

Springer Proceedings in Earth and Environmental Sciences

Natalia Ankusheva
Andrey V. Epimakhov
Maksim Ankushev
Polina Ankusheva *Editors*

Geoarchaeology and Archaeological Mineralogy

Proceedings of 11th Geoarchaeological
Conference (16–18 September 2024,
Miass, Russia)

 Springer

Springer Proceedings in Earth and Environmental Sciences

Series Editors

Natalia S. Bezaeva, *The Moscow Area, Russia*

Heloisa Helena Gomes Coe, *Niterói, Brazil*

Muhammad Farrakh Nawaz , *Institute of Environmental Studies, University of Karachi, Karachi, Pakistan*

The series Springer Proceedings in Earth and Environmental Sciences publishes proceedings from scholarly meetings and workshops on all topics related to Environmental and Earth Sciences and related sciences. This series constitutes a comprehensive up-to-date source of reference on a field or subfield of relevance in Earth and Environmental Sciences. In addition to an overall evaluation of the interest, scientific quality, and timeliness of each proposal at the hands of the publisher, individual contributions are all refereed to the high quality standards of leading journals in the field. Thus, this series provides the research community with well-edited, authoritative reports on developments in the most exciting areas of environmental sciences, earth sciences and related fields.

Natalia Ankusheva · Andrey V. Epimakhov ·
Maksim Ankushev · Polina Ankusheva
Editors

Geoarchaeology and Archaeological Mineralogy

Proceedings of 11th Geoarchaeological
Conference(16–18 September 2024,
Miass, Russia)

Editors

Natalia Ankusheva
UB RAS
South Ural Federal Research Center
Mineralogy and Geoecology
Miass, Russia

Maksim Ankushev
UB RAS
South Urals Federal Research Center
of Mineralogy and Geoecology
Miass, Russia

Andrey V. Epimakhov 
South Ural State University
Chelyabinsk, Russia

Polina Ankusheva 
UB RAS
South Urals Federal Research Center
of Mineralogy and Geoecology
Miass, Russia

ISSN 2524-342X

ISSN 2524-3438 (electronic)

Springer Proceedings in Earth and Environmental Sciences

ISBN 978-3-032-23182-6

ISBN 978-3-032-23183-3 (eBook)

<https://doi.org/10.1007/978-3-032-23183-3>

© The Editor(s) (if applicable) and The Author(s), under exclusive license
to Springer Nature Switzerland AG 2026

This work is subject to copyright. All rights are solely and exclusively licensed by the Publisher, whether the whole or part of the material is concerned, specifically the rights of translation, reprinting, reuse of illustrations, recitation, broadcasting, reproduction on microfilms or in any other physical way, and transmission or information storage and retrieval, electronic adaptation, computer software, or by similar or dissimilar methodology now known or hereafter developed.

The use of general descriptive names, registered names, trademarks, service marks, etc. in this publication does not imply, even in the absence of a specific statement, that such names are exempt from the relevant protective laws and regulations and therefore free for general use.

The publisher, the authors and the editors are safe to assume that the advice and information in this book are believed to be true and accurate at the date of publication. Neither the publisher nor the authors or the editors give a warranty, expressed or implied, with respect to the material contained herein or for any errors or omissions that may have been made. The publisher remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

This Springer imprint is published by the registered company Springer Nature Switzerland AG
The registered company address is: Gewerbestrasse 11, 6330 Cham, Switzerland

If disposing of this product, please recycle the paper.

Contents

General Issues of Geoarchaeology and Methods for Studying Objects and Artifacts

Solar and Volcanic Activity and the Bronze Age Chronology	3
<i>Stanislav A. Grigoriev</i>	

Social Networks and the Spread of Innovations Among Epipaleolithic Hunter-Gatherers 10–17 ka cal BP: New Data from the Piedmonts of Mt. Elbrus	11
<i>Ekaterina V. Doronicheva, Liubov V. Golovanova, Vladimir B. Doronichev, and Elena I. Revina</i>	

Use-Wear Analysis of the Chalcolithic Stone Jewellery from the Sites of the Upper and Middle Kama Region	19
<i>A. Yu. Smertina, S. N. Skochina, and E. L. Lychagina</i>	

“Ash Heap” Near the Stepnoye Settlement: To the Question About Domestic Cycles of the Sintashta Fortified Settlements of the Bronze Age in the Southern Trans-Urals (Russia)	30
<i>Elena V. Kupriyanova</i>	

Soils of the Zvyagino-4 Settlement with the Included Bronze Age «Ash Heap» Cultural Layer	39
<i>Liudmila N. Plekhanova, Irina P. Alaeva, and Natalia N. Ankusheva</i>	

Glass Ware Excavated at the Church in the Markula Fortified Settlement (Republic of Abkhazia): Composition, Origin, Chronology	50
<i>Ekaterina K. Stolyarova and Galina V. Trebeleva</i>	

Bioarchaeology and Geochemistry of Bone Remains

Strontium Isotopes as a Tool for Diachronic Analysis of Bronze Age Animal Husbandry (Konoplyanka Microdistrict in the Southern Urals)	61
<i>Andrey V. Epimakhov, Polina S. Ankusheva, Igor V. Chechushkov, Darya V. Kiseleva, Ludmila N. Koryakova, Pavel A. Kosintsev, Rudiger Krause, Ivan V. Molchanov, Sofya E. Panteleva, Alexey Yu. Rassadnikov, Svetlana V. Sharapova, and Eliza Stolarczyk</i>	

Trace Elements in Bones and Teeth as Markers for Reconstructing Human Diet: Based on Materials from the Kamennyi Ambar-5 Bronze Age Burial Ground	69
<i>Egor O. Vasyuchkov and Darya V. Kiseleva</i>	

Mining, Archaeometallurgy and Metalworking of the Paleometallic Era

Antler and Bone Handles of Volga-Ural Bronze Age Knives in the Context of an Artifact from the Bolshekaraganskiy Cemetery	79
<i>Fedor N. Petrov, Ivan A. Blinov, and Nikolay F. Petrov</i>	

Crushed Metallurgical Slag in the Ditch Filling of the Stepnoye Fortified Settlement (Late Bronze Age, Southern Trans-Urals)	86
<i>Natalia S. Batanina, Maksim N. Ankushev, Fedor N. Petrov, and Ivan A. Blinov</i>	

The Mineral Composition of the Slags of the Semiozernoye-2 Settlement According to the SEM Data	95
<i>Ivan A. Blinov, Valery G. Loman, and Natalia N. Ankusheva</i>	

Experimental Smelting of Lead Ores in the Donets Ridge Using Ancient Technologies	101
<i>Yuri P. Shubin and Igor Kh. Shumilov</i>	

First Data on the Chemical and Isotopic (Pb-Pb) Compositions of Bronze Age Metal Finds from Crimea	109
<i>Marianna A. Kulkova, Irina M. Vasilieva, Yulia V. Plotkina, Maya T. Kashuba, Alexander M. Kulkov, and Yulia V. Kozhukhovskaya</i>	

Early Iron Age and Medieval Metal Production

Construction of Metallurgical Structures in the Perm Pre-Ural in the Middle Ages	125
<i>Andrey R. Smertin, Nadezhda S. Smertina, and Elena M. Tomilina</i>	

Results of Mineralogical and Chemical Analyses of Slag Samples From the Excavations of Medieval Settlements Novy Bor I, III, IV (The Republic of Komi, Russia)	135
<i>Alexander M. Murygin and Irina S. Astakhova</i>	

Comparative Analysis of the Chemical Composition of the Belt Decorations of Different Types of the Nevolinskaya Culture Belts	143
<i>Anastasia A. Chernykh</i>	

Tracing the Origins: First Archaeometallurgical Analysis of Slags from Kara-Dyt III (The 3 rd –6 th Centuries CE, Tuva, Southern Siberia)	149
<i>Varvara S. Busova, Maksim N. Ankushev, Maya O. Filatova, Anna R. Agatova, Roman K. Nepop, and Olga V. Sycheva</i>	

Landscape Archaeology

Exploration Survey of the Tashkovskaya Dune in 2023	159
<i>Ekaterina S. Yakovleva and Ekaterina V. Gladysheva</i>	

Historic-Geographical Study of the Architectural Monuments of Old Orhey	165
<i>Andrey A. Herzen and Tamara P. Nesterova</i>	

Geoarchaeological Studies and Analysis of the Settlement System in Northwestern Colchis During the Ancient and Medieval Periods: Interim Results	176
<i>Galina V. Trebeleva, Marina E. Klemeshova, Tamara A. Sadchikova, Suram M. Sakania, Irina A. Saprykina, Vladlen G. Yurkov, Andrey L. Chepalyga, David G. Yurkov-Trebelev, and Gleb Yu. Yurkov</i>	

Author Index	187
---------------------------	-----



Comparative Analysis of the Chemical Composition of the Belt Decorations of Different Types of the Nevolinskaya Culture Belts

Anastasia A. Chernykh^(✉)

Institute of History and Sociology, Udmurt State University, Izhevsk, Russian Federation
anasteisha2028@mail.ru

Abstract. Belts belong to a category of inventory that provides a good dating base for burial grounds. The purpose of this study is to compare the results of X-ray fluorescence analysis (XRF) of the Nevolinskaya culture belts based on the typology proposed by Rimma D. Goldina. This work is the first generalization of the obtained results of the chemical analysis of the Nevolinskaya culture belts. A total of 323 items (142 overlays, 79 belt tips and 102 buckles) from 103 graves of 5 burial grounds were examined. The metal items were analyzed using an XRF spectrometer using a non-destructive method, and their chemical composition was determined. The study showed that the division into belt types identified by Goldina based on morphological features can be confirmed at the chemical level. Individual types of belts are similar in chemical composition within their groups, but are different if compared to each other. The evolution of the use of certain impurities is also traced. Early types of belts (the V–VIIth centuries CE) contain Zn and Ag. These elements gradually disappear from the alloys, after which an alloy based on copper and lead gradually appears, which eventually becomes the only one used.

Keywords: Perm Krai · the Nevolinskaya culture · belt set · XRF · chemical composition

1 Introduction

Currently, the Nevolinskaya archaeological culture of the early Middle Ages is one of the best studied in the Kama region. As a result of many years of archaeological explorations by the Kama-Vyatka archaeological expedition, a huge collection of clothing, jewelry, dishes, coins, tools, horse equipment, weapons, etc. was obtained and studied. The notable amount of materials of this culture was published to date. During studying the materials, the belts were reconstructed, and the belt set was studied from the point of view of classification, periodization and chronology. These issues were primarily dealt with by Rimma D. Goldina, as well as specialists such as Alexey V. Komar and Igor O. Gavritukhin. But from a technical point of view, and even more so from a chemical one, the belt set has never been considered. The purpose of this study is to compare the results of X-ray fluorescence analysis of the Nevolinskaya culture belts, conducted over three

years of work with material, with a pre-existing typology based on their morphology. This work is the first attempt to generalize the results of the chemical analysis of belts from the Nevolinskaya culture.

The Nevolinskaya culture is localized in the Sylva-Irensky River region (Perm Krai) and dates back to the end of the IVth – first quarter of the IXth century CE. Its burial grounds are complexes that combine burial mounds (at the beginning of the 7th century CE) and non-mound parts (Goldina 2012b). About 33.3% of burials contain complete belt sets as, for example, in the Nevolinsky burial ground (Goldina 2012a). Separate parts of the belt (overlays, belt tips, buckles) are found in 17% (Goldina et al. 2018) to 50% of all cemetery graves (Goldina et al. 2012). The position of the belts in the graves varied. The belt could be put on the deceased, folded in half and placed nearby, located in the waist area but not put on, or stretched along the body, as well as lying on the shin bones (Goldina et al. 2018).

Rimma D. Goldina divided the belts into the four types: the Kharinsky (Verkh-Sainsky) type of the V–VIth centuries; the Bartymsky (Agafonovsky) type of the VIIth century; the Nevolinsky type (with 3 sub-variants) of the VIIIth century; and the Sukholozhsky type of the last quarter of the VIIIth – first quarter of the IXth centuries (Goldina et al. 2018).

The Kharinsky (or Verkh-Sainsky) type fittings (Fig. 1-A) are buckles with a large B-shaped ring, rectangular overlays and box-shaped belt tips, often with pseudo-graining and filigree (Goldina 2012b). The first name of this type of belt fitting was Kharinsky. This type is related in time to two chronological groups: Brodovskaya and the Verkh-Sainskaya, named after the burial grounds with characteristic items. However, Goldina suggests that it is correct to use the term “the Verkh-Sainsky type” to designate them, due to the large amount of material in the Verkh-Sainsky burial ground. The Verkh-Sainsky version of belts differs from the earlier Brodovsky type in size, massiveness, shape of buckles and the presence of overlays.

The Bartymsky type (Fig. 1-B) represents belts with leather pendants that are decorated with heraldic overlays (Goldina 2012a).

The *Nevolinsky* type of belt has three subtypes. *The Nevolinsky* subtype (Fig. 1-C) has leather band of 2–2.5 cm wide and 70 cm long, with pendants decorated with three-ended and rectangular overlays. *The Eastern* subtype (Fig. 2-A) is decorated with rectangular, arched, sickle-shaped and other original overlays. *The Eastern belt with the pre-Saltovsky* details subtype (Fig. 2-B) is distinguished by the presence of buckles and belt tips with the image of palmettes (Goldina 2012b).

The Sukholozhsky type (Fig. 2-C) has overlays with the image of a mask, heart-shaped, sickle-shaped, semi-oval with slits (Goldina 2012b).

The belt sets for analysis were selected from five burial grounds of the Nevolinskaya culture: the Brodovsky burial ground (the late IV–IXth centuries CE) (Goldina 1986, p. 47–99), the Verkh-Sainsky burial ground (the VIth – first quarter of the IXth centuries CE) (Goldina et al. 2018), the Nevolinsky burial ground (the last quarter of the VII–VIIIth centuries CE) (Goldina, 2012a), the Ust-Irginsky burial ground (the late VII–VIIIth centuries CE) (Volkov & Pastushenko 2006, p. 5–39), and the Sukhoi Log burial ground (the last quarter of the VIII – first quarter of the IX centuries CE) (Goldina et al. 2012).

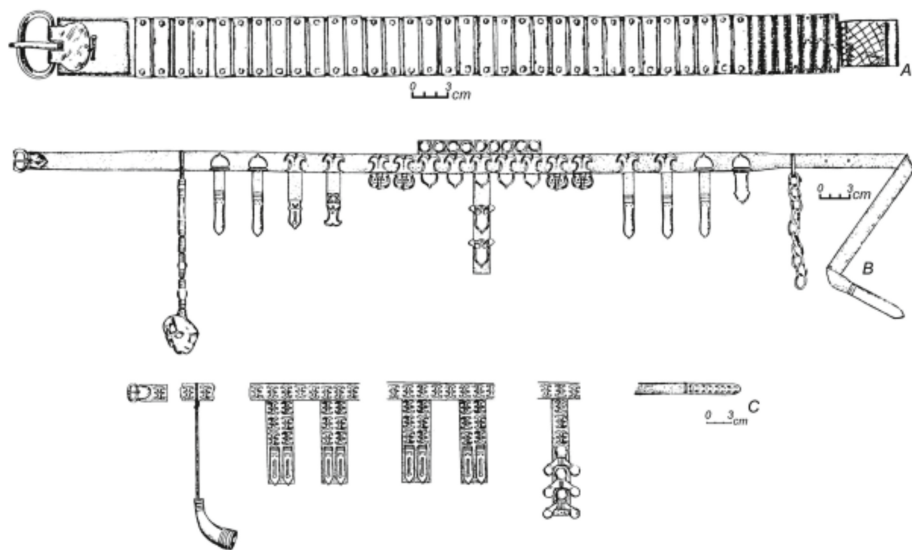


Fig. 1. Types of belt fittings of the Nevolinskaya culture. A – the kharinsky type; B – the bartymsky type; C – the nevolinsky subtype.

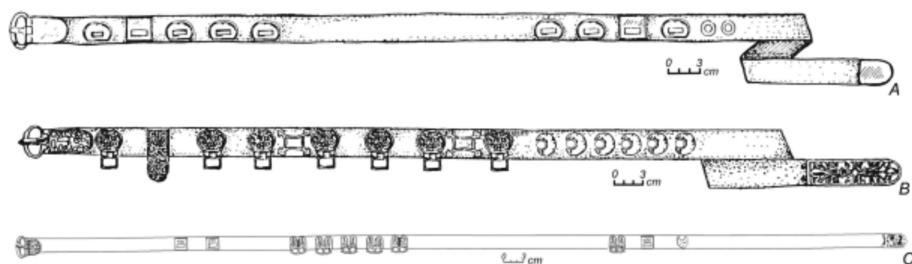


Fig. 2. Types of belt fittings in the Nevolinskaya culture. A – the eastern subtype; B – the pre-saltovsky subtype; C – the sukholozhsky type.

2 Materials and Methods

The analysis was carried out using a portable X-ray fluorescence analysis (XRF) device for the surface S1 Turbo SD LE (the analysis was carried out at a voltage of 40 kV, the current strength was up to 60 mA). XRF is based on the principle of measuring the spectrum of secondary X-ray radiation. The XRF spectrometer measures the X-ray fluorescence of atoms, and this method of analysis can be used as an independent method, even in the field. It belongs to the non-destructive types of analysis, which allows preserving the archaeological find for further description and study (Mokrushin et al. 2020, p. 17). The presence of lines (secondary radiation) of a given element in the spectrum indicates its presence in the sample, and the intensity of these lines provides a basis for judging the concentration of the elements.

Since the XRF spectrometer analyzes the composition of the surface of the object, patina, which distorts the results, was removed from the objects before the analysis. The items were cleaned using citric acid until the patina layer disappeared. A total of 323 finds were analyzed using the XRF spectrometer: 142 overlays, 79 belt tips, and 102 buckles from 103 graves.

3 Results and Discussion

Early types of belts (*the Brodovsky and Verkh-Sainsky types*) are distinguished by a minimal presence of lead (average value – from 0.25 to 4 wt %) (regardless of the burial ground – Brodovsky or Verkh-Sainsky). Copper (71–99 wt %) with Zn (6–20 wt %) and Cu (4–55 wt %) with Ag (43–90 wt %) (mostly belt tips consist of such an alloy) are characteristic alloys. In two cases, the finds consisted of tin bronze (Cu 55 and 86 wt %, Pb 1 and 5 wt %, Sn 12 and 30 wt %).

Alloys of Cu (3–42 wt %) with Ag (43–91 wt %), as well as Cu (70–86 wt %) with Zn (5–22 wt %) are still present in *the Bartymisky type*. However, it can already be noted that the craftsman began to use Sn and Pb as an admixture more often (in the previous type, only three finds from those tested consist of lead bronze (the amount of Pb varies from 13 to 30 wt %), in the Bartymisky type, 6 overlays consist of lead bronze (Cu 23–65 wt %, Pb 29–71 wt %). Four overlays from 120 graves of the Verkh-Sainsky burial ground consist of a triple alloy of Cu, Pb and Sn (Cu 31–68 wt %, Pb 20–50 wt %, and Sn 12–14 wt %)).

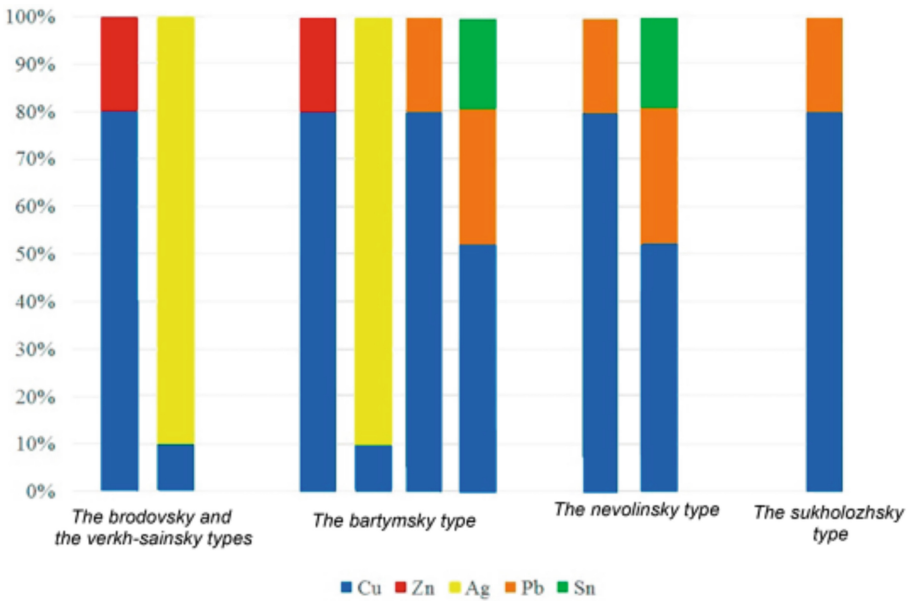


Fig. 3. Graph of the ratio of chemical alloys by types of the Nevolinsky belts.

The third type – *the Nevolinsky type* – consists of three subtypes described above. Almost all details of the belts of this type regardless of the subtype contain Cu and Pb. The Cu and Pb contents vary greatly within the range from 22 to 93 wt percent and from 2 to 74 wt %, respectively. The chemical composition was similar for all three subtypes.

Zinc is present in this type, but its concentration reaches only 4 wt %.

The number of items containing Ag decreased (only 5 pieces), and the percentage indicators did not exceed 5 wt %, although the previous two had items consisting of 80–90 wt percent Ag.

Separately, 6 items consist of a triple alloy of Cu (40–55 wt %), Pb (21–34 wt %), and Sn (19–25 wt %). All these objects are not on one belt, but are single finds from different burials.

The last is *the Sukholozhsky type*. Lead bronze acts as the predominant alloy, in which the Cu content varies from 24 to 97 wt %, and the Pb content varies from 3 to 59 wt %.

Zinc is present (1–15 wt %), but only in one find does the amount of zinc exceed other impurities. Silver also did not disappear from the composition but no longer exceeded 1 wt %.

The finds also contain tin, but also in smaller proportions than in the previous types of belts – 6 wt %.

A distinctive feature of all the results, regardless of the type of belt, was that the alloy contained Fe, on average 1–5 wt %, but there were items with more than 10 wt %. The main microimpurities are Co, In, Se, Pt, Nb, Ag, Mn, Zr, Cd, Rh, As, and Ni.

4 Conclusions

As a result, the following pattern can be seen: in the belts of the Brodovsky and Verkh-Sainsky types, copper-zinc and copper-silver alloys are the leading ones, and lead is almost absent in the complex. In the Bartymisky type, copper-zinc and copper-silver alloys remain, but the wt.% of lead and tin in the artefacts increase. In the Nevolinsky type, silver and zinc cease to be found in large wt.% in alloys, the main additive is lead, less often tin. In the Sukholozhsky type, silver, zinc and tin have practically disappeared from the composition of the objects, and lead is present in all alloys.

Thus, based on the above results of the X-ray fluorescence analysis, the following conclusions can be made. First, the division into types of belts identified by Goldina based on morphology was confirmed at the chemical level. Individual types of belts are similar within their groups, but different compared with each other.

Second, there is no sharp transition in the use of a certain alloy between different types of belts (Fig. 3). That is, the evolution of the use of a certain admixture is traced. The levels of zinc and silver gradually decreased. These impurities were characteristic of the Brodovsky (ye 5th century CE), Verkh-Sainsky (the 6th century CE) and the Bartymisky (the 7th century CE) types of belt fittings. An alloy based on copper and lead also gradually appeared (the appearance of such an alloy refers to the Nevolinsky type of belt fittings of the 8th century CE), which eventually became the only one used in the Sukholozhsky type (the 8th – first quarter of the 9th centuries CE). Most likely, this

depends on the fact that the craftsmen gradually stopped using imported material, but continued to develop ore deposits and improve their level of skill.

In the future, the option of rethinking the methodology of working with the results of chemical analysis is being considered. The obtained statistical materials will be grouped by alloy composition and considered in comparison with the existing typology of things.

Acknowledgments. The author appreciates the Udmurt State University and, in particular, the Kama-Vyatka Archaeological Expedition for the opportunity to work with an X-ray fluorescence spectrometer and for providing archaeological material.

References

- Volkov, S.R., Pastushenko, I.U.: Issledovaniya Ust-Irginskogo mogilnika nevolinskoj kultury. Finno-Ugrica. Kazan, pp. 5–39 (2006). (in Russian)
- Goldina, R.D., Vodolago, N.V.: Mogilniki nevolinskoj kultury v Priural'e., p. 176. IGU, Irkutsk (1990) (in Russian)
- Goldina, R.D.: Issledovaniya kurgannoj chasti Brodovskogo mogilnika // Priurale v drevnosti i srednie veka. Mezhdvuzovskij sbornik nauchnyh trudov. Ustinov, pp. 47–99 (1986). (in Russian)
- Goldina, R.D.: Nevolinskij mogilnik VII-IX vv. v Permskom Predurale. Materialy i issledovaniya Kamsko-Vyatskoj arheologicheskoy ekspedicii, p. 472. Sarapulskaya tipografiya, Izhevsk (2012a) (in Russian)
- Goldina, R.D., Pastushenko, I.U., Chernykh, E.M., Perevozchikova, S.A., Goldina, E.V., Perevoshchikov, S.E.: Gorodishche Lobach i ego okrestnosti v epohu srednevekovya: Materialy i issledovaniya Kamsko-Vyatskoj arheologicheskoy ekspedicii, p. 264. Sarapulskaya tipografiya, Izhevsk (2012) (in Russian)
- Goldina, R.D., Perevozchikova, S.A.: O datirovke i hronologii Verh-Sainskogo mogilnika nevolinskoj kultury (VI- nachalo IX v. n. e.). Drevnosti Prikamya epohi zheleza (VI v. do n.e. – XV v. n.e.): hronologicheskaya atribuciya. Materialy i issledovaniya Kamsko-Vyatskoj arheologicheskoy ekspedicii, pp. 321–375. «Udmurtskij universitet», Izhevsk (2012). (in Russian)
- Goldina, R.D., Perevozchikova, S.A., Goldina, E.V.: Mogilnik VI–IX vv. u d. Verh-Saya v Kungurskoj lesostepi: Materialy i issledovaniya Kamsko-Vyatskoj arheologicheskoy ekspedicii, p. 720. Monporazhyon, Izhevsk (2018) (in Russian)
- Goldina, R.D.: O datirovke i hronologii nevolinskoj kultury (konets IV – nachalo IX vv.). Drevnosti Prikamya epohi zheleza (VI v. do n.e. – XV v. n.e.): hronologicheskaya atribuciya. Materialy i issledovaniya Kamsko-Vyatskoj arheologicheskoy ekspedicii T, vol. 25, pp. 203–285. «Udmurtskij universitet», Izhevsk (2012b) (in Russian)
- Mokrushin, I.G., Krasnovskih, M.P., Podosenova, Y.A., Sarapulov, A.N.: Fiziko-himicheskie metody analiza v arheologicheskikh issledovaniyakh. Trudy Kamskoj arheologo-etnograficheskoy ekspedicii, pp. 14–26. PGPU, Perm (2020) (in Russian)
- Chernykh, E.N.: Drevnejshaya metallurgiya Urala i Povolzhya, p. 185. Nauka, Moskva (1970) (in Russian)

Author Index

A

Agatova, Anna R. 149
Alaeva, Irina P. 39
Ankushev, Maksim N. 86, 149
Ankusheva, Natalia N. 39, 95
Ankusheva, Polina S. 61
Astakhova, Irina S. 135

B

Batanina, Natalia S. 86
Blinov, Ivan A. 79, 86, 95
Busova, Varvara S. 149

C

Chechushkov, Igor V. 61
Chepalyga, Andrey L. 176
Chernykh, Anastasia A. 143

D

Doronichev, Vladimir B. 11
Doronicheva, Ekaterina V. 11

E

Epimakhov, Andrey V. 61

F

Filatova, Maya O. 149

G

Gladysheva, Ekaterina V. 159
Golovanova, Liubov V. 11
Grigoriev, Stanislav A. 3

H

Herzen, Andrey A. 165

K

Kashuba, Maya T. 109
Kiseleva, Darya V. 61, 69
Klemeshova, Marina E. 176

Koryakova, Ludmila N. 61
Kosintsev, Pavel A. 61
Kozhukhovskaya, Yulia V. 109
Krause, Rudiger 61
Kulkov, Alexander M. 109
Kulkova, Marianna A. 109
Kupriyanova, Elena V. 30

L

Loman, Valery G. 95
Lychagina, E. L. 19

M

Molchanov, Ivan V. 61
Murygin, Alexander M. 135

N

Nepop, Roman K. 149
Nesterova, Tamara P. 165

P

Panteleeva, Sofya E. 61
Petrov, Fedor N. 79, 86
Petrov, Nikolay F. 79
Plekhanova, Liudmila N. 39
Plotkina, Yulia V. 109

R

Rassadnikov, Alexey Yu. 61
Revina, Elena I. 11

S

Sadchikova, Tamara A. 176
Sakania, Suram M. 176
Saprykina, Irina A. 176
Sharapova, Svetlana V. 61
Shubin, Yuri P. 101
Shumilov, Igor Kh. 101
Skochina, S. N. 19
Smertin, Andrey R. 125

Smertina, A. Yu. 19
Smertina, Nadezhda S. 125
Stolarczyk, Eliza 61
Stolyarova, Ekaterina K. 50
Sycheva, Olga V. 149

T

Tomilina, Elena M. 125
Trebeleva, Galina V. 50, 176

V

Vasilieva, Irina M. 109
Vasyuchkov, Egor O. 69

Y

Yakovleva, Ekaterina S. 159
Yurkov, Gleb Yu. 176
Yurkov, Vladlen G. 176
Yurkov-Trebelev, David G. 176