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N.V. Polosmak[1], S.S. Shatskaya[2], M.V. Zadorozhnyy[3], L.P. Kundo[1], and E.V. Karpova[4, 5]

[1]Institute of Archaeology and Ethnography, Siberian Branch, Russian Academy of Sciences, Pr. Akademika Lavrentieva 17, Novosibirsk, 630090, Russia
E-mail: polosmaknatalia@gmail.com; kundoludmila@ngs.ru
[2]Institute of Solid State Chemistry and Mechanochemistry, Siberian Branch, Russian Academy of Sciences, Kutateladze 18, Novosibirsk, 630128, Russia
E-mail: shatskaya@solid.nsc.ru; lana46@ngs.ru
[3]Sobolev Institute of Geology and Mineralogy, Siberian Branch, Russian Academy of Sciences, Pr. Akademika Koptyuga 3, Novosibirsk, 630090, Russia
E-mail: zador@igm.nsc.ru
[4]Vorozhtsov Novosibirsk Institute of Organic Chemistry, Siberian Branch, Russian Academy of Sciences, Pr. Akademika Lavrentieva 9, Novosibirsk, 630090, Russia
[5]Novosibirsk State University, Pirogova 1, Novosibirsk, 630090, Russia
E-mail: karpovae@nioch.nsc.ru

The Xiongnu Gold from Noin-Ula (Mongolia)

This article presents the results of interdisciplinary studies of gold artifacts from the elite Xiongnu burials at Noin-Ula (Noyon Uul, Mongolia, early 1st millennium AD), excavated by the Russian-Mongolian expedition in 2006–2012. Using scanning electron microscopy, atomic absorption spectroscopy, and inductively coupled plasma mass spectrometry, as much as 17 artifacts were analyzed. These include ornaments from coffins and clothes, made by Chinese artisans. Results suggest that they were all made of native gold, similar to that from the known deposits of Mongolia as far as the elemental composition is concerned (we used an electronic database containing information on 3338 samples of Mongolian native gold, as a reference). Results of statistical tests suggest that placer deposits were the most probable source of the gold. The results do not contradict the idea that Chinese artisans used Mongolian gold. In the Han era, the Xiongnu could have been among their principal providers. The relationships between the two empires and peoples were always beneficial for the Xiongnu. Enjoying the numerous achievements of the Han civilization, they offered too little in return. One of the ways the Han dynasty could have benefited from their tumultuous neighbors was to receive native gold from them.

Keywords: *Noin-Ula, interdisciplinary studies, gold artifacts, native gold, Mongolia, Xiongnu, Western Han era.*

Introduction

Since the time when the methods of natural sciences started to be used for studying ancient metal items, the results of such studies have served for establishing the sources of raw materials from which the finds were made. This article will discuss one category of gold artifacts from Xiongnu burials.

Physicochemical analysis of archaeological finds has its own specific aspects. Previously, nondestructive methods of analysis, such as X-ray fluorescence (XRF) (Malakhov et al., 2000: 170; Revenko, 2009) and electron probe microscopic analysis (EPMA) (Mulvey et al., 1986; Spektroskopicheskiye metody…, 1979) were mainly used for studying metal items from ancient burials. These methods are indispensable in the study of surfaces and coatings, but do not always make it possible to accurately determine the composition of the alloy of which the ancient items were made.

Currently, atomic absorption spectroscopy (AAS) (Bolshakov, Ganeev, Nemets, 2006; Pupyshev, 2009) is widely used for studying alloy compositions. This method makes it possible to determine a large number of elements at the level of thousandths of a percent. The most sensitive and detectable metals with the least errors for this method are copper, magnesium, lead, manganese, zinc, and silver. Elements such as aluminum, chromium, silicon, and tin are determined in the high-temperature flame of acetylene, and there are interferences that must be taken into account. Representative weights of samples are required for accurate determination of these elements, which is not always possible in practice.

The multi-element method of inductively coupled plasma mass spectrometry (ISP-MS) has been rapidly developing over the last twenty years. It has also been successfully used for analyzing archaeological finds, when it is needed to determine the full composition of elements in one sample in a wide range of concentrations up to the level of less than 10^{-6} % (Vertman, Dubova, 2013; Ryndina, Ravych, 2012). The high sensitivity of the method makes it possible to establish the elemental composition of the inclusions of uranium, rare-earth elements, arsenic, mercury, and difficult-to-detect elements without destroying the artifact. The main disadvantage of the AAS and ISP-MS methods is the need to transfer the sample to a solution form, since the analyses entail spraying the solutions in a flame of air-acetylene, acetylene-nitrous oxide, or in argon plasma. Therefore, sample preparation is crucial for the analysis using these methods (Drugov, Rodin, 2002; Karpov, Savostin, 2003).

Each of the described methods of analysis has its limitations as to the number of elements to be determined or the limits of detection. The most reliable information can be obtained from the results of study by all three methods.

Measuring instruments, auxiliary equipment, reagents, and materials

The elements were determined using a TM1000 scanning electron microscope (Hitachi) with an X-ray fluorescence EDS unit (SwiftED), AA280FS atomic absorption spectrometer (Varian), and Agilent 7500a spectrometer with ionization in the inductively coupled plasma. For calibration of instruments, samples (GOST 8.315 (GSO)) containing aqueous solutions of ions of detectable elements, with the error of the certified value not exceeding 2 %, as well as multi-element standards Tuning Solution No. 5183-3566 and Multi-Element Calibration Standard-2 by Agilent, with the accuracy of the certified value not exceeding 2 %, were used.

For analysis, the samples were decomposed with hydrochloric and nitric acids of extra high purity grade, chemically pure hydrofluoric acid, and wine acid of pure grade. For the preparation of solutions, deionized water from the Millipore Q3 unit was used with the specific resistance (18.2 $M\Omega cm^2$) MOhm × cm^2.

For establishing trace elements, batches of samples weighing 0.01–0.07 g were decomposed into 5 ml of aqua regia (hydrochloric and nitric acids in a ratio of 3:1) in a Berghoff 4 microwave oven, at a temperature of 240 °C and pressure of 40 atm, and were brought to a volume of 100 ml with deionized or bidistilled water. The resulting solutions were analyzed by the ISP-MS method.

Description of study objects

Seventeen metal items from Xiongnu kurgans 20, 22, and 31 from the Noin-Ula burial site were subjected to physicochemical analysis. All artifacts were discovered during restoration of the Noin-Ula textiles in the restoration laboratory of the Institute of Archaeology and Ethnography SB RAS.

According to their functional purpose, the artifacts belong to two groups. The first group includes ornaments on the walls of coffins; the other group comprises decorations on clothes. The ornaments from the coffin walls include carved wooden trefoils covered with gold foil. These were elements of ornamental composition, and were located in the center of diamond-shaped thin planks covered with gold foil (Fig. 1). There are holes for nails made of foil in the crossbars of these golden strips. The thickness of the nail stem is 0.84 × 0.65 mm; the thickness of the nail cap is 125 μm; the thickness of the foil on the rim of the cap is 1.17 × 0.65 mm (Fig. 2).

Fig. 1. Ornaments of a coffin wall. Reconstruction based on the evidence from kurgan 22.

Eleven items were ornaments of clothes. These include narrow (600 μm wide) strips of foil, which wrapped around kingfisher feathers; openwork onlay on a belt buckle (Fig. 3); a spherical sewn-on plaque with a round step-like relief, which may have been formed as a result of external pressure on a wooden matrix; and a sewn-on plaque in the form of a dragon representation (Fig. 4). These things were made of foil 150–200 μm thick. In addition, there is a clasp for clothing in the form of a thin hollow cylinder 48 mm long and 4 mm in diameter (Fig. 5). Its ends are decorated with an edging of miniature balls 600 μm in diameter, which were soldered in a circle and covered with a miniature insert of turquoise framed in gold (Fig. 6). The ornaments include sewn-on plaques of rectangular, square, and round shape, with a relief pattern of twisted strips of foil on the front side (Fig. 7). The items show roughly made holes for fastening to fabric. The category of finds under consideration includes a belt buckle, which was made of round wire 2–3 mm in diameter. The ends of the wire were flattened; they have square holes, into which nails for fastening the textiles or leather were inserted (Fig. 8). Another adornment with stone inserts is a semi-oval plate framed with gold wire of rectangular cross-section. The front part of this artifact is divided by the same wire into scale-like cells with the inserts of a gray mineral (Fig. 9).

Results of physicochemical analysis

The elemental composition of gold items was established using the XRF*, AAS, and ISP-MS methods (Table 1). According to the XRF data, along with gold and silver, mercury was present in significant concentrations (0.5; 4.1; 1.4; 3.1; 0.24; 6.0 %) on the surface of six artifacts: strips of the foil of the coffin decoration from kurgans 22 and 31, the spherical sewn-on plaque, the edging of the turquoise inserts from kurgan 22, the plaque with the dragon representation, and the decoration with the stone inserts from kurgan 20, which may indicate the use of amalgam for treating the surface of these items. The gold foil of the coffin decoration, onlay on the belt buckle, spherical sewn-on plaque, and edging of the turquoise inserts from kurgan 22 included platinum (0.008–0.004 %) and palladium (up to 0.002 %). The content of the remaining metals of the platinum group was less than 10^{-6}–10^{-5} %; the uranium content was at the level of 10^{-6}–10^{-5} %.

According to the quantitative elemental analysis of 17 artifacts, the gold content ranged from 71.3 ± 2.5 to 98.00 ± 2.0 %, the silver content from 0.499 to 26.8 %, and the copper content from 0.01 to 4.4 %.

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*SEM-XRF analyses were conducted at the Chemical Research Center for Collective Use of the SB RAS.

Fig. 2. Decorative nail, kurgan 22.

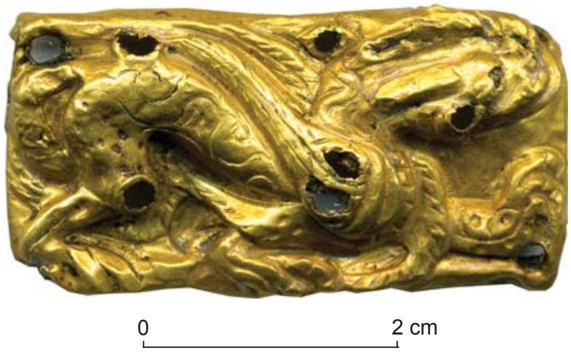

Fig. 4. Plaque with dragon representation, kurgan 20.

Fig. 3. Openwork onlay on belt buckle, kurgan 22.

Fig. 5. Clasp, kurgan 22

Fig. 6. Insert of turquoise in a gold frame, kurgan 22.

Fig. 7. Rectangular (*1*), square (*2*), and round (*3*) sewn-on plaques, kurgan 22.

Fig. 8. Belt buckle, kurgan 22.

Fig. 9. Gold adornment with stone inserts, kurgan 20.

A gold content from 79 ± 3 to 90.3 ± 3.0 %, silver content from 3.7 to 16.9 %, and copper content from 0.1 to 4.4 % were established for ten artifacts: the nails of the coffin decoration from kurgans 22 and 31, the onlay on the belt buckle, spherical plaque, clasp, edging of the turquoise inserts, the rectangular, square, and round plaques, belt buckle from kurgan 22, and decoration with stone inserts from kurgan 20. The share of gold in three items (strips of foil on the decoration of the coffins from kurgans 20 and 31, and the edging of the turquoise inserts from kurgan 22) ranged from 71.3 ± 2.55 to 77.5 ± 2.0 %, while the percentage of silver increased to 26.29; 26.8, and 19.3 %. Four artifacts (strips on the coffin decoration, coverings of trefoils, foil on the decoration with feathers from kurgan 22, and the sewn-on plaque with the dragon representation from kurgan 20) were made of high-grade gold. Their composition included high shares of gold (97 ± 3; 97 ± 3; 98 ± 2; 96.5 ± 3 %), and small admixtures of silver (0.6; 0.6; 0.6; 0.499 %) and copper (0.08; 0.09; 0.05 %)*.

Sources of gold from the Xiongnu burials in Mongolia

The method of comparing archaeological gold with gold of ore deposits and placers has been described in detail in the studies of V.V. Zaikov and his colleagues (Zaikov et al., 2012; Tairov, Beisenov, Blinov, 2014; Gusev, Zaikov, 2015). The experience of such studies was also described in the monograph "Ancient Silver of Siberia" (Drevneye serebro Sibiri…, 2005).

The composition of archaeological gold was compared to that of native gold of Mongolia, the chemical contents of which are provided in the electronic database (Zadorozhnyy et al., 2017). All analytical procedures were carried out at the Analytical Center for Multi-Elemental and Isotope Research SB RAS. The database was compiled based on the information collected during the long-term field works aimed at the identification of perspective gold deposits in Mongolia by the researchers from the Sobolev Institute of Geology and Mineralogy of the SB RAS.

The map of the northeastern part of Mongolia, on which the presently known placers and ore deposits are indicated (Geographic Information Systems (GIS)…, 2006; Goldfarb et al., 2014), shows that the burial site in Sudzukte Pass is located in close proximity to ore deposits and placers of native gold (Fig. 10).

For comparing native and archaeological gold, a statistical method of the Student's t-test was used for calculation. The hypothesis that two samples belong to one general totality was tested. Ten samples were created for comparison with archaeological gold. The first sample contained all values of gold fineness available in the catalog; the second sample contained all values of fineness for placer gold; the third group contained all values of fineness for ore gold from the catalog. The subsequent seven samples contained definitions of gold fineness for four ore-placer sites nearest to the burial: Zunharaa, Sharyngol, Tolgoit, and Zaamar (Table 2). The eleventh sample combined the values of fineness for archaeological gold. The distribution of random variables in all the samples was close to normal, which means that the gold was not doped with silver, and retained a natural ratio of elements.

*By itself, fineness is not an informative feature for determining the source of gold. The difference in the composition of gold in the artifacts found in the Xiongnu graves in this case indicates that it was native gold. Its fineness may vary within even one ore field. A deposit is usually a multi-stage site, and its gold may correspond to each stage. Usually gold is high-grade in the early stages and low-grade in the late stages. The difference in values may reach 40–50 %. In addition, gold available for extraction by primitive methods (not counting placer gold) was usually concentrated on the surface in the oxidation zones where its purification and increase in fineness occurred.

Table 1. **Elemental composition of gold items according to XRF, AAS, and ISP-MS analyses, mass %**

Sample No.	Research objects	Research method	Au	Ag	Cu	Zn	Pb	Fe	Pd	Pt	As	Sn	Hg	Bi
1	Foil strips of coffin decoration, kurgan 31	XRF	83.50	15	–	–	–	1.0	–	–	–	–	0.5	–
		AAS	71.0 ± 2.0	26.8	0.02	0.006	< 0.002	0.03	–	–	–	–	–	–
2	Foil strips of coffin decoration, kurgan 20	XRF	78.80	19.30	–	–	–	–	–	–	–	–	–	–
		AAS	77.50 ± 2.0	18.7	0.17	0.003	0.01	0.06	–	–	–	–	–	–
		ISP-MS	77.40	19.20	0.12	0.003	0.005	–	–	–	0.004	0.040	0.002	0.001
3	Foil strips of coffin decoration, kurgan 22	XRF	93.1	0.9	–	–	–	–	–	–	–	–	4.1	–
		AAS	97.0 ± 3.0	0.6	0.08	0.004	–	0.09	0.002	0.008	–	0.001	0.02	–
4	Foil covering of trefoils, kurgan 22	XRF	96.80	3.2	–	–	–	–	–	–	–	–	–	–
		AAS	97.0 ± 3.0	0.6	0.09	0.005	–	0.1	–	–	–	–	–	–
5	Nails: edge, cap, and stem, kurgan 31	AAS	79.0 ± 3.0	16.91	0.10	–	–	–	–	–	–	–	–	–
			79.0 ± 3.0	19.83	0.16	–	–	–	–	–	–	–	–	–
			81.0 ± 3.0	15.91	0.10	–	–	–	–	–	–	–	–	–
6	Nails: edge, cap, and stem, kurgan 22	AAS	82.0 ± 2.5	14.92	0.63	–	–	–	–	–	–	–	–	–
			82.0 ± 2.5	15.06	0.90	–	–	–	–	–	–	–	–	–
			82.0 ± 2.5	16.0	0.50	–	–	–	–	–	–	–	–	–
7	Foil strip of decoration with feathers, kurgan 22	XRF	81.6	0.5	–	–	–	2.1	–	–	–	–	–	–
		AAS	98.60 ± 2.0	0.6	0.05	0.006	–	0.10	–	–	–	–	–	–
8	Onlay on belt buckle, kurgan 22	XRF	89.8	8.6	–	–	–	1.5	–	–	–	–	–	–
		AAS	87.0 ± 2.0	11.61	0.09	0.009	–	0.05	–	–	–	–	–	–
		ISP-MS	91.2	12.0	0.04	0.003	< 2.6E^{-5}	0.21	5.4E^{-4}	0.006	–	0.032	0.005	–
9	Spherical sewn-on plaque, kurgan 22	XRF	90.4	5.4	2.6	–	–	–	–	–	–	–	1.4	–
		AAS	90.3 ± 3.0	8.82	0.46	0.04	–	0.07	–	–	–	–	–	–
		ISP-MS	85.0 ± 3.0	12.0	0.43	≤ 0.0001	< 2.6E^{-5}	< 0.007	7.7E^{-5}	0.005	–	–	0.06	–
10	Plaque with dragon representation, kurgan 20	XRF (on the inside)	95.8 (96.5)	0.4 (1.4)	–	–	–	0.7 (2.2)	–	–	–	–	3.1 (–)	–
		AAS	96.5 ± 3.0	0.499	0.01	0.008	< 0.002	0.01	–	–	–	–	–	–
11	Clasp for clothing, kurgan 22	XRF	89.4	8.9	0.5	–	–	–	–	–	–	–	–	–
12	Edging of turquoise, kurgan 22	AAS	71.3 ± 2.5	26.29	0.49	–	–	0.06	0.001	0.003	0.019	–	–	–
		ISP-MS	82.0 ± 2.5	≥ 18.0	>0.1	0.006	0.005	0.03	0.001	0.004	0.024	0.029	0.24	–
13	Sewn-on plaque, rectangular, kurgan 22	XRF	88.0	9.0	2.8	–	–	–	–	–	–	–	–	–
14	Sewn-on plaque, square, kurgan 22	XRF	91.9	3.7	4.4	–	–	–	–	–	–	–	–	–
15	Sewn-on plaque, round, kurgan 22	XRF	91.9	3.7	4.4	–	–	–	–	–	–	–	–	–
16	Belt buckle, kurgan 22	XRF	87.6	12.4	–	–	–	–	–	–	–	–	–	–
17	Adornment with stone inserts, kurgan 20	XRF	84–87	10–12	0.7	–	–	–	–	–	–	–	3–6	–
		AAS	87.3 ± 3.0	12.5	0.6	0.002	< 0.002	0.01	–	–	–	–	–	–

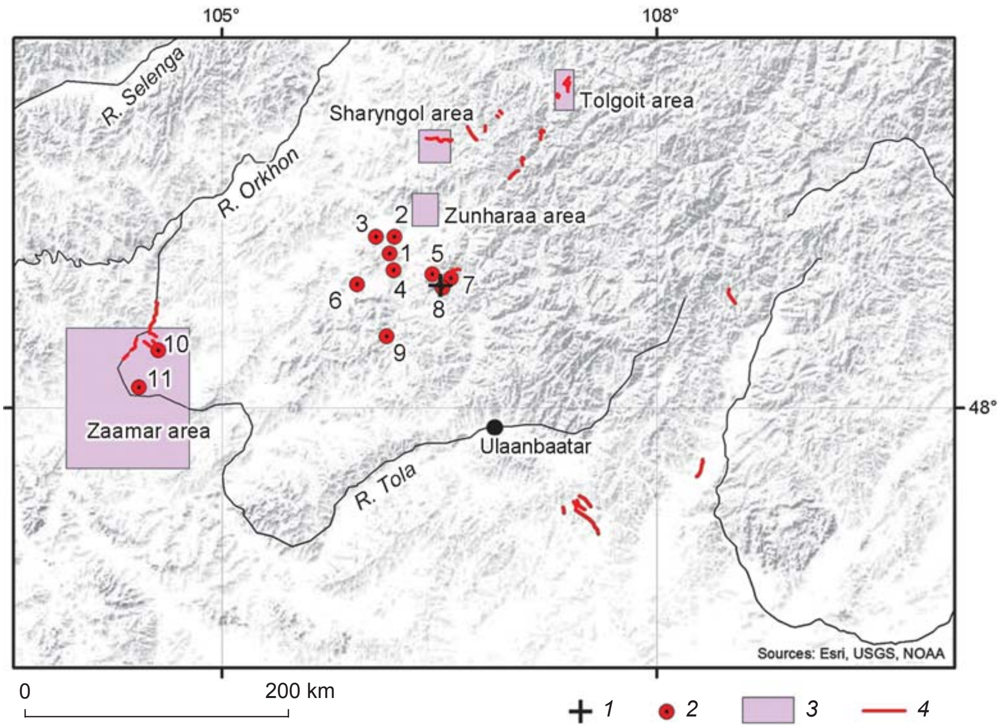

Fig. 10. Overview map of gold occurrences in Northeastern Mongolia.
1 – the Noin-Ula burial site; *2* – gold deposits; *3* – territory of the site; *4* – gold placers. Gold deposits: 1 – Boroo; 2 – Boroo 4; 3 – Boroo 7; 4 – Narantolgoi; 5 – Urt; 6 – Baavgait; 7 – Eriin; 8 – Sudzukte; 9 – Bayantsagaan 2; 10 – Bumbat; 11 – Narijn Gol.

Table 2. **Descriptive characteristics of fineness samplings for native and archaeological gold**

No.	Sampling	Number of samples	Fineness, average	Standard deviation	Standard error	Median	Dispersion
1	All fineness values	3338	83.81956	12.65071	0.21896	85.66	160.4051
2	Placer gold	2117	85.1517	11.44195	0.24868	86.59	130.91829
3	Ore gold	997	79.22644	14.12168	0.44724	79.85	199.42197
4	Placer gold from Zunharaa area	14	91.81857	4.65702	1.24464	92.405	21.68781
5	Ore gold from Sharyngol area	22	85.66909	8.78563	1.8731	88.925	77.18728
6	Placer gold from Sharyngol area	20	86.0625	5.98843	1.33905	87.465	35.86133
7	Ore gold from Tolgoit area	35	93.28314	8.68508	1.46805	96.71	75.43068
8	Placer gold from Tolgoit area	25	91.4976	7.45549	1.4911	93.15	55.58435
9	Ore gold from the Zaamar area	30	80.95067	12.35851	2.25635	81.79	152.73279
10	Placer gold from Zaamar area	197	88.98772	8.33941	0.59416	90.05	69.54583
11	Archaeological gold	35	86.70571	7.45512	1.26015	87.3	55.57879

The Student's t-test was calculated using the Microcal Origin 6.0 Professional software and the standard method for independent samples, at a confidence level of 95 % ($p = 0.05$) (Miller, 1965; Isakova, Tarasevich, Yuzyuk, 2009). In five cases out of ten, these comparisons did not contradict the hypothesis that the compared samples might have belonged to the same general totality (Table 3). For getting a more accurate answer to the question concerning the sources of gold, the archaeological gold was compared with the gold that was mined in the areas adjacent to Mongolia, such as Altai, Khakassia, Tuva, and China. According to the results, the gold was most likely procured from placer sources. It is also possible that it was mined within the Sharyngol and Zaamar areas.

Special attention should be given to the Zaamar gold-bearing ore-placer area. At present, the Zaamar ore cluster is one of the largest ore-placer regions of Eurasia, as far as the explored reserves are concerned. A significant part of its gold reserves is associated with Quaternary sediments of the Tuul River. The development of these placers has become possible only due to modern technologies. However, gold-bearing placers of Cretaceous and Neogene ages, located on the slopes of the valley, which essentially represent ancient placers and appear as positive forms in modern relief, could have been a source of easily accessible placer gold (including large nuggets) for ancient prospectors.

Further, the content of trace elements (Hg and Cu) was compared. For clarity, the compositions are indicated on ternary diagrams of the systems Au-Ag-Cu and Au-Ag-Hg (Fig. 11). The studies of Zaikov and his co-authors indicate that copper contents exceeding 2 %

Table 3. **Values of Student's t-test**

No.	Sample	t	p	Result
1	Placer gold from Sharyngol area	–0.32946	0.7431	Average values differ insignificantly
2	Ore gold from Sharyngol area	–0.47689	0.63533	″
3	Total data for placer gold	–0.8006	0.42345	″
4	All values of fineness from e-catalog	–1.34712	0.17803	″
5	Placer gold from Zaamar area	1.51433	0.13129	″
6	Ore gold from the Zaamar area	–2.30959	0.0242	Average values differ significantly
7	Placer gold from Zunharaa area	–2.3786	0.02149	″
8	Placer gold from Tolgoit area	2.45455	0.01713	″
9	Total data for ore gold	–3.11708	0.00188	″
10	Ore gold from Tolgoit area	3.39969	0.00113	″

Note. t – Student's t-test, p – probability.
The lines are arranged in the descending order of the calculated probability value.

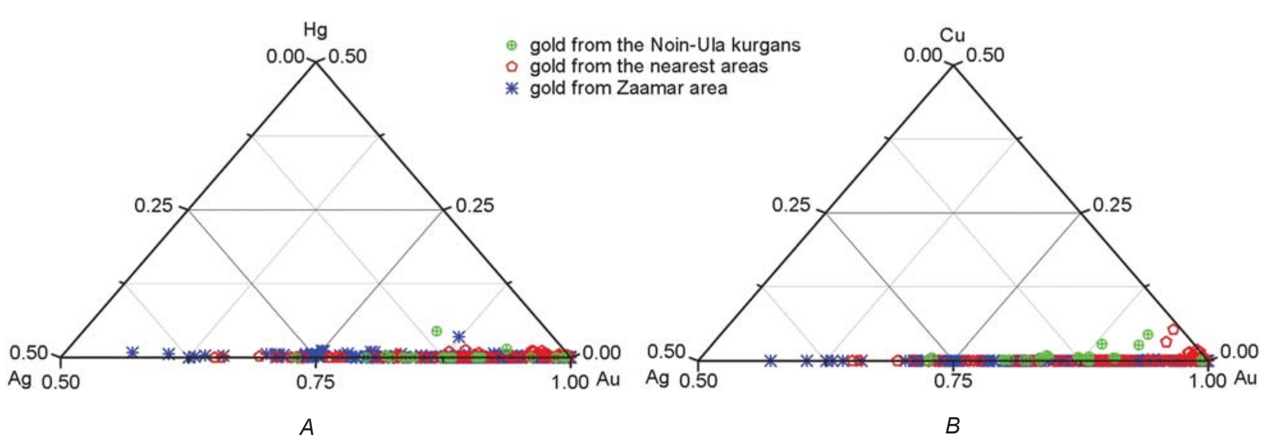

Fig. 11. Gold composition in triple diagrams.
A – Au-Ag-Hg; *B* – Au-Ag-Cu.

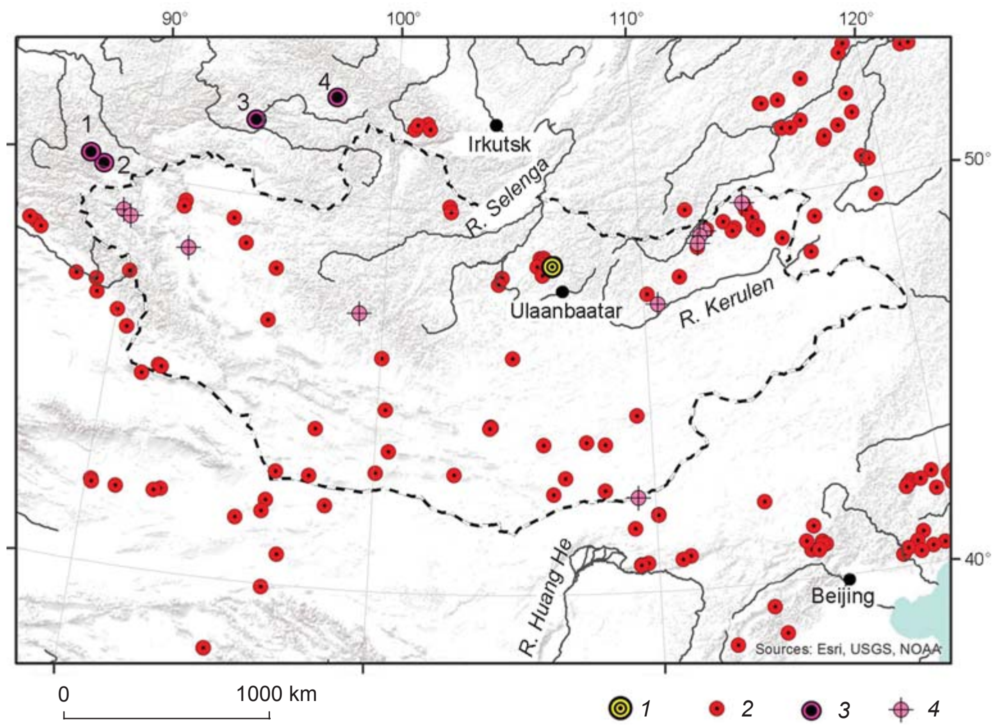

Fig. 12. Gold ore and mercury sites in Central Asia (after (Dejidmaa et al., 2002; Geographic Information Systems (GIS)…, 2006; Goldfarb et al., 2014)).
1 – the Noin-Ula burial site; *2* – gold deposits; *3* – mercury deposits; *4* – mercury ore occurrences. Mercury deposits: 1 – Aktash; 2 – Chagan-Uzun; 3 – Terligkhay; 4 – Chazadyr.

is indicative of a gold alloy doped with copper (Zaikov et al., 2012). Indeed, copper impurities in gold rarely exceed 1 %; however, native gold (in particular, in Mongolia) sometimes contains 3–6 % Cu (Zadorozhnyy et al., 2017). The increased copper contents in native gold correlate with the presence of basic and ultrabasic intrusions near deposits and ore manifestations.

The presence of mercury impurities, as well as thin amalgam coatings, were detected in the composition of gold artifacts. Ancient metallurgists obviously used mercury, but it is unclear in what capacity—to enrich gold concentrates or only as a "solvent" for applying thin layers of gilding. Amalgamation is one of the earliest methods of gold purification; it is quite possible that it was used by prospectors in the Mongolian steppes in the early first millennium AD. There is some indirect evidence in favor of this assumption. Numerous strands of hair and braids discovered in burial mounds of the nobility at the Noin-Ula burial site have been analyzed using X-ray fluorescent analysis using synchronous radiation of elements at the Siberian Synchrotron and Terahertz Radiation Center of the Institute of Nuclear Physics of the SB RAS. According to the researchers, "the mercury content was extremely high in the hair from the burial, while its levels did not exceed the regular values in the clay from the burial. These data indirectly indicate an internal source of mercury in the hair"* (Trunova et al., 2017: 324). The largest mercury deposits closest to Noin-Ula are located on the territory of the Altai Mountains and Tuva. There are no gold and mercury deposits on the territory of China adjacent to the location of the burial site under study (Fig. 12).

Steppe gold (instead of conclusions)

For the first time, the analysis of gold artifacts (foil strips and quatrefoils on ornaments of coffins from four Xiongnu burials at the Gol-Mod burial ground, Mongolia) was conducted by French researchers (Guerra, Calligaro, 2003: 177–179), who concluded that native and alluvial gold was used for making the finds under consideration. However, owing to the lack of sufficient amount of comparative evidence they were unable to establish whether these things had been produced locally or resulted from interaction with neighbors. Our study has made it possible to answer this question in a substantiated way.

*It is known that in ancient China people attributed special properties to mercury: it was procured by heating cinnabar and was used to create medicines which were believed to ensure immortality (see, e.g., (Eliade, 1998: 50–51)).

All gold artifacts from the Xiongnu kurgans analyzed in this article were made of foil or wire. The apparent simplicity of manufacturing may be misleading. Foil production, just like wire production, required knowledge, skills, and certain conditions to complete the task. Wooden coffins of a special design, known from the finds in the burials of Xiongnu nobility, were made and decorated, imitating Han coffins with silk fabrics and a rhombic net of wooden strips and quatrefoils covered with thick gold foil (Polosmak, Bogdanov, Tseveendorj, 2011: 73). Probably, the coffins and their decorations were made by Chinese artisans, who also created clothing, fragments of which are found in the graves of the noble Xiongnu. Decorations on such clothing, numerous gold sewn-on plaques, which constituted one of the most common categories of gold items in the Han period (Kravtsova, 2004: 758), could have been made in China. Together with sets of clothes mostly made of silk, they were a part of the gifts from the imperial court sent to the Chanyu, who would hand out all gifts of the Emperor to his courtiers (Barfild, 2009: 96–97). Therefore, many valuable items of Han production have been found in the graves of the Xiongnu nobility. In addition to the Chinese and Han items, the graves of the Xiongnu contain many things originating from Western countries; such finds can be present among gold artifacts (Polosmak, Bogdanov, Tseveendorj, 2011: 67, fig. 2, 39). Like our French colleagues, we have analyzed only a specific category of gold items associated with decorations of coffins and clothes. These items, related to the Han culture and traditions (clothing and fabrics), were a part of the gifts which the Chanyu received from the Emperor. Massive coffins may have been made to order by Chinese artisans. These things could have been made on the Mongolian steppe, but their production remained the prerogative of Chinese artisans.

In ancient times, China did not possess gold reserves, and therefore gold items were not produced in such great numbers as was the case with Rome, Parthia, Bactria, or Egypt. Gold was valued throughout the entire ancient world, but jade, jasper, and jadeite were especially highly valued in China. China has always lacked gold, and its domestic production has never satisfied the country's needs (Khokhlova, 2016). In ancient China, "gold was at first used in decorative and applied art as an auxiliary material for decoration", and only in the Warring States period did goldsmithery become a relatively independent activity—belt buckles and clothing plaques started to be made of gold (Kravtsova, 2004: 756). The Noin-Ula kurgans, like almost all large kurgans of the Xiongnu, date back to the reign of Wang Mang (9–23 AD). According to the written sources, in order to replenish the treasury, Wang Mang ordered his aristocrats to turn in gold in exchange for gilded bronze knives, which replaced money. The treasury was significantly replenished not from procuring the valuable metal, but from withdrawing it from circulation. Where did gold appear in ancient China from? Judging by the chronicles of the Tang period, the court would receive rich gold offerings from Tibet, Korea, and Central Asian possessions, such as Chach, Kesh, and other lands (Shefer, 1981: 335), but very little gold was mined in China's own gold deposits. In the Han period, the famous gold-bearing provinces of China (Guangdong, Guangxi, and Yunnan) were not yet a part of the Empire (Kravtsova, 2004: 754).

The interdisciplinary studies conducted allow the conclusion to be made that the gold artifacts from the Xiongnu graves, which were most likely manufactured by Chinese artisans, were made of the native gold of Mongolia. Along with gold from other known and unknown sources, it came to Han China from the Xiongnu.

There was always exchange of goods between the Xiongnu and the Han people. The Han people gave much more than they received. Silk, grain, chariots, weapons, jewelry, lacquer and bronze dishware, even princesses were sent to the steppe on a regular basis; while the Xiongnu could only give in return horses and livestock products. The exchange was clearly not equivalent, so it was always perceived as a disguised homage to the Xiongnu from China in exchange not for goods, but for peace along the border. Yet, if gold appears in this whole chain of goods, the picture changes. The Xiongnu lands, so useless for China, as the Eastern Han historian Ban Gu (32–92 AD) wrote that "one cannot feed from their land through farming" (cited after (Krol, 2005: 195)), hid other riches in themselves—easily accessible placer gold, which could be mined during the time of interest for our study in the area from the Gobi Desert to the Trans-Baikal region. Complex and controversial relations, which evolved between the neighboring states, may have been to some extent advantageous to the Han Empire. It received gold, which the Xiongnu had, who wandered over one of the richest gold-bearing territories of Central Asia. Everything that the imperial court regularly gave as a gift to the Xiongnu was to some degree compensated by the gold, which was partially returned to the steppe in the form of gold items. The absence of direct references to this exchange in the written sources can be easily explained by the fact that the sources (chronicles) belong to the Chinese side. These manifest undisguised disrespect, misunderstanding, and contempt for the wild barbarians "with the face of a man, but with the heart of a beast" (Ibid.: 194). Not surprisingly, there is no direct information about such mutually beneficial relationships. Archaeology opens our eyes to many things when written sources are biased.

In conclusion, it should be mentioned that at the beginning of the 21st century, Mongolia became one of the leaders in world gold production. The country annually produces over 20 tons of gold, almost half of which is mined by placer miners (now there are about 100,000 of them). In several aimags, gold mining has become the main occupation, pushing aside traditional nomadic cattle breeding (Mikhalev, 2012: 196). Modern placer miners work using the same methods, which were probably known two thousand years ago to the Xiongnu, and on the same sources of native gold, which could have been developed by ancient miners. Gold is being smuggled in large amounts from Mongolia to China, which still lacks this metal. In some ways, the situation of two thousand years ago is repeating itself.

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