язана з високою пожежною небезпекою; можливість збувати свою продукцію на ринкових площах; доступ до порту, завдяки чому водними шляхами відбувався імпорт сировини та експорт готових виробів.

К л ю ч о в і с л о в а: Київська Русь, київський Поділ, кольорові метали, бронзоліварні та ювелірні майстерні, металообробні майстерні, сировина та відходи виробництва, тиглі та лячки, ливарні форми та інструменти.

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