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Irrigation Systems of the Altai: Results and Prospects of Archaeological Studies

We present the findings of studies concerning the irrigation systems of the Altai and outline the directions of their further exploration. Irrigation canals, widely distributed in alpine valleys and intermontane depressions, are streams of the drift type. Most are found in central Altai and in the Chulyshman River valley of eastern Altai. Complex irrigation systems were recorded in the Bilgebash and Sarduma river mouths in the Chuya valley, in the Chulcha River mouth in the Chulyshman valley, and in Tötö, the Kurai basin. Pilot excavations of the main canals showed that wooden troughs had been placed on their bottoms. Radiocarbon analysis of wood from those troughs (Cheba and Oroktoi) suggests that they date to the Late Middle Ages, and a soil sample from the bottom of the canal of the Tenga irrigation system indicates early medieval age. In the 1800s and early 1900s, canals were used by the natives mainly for watering small plots of barley, but also of wheat and rye. Agriculture has been practiced in the Altai at least since the Early Iron Age, having flourished, apparently, during the Early Middle Ages. The first irrigation systems must have appeared together with the first farmers; however, taking into account the prolonged use and modifications of the main canals, assessing the time of their initial construction is difficult.

Keywords: *Irrigation, irrigation systems, Altai, canals, agriculture, suvak, dating.*

Introduction

The relatively high number of explored and studied archaeological sites in the Altai makes it possible to consider this territory as one of the key regions for understanding the processes that took place in Southern Siberia and Central Asia in antiquity and the Middle Ages. In the Altai, where the most-studied are burial sites, less attention has been paid to the objects associated with economic activities. Among others, numerous but poorly studied are irrigation systems.

The presence of irrigation practice in the Altai is associated with the environmental and climatic conditions. The Russian part of the Altai Mountains has a harsh continental climate. The terrain is typically mountainous, with clearly marked altitudinal zonation. The heights

of river valleys, intermontane depressions and plateaus rise significantly from north to south. Noteworthy is the hydrological situation favorable for the construction of irrigation systems. The river network of the Altai includes more than 20,000 mountain rivers, with their total length exceeding 62 thousand km (Marinin, Samoylova, 1987: 4, 45–46). The flow velocity is high, owing to the significant slope of the longitudinal profiles of the rivers.

Irrigation systems are numerous in river valleys and intermontane basins, as well as in some other regions of the central, southern and eastern Altai. Canals are common elements of Altai landscapes; these are mentioned in the works of researchers such as A.A. Bunge (Ledebour, Bunge, Mayer, 1993: 204), V.V. Radlov (1989: 437, 474), N.M. Yadrintsev (1883: 192, 202), and others. The study of irrigation canals in Tötö, Altai, in 1935 was carried out by S.V. Kiselev (1949: 287–289), in various regions of the Altai in 2003–2007 by T.A. Beketova (Akimova) (see (Vdovina, Trifanova, 2003; Vdovina, 2004, 2005, 2007a, b; Smirnov, Akimova, 2014)).

In 2019–2021, as part of a project to study the medieval economy of the Altai population, field works were carried out aimed at the identification of irrigation systems in the central and eastern parts of the region.

The purpose of this article is to summarize the results of the study of irrigation systems in the Altai and to determine the directions for further research.

Material and methods

Irrigation canals (Alt. *suaks*, *suvaks*) are spread over a large area of the Russian Altai (Fig. 1). Bunge reported in 1826 that the Altaians use the canals to irrigate plots with crops, most often barley (Ledebour, Bunge, Mayer, 1993: 204). According to 19th-century researchers, the canals had been built in earlier times (Yadrintsev, 1883: 192; Radlov, 1989: 437; Shvetsov, 1900: 280). In the 20th century, many canals were rebuilt by Soviet meliorators.

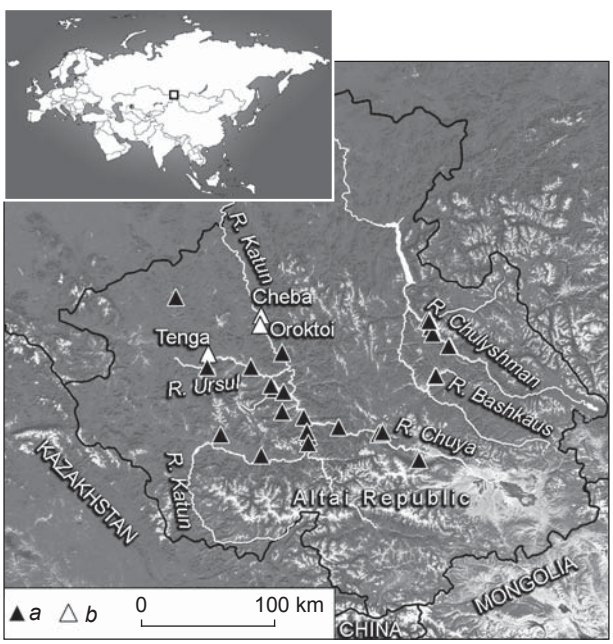

Fig. 1. Irrigation systems of the Altai (*a*); canals where cross-sections were made (*b*).

Most of the well-known Altai irrigation systems have the following arrangement (Fig. 2). Depressions were dug into the soil, through which water flowed by gravity to the areas in need of irrigation. Water intake was usually carried out from rivers of the second order, using various kinds of dam, or a natural slope. In some valleys, several levels of main canals are recorded, whose water-intake points were in different parts of the river flow. Such a system was examined by the authors on the left bank of the Kupchegen River (Fig. 3). In the topographic low areas, stone or wooden water-support conduits (aqueducts) were often built for the water's passage. When laying the canals, rock ledges were sometimes hewed (Vdovina, 2005: 174; 2007b: 63). Water storage reservoirs were also created.

Water was supplied to the irrigated fields through diversion canals. It spread over the plots with the help of diversion ditches. In the Katky area, in the lower part of the Chulyshman valley, A.S. Surazakov discovered the abandoned fields that he described as previously cultivated "cells", ca 30 × 40 m, separated by partially eroded berms (2003: 93).

A similar situation we observed on the right bank of the Chulyshman, where the Karasu-1 irrigation system is located. At the foot of the mountain slope, on a small ledge, there was a series of elongated plots, separated by partially eroded berms, along which the distribution canals passed (Fig. 4). Below these sections, there were two elongated narrow ledges resembling artificial terraces.

To capture irrigation systems, we used the photogrammetry (aerial photography) method. The acquired relief models and orthophotomaps were loaded into the QGIS program, where plans of irrigation systems were drawn. Modern methods of identification ofarchaeological sites significantly facilitate the process of studying irrigation systems.

At the sites of Cheba, Oroktoi, and Tenga, T.A. Beketova (Akimova) made cross-sections of the main canals in 2006 (Vdovina, 2007b).

Cheba. A cross-section of the main canal on the Cheba River (the right tributary of the Katun) was made at the point where the canal crossed the rocky outcrop. The rock ledge was hemmed, and the cliff behind the ledge was shaped with a stone and earth embankment. The test

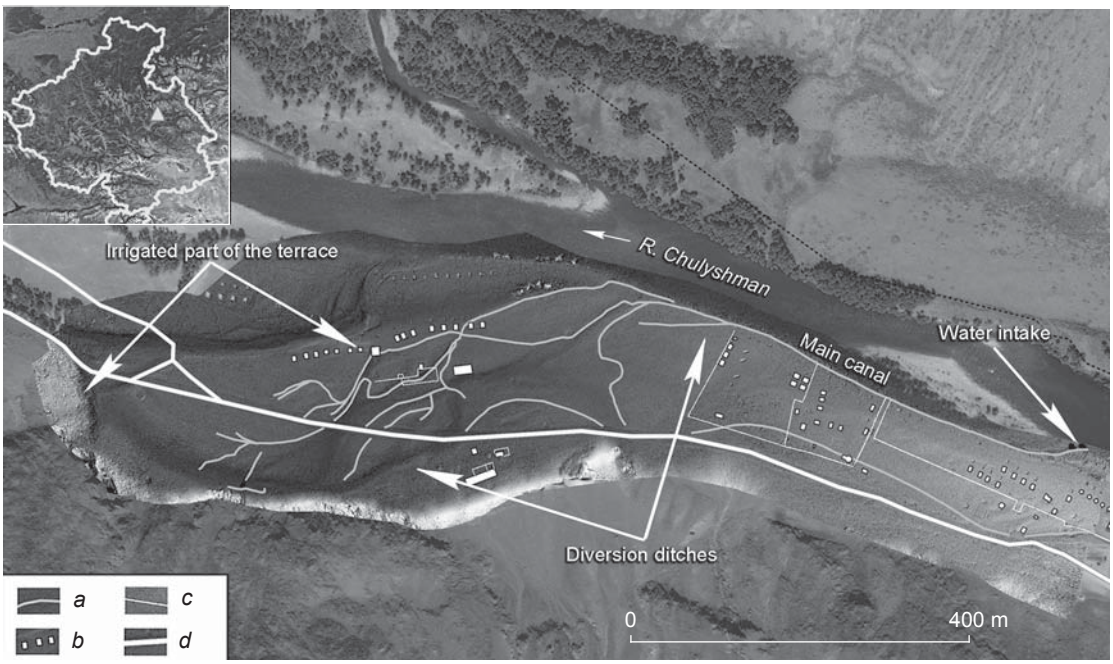

Fig. 2. Katu-Yaryk-1 irrigation system. Eastern Altai, the Chulyshman River valley.
a – irrigation canals; *b* – modern buildings; *c* – modern enclosures; *d* – road.

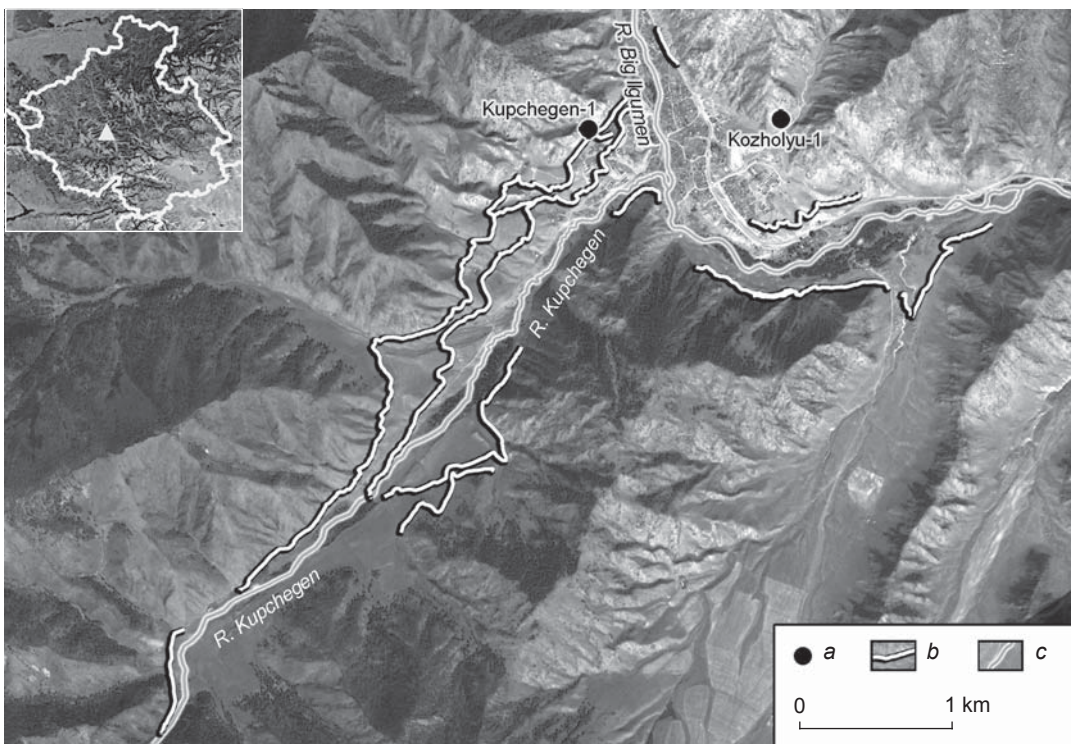

Fig. 3. Irrigation systems near the Kupchegen village. Central Altai, the Big Ilgumen River valley.
a – medieval settlements; *b* – irrigation canals; *c* – rivers.

pit was made between the rocky outcrop and the stone embankment of the canal. At the bottom of the canal, a wooden trough 45 cm wide, with sides up to 10 cm high, was found (Fig. 5; 6, *1*, *2*).

Oroktoi. At the exit of the main canal from the Orokta River valley to the left-bank terrace of the Katun, the wall of the trench crossing the canal was cleaned. The canal's depth is ca 1m from the daylight surface. At the bottom, the remains of a wooden trough were found, covered with aninterlayer of sediments of loose coarse-grained sand. Higher, at a depth of 0.2 and 0.35 m, two interlayers of sand were recorded.

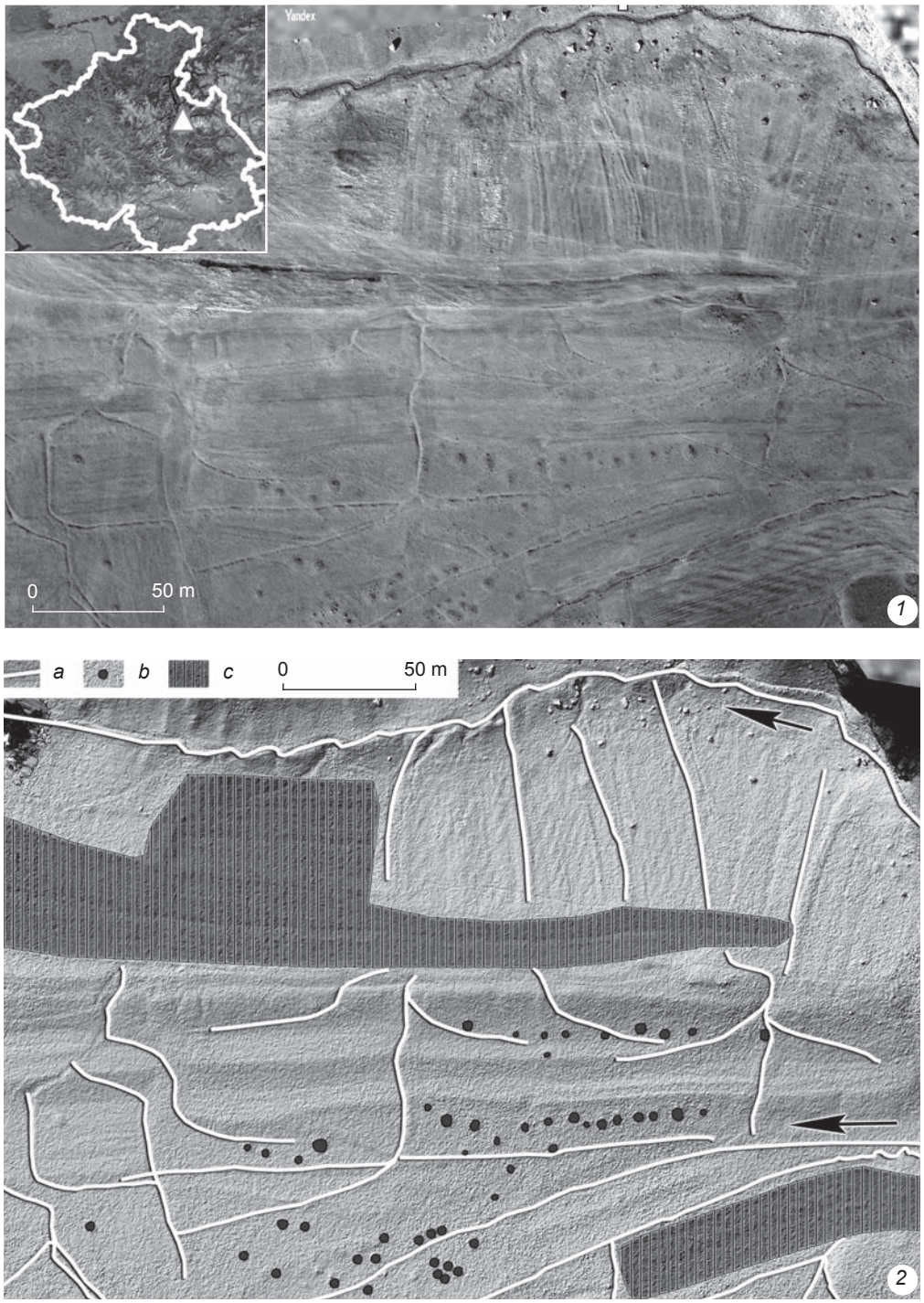

Fig. 4. Orthophotomap (*1*) and relief model (*2*, arrows indicate the direction of flow) of the section of the Karasu-1 irrigation system. Eastern Altai, the Chulyshman River valley.
a – canals; *b* – accumulations of stones; *c* – arable land of the 20th century.

Fig. 5. Wooden trough of the Cheba main canal.

Tenga (Argymaya Canal). On the left bank of the Tenga River (left tributary of the Ursul), the wall of the trench crossing the canal was cleaned. The canal's depth is ca 0.4 m. A discharge is recorded on the lower bank of the canal. At the bottom, there is aninterlayer of dense silted soil (Fig. 6, *3*).

Results

All the irrigation canals studied in the Altai belong to the systems of drift/gravity irrigation. The

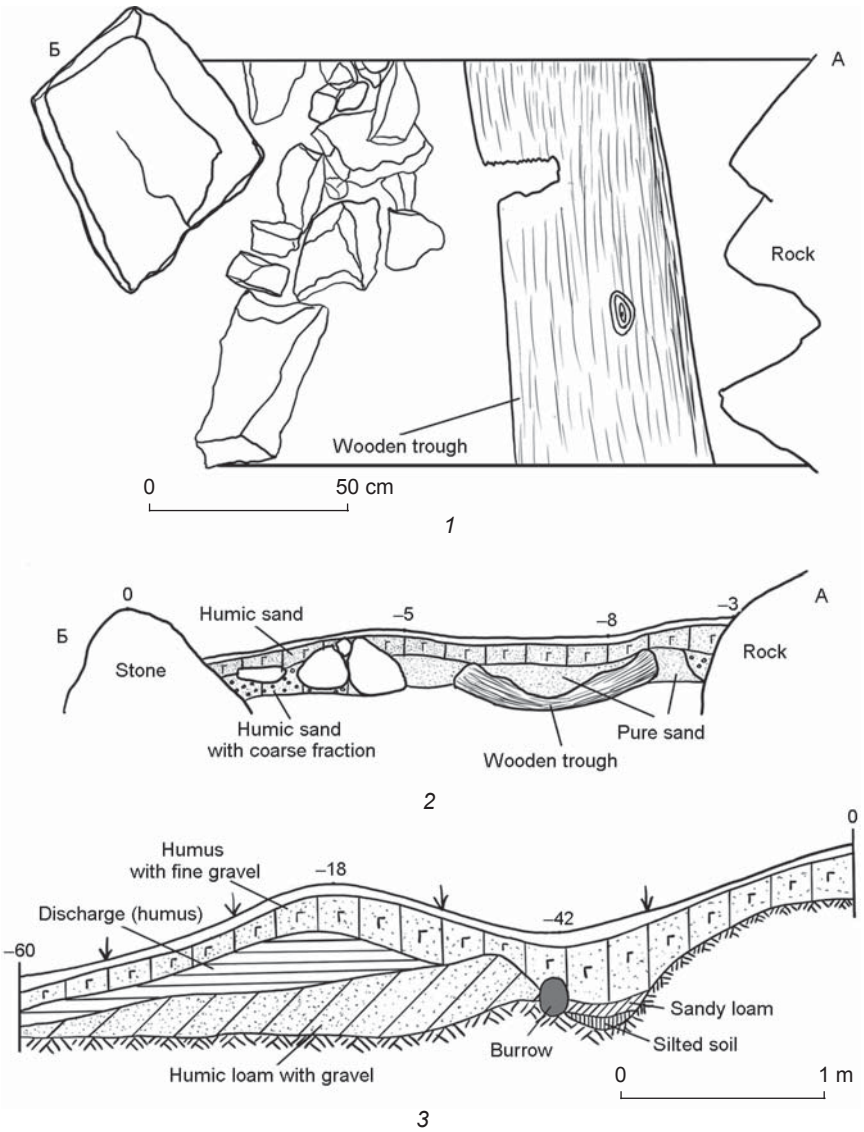

Fig. 6. Plan (*1*) and cross-section (*2*) of the Cheba main canal excavation, cross-section of the Tenga main canal (*3*).

Radiocarbon dates of the main canals in the Altai

Site	Material	Code	Age, BP	Calibrated date (probability)
Cheba	Wood of the trough	SOAN-6618	285 ± 30	16th century (60 %)
Oroktoi	"	SOAN-6619	420 ± 50	15th century to the first third of the 16th century (69.8 %)
Tenga	Sediments of soil from the bottom of the canal	SOAN-6620	1340 ± 100	6–9 centuries (95.4 %)
	Soil of the ancient buried surface from the outer side of the canal	SOAN-6621	2395 ± 65	761–384 BC (95.4 %)

efficiency of such canals is provided by the natural slope of mountains and river valley bottoms.

The most difficult issue is to determine the time of construction of the canals. In mountainous terrain, the main canals were usually laid only once. These passed at the optimum level and could be used repeatedly. In Soviet times, such canals were rebuilt, often with the use of concrete and metal structures.

The results of radiocarbon dating attribute the wooden troughs from the Cheba and Oroktoi canals to the Late Middle Ages (see *Table*). These dates correspond to the last stage of the canals' use. However, the dating of the initial stage of their construction and use still remains open. According to radiocarbon analysis data, the silty soil from the bottom of the Tenga canal belongs to the Early Middle Ages.

The use of irrigation canals by the local population for watering the crops is confirmed by direct reports from researchers in the 19th century (Vdovina, 2004: 116). Settlements and other utility sites of the Altai are poorly studied, but there is a lot of evidence of agriculture in the Altai from antiquity and the Middle Ages.

Such materials include millet grains found in mound 1 at the Tuektacemetery (Scythian time) (Rudenko, 1960: 200). In Denisova Cave, an accumulation of wheat (about 15 kg) was found, dating back to the last centuries of the 1st millennium BC (Derevianko, Molodin, 1994: 26, 105; Orlova, 1994: 202). During paleobotanical study, a large number of cereal-type starch grains were revealed in soil samples from the cultural layer of the medieval settlement of Kozholyu-1. Pollen from cultivated cereals was not found, probably owing to its low concentration in general.The presence of starch grains in soil samples is not considered reliable evidence of agriculture, since the conditions for their preservation and distribution in various types of sediments are poorly understood (Haslam, 2004; Hutschenreuther et al., 2017). However, a large number of cereal-type starch grains, in combination with other data, may suggest farming practices.

The early medieval moldboards and ploughshares are another evidence of agriculture (Kubarev, 1997; Polosmak, Dyadkov, 2021: 605). At the cemeteries of Kok-Pash (4th–5th centuries AD), Kudyrge (6th–8th centuries AD), and in the upper layer of the Tytkesken-3 settlement (1st millennium AD) (Bobrov, Vasyutin A.S., Vasyutin S.A., 2003: 175, fig. 6, *19*; Gavrilova, 1965: Pl. V, *3*; Kungurov, 1994: Fig. 4, *9*), iron sickles and reaping-knives were found (Fig. 7, *1*). During the study of archaeological sites of the Altai, dating from the Early Scythian time to the Middle Ages, millstones of hand mills (Fig. 7, *2*, *3)* and their blanks were found (Surazakov, Tishkin, 2007: 63–69; Molodin, Borodovsky, 1994; Soenov, Konstantinov, Trifanova, 2018: 51). The sites of various times contained numerous grinding stones (Fig. 7, *5*) (Soenov, 2003; Shulga, 2015: 54–57).

It is believed that mechanical (water) mills appeared in the Altai at the end of the 19th century (Torushev, 2017: 96), with

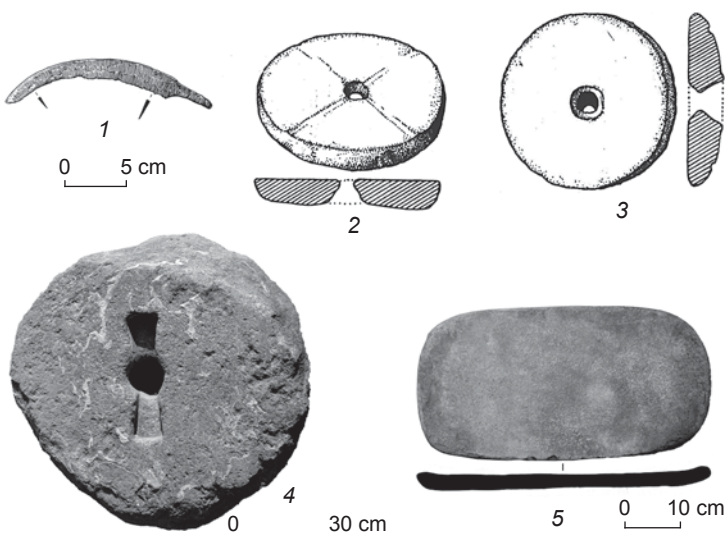

Fig. 7. Agricultural tools.
1 – sickle knife; *2*, *3* – millstones of hand mills; *4* – millstone of mechanical mill; *5* – grinding stone. *1* – Kudyrge cemetery (Gavrilova, 1965: Pl. 5); *2*, *3* – Kurai VI cemetery (Evtyukhova, Kiselev, 1941: Fig. 21); *4* – Karasu River (Chulyshman valley); *5* – Kozholyu-1 settlement.

the arrival or under the influence of Russian settlers. However, in 1880, N.M. Yadrintsev discovered in the Chulyshman valley the abandoned large millstones of a mechanical mill, obviously belonging to an earlier period (1883: 192). In 2020, we examined probably one of these millstones stored in the same place at a livestock camp (Fig. 7, *4*).

Discussion

Sites of ancient and medieval irrigation are known both in the territories adjacent to the Altai and in the more distant ones. The remains of irrigation systems are often found in Southern Siberia. Canals in Khakassia, similar in structure to those in the Altai, also belong to the gravityirrigation system. Researchers associate them with the Tagar time (Kiselev, 1949: 149, 322; Levasheva, 1965; Sunchugashev, 1973; and others). Irrigation canals are also well known in Tuva (Rodevich, 1912: 17–18; Grumm-Grzhimailo, 1926: 356). The results of studying the Tuva irrigation systems are given in summarizing works (Prudnikova, 2005, 2018; Ashak-ool, 2005).

Recently, the irrigation canals of Xinjiang have been explored, the dates of which correspond to the Early Iron Age—the Han Period. The emergence of irrigation traditions in this area, according to scholars, was the result of Western influence or of the local development of the integrated farming culture (Li et al., 2017: 31, tab. 1).

The most important region, which may be associated with the spread of irrigation traditions in Southern Siberia, is Central Asia (Tolstov, 1962; Andrianov, 1969). In this area, with ancient agricultural culture, different methods of irrigation were used. Notably, even in Soviet times, when studying the irrigation sites of the region, special attention was paid to aerial photography (Igonin, 1968), which is still used today (Galieva, 2007). This method greatly facilitates the process of studying the complexes occupying large areas.

In view of the poor knowledge of the paleo-economics of the Altai, the question of the period in which agriculture appeared here remains open. Archaeological sources indicate that agriculture in the Altai was quite well developed already in the Early Iron Age, and flourished in the Middle Ages (Soenov, 2003: 171–172). Taking into account the arid climate of this territory, it can be assumed that the need to create irrigation canals arose along with the emergence of agriculture (Ibid.: 171).

The results of a paleo-botanical study of the soil in the Kurai basin in 1935, where there was a large irrigation system, led S.V. Kiselev to the conclusion "that the Tötö steppe was plowed and seeded in ancient times" (1949: 277). On the basis of stratigraphic observations, the researcher attributed the canals in this area to the Early Middle Ages (Ibid.: 288).

According to the data recorded by researchers and travelers in the 19th to early 20th centuries, canals in the valleys of the Chulyshman, Chuya, Katun and their tributaries were built to irrigate cultivated areas. One of the earliest reports is that of A.A. Bunge about the irrigated plots of barley, rye, and wheat in the central Altai, which he saw in 1826 (Ledebur, Bunge, Meyer, 1993: 204). Later sources also contain numerous references to the agriculture of the Altaians. Ethnographic observations, including modern ones, showed that canals were also used for irrigation of haylands; these were laid most often in floodplain zones. Such canals were usually shallow, short in length and simple in design.

All the canals, as noted, belonged to the drift/gravity irrigation method, effective in mountainous terrain. S.P. Shvetsov divided the irrigation systems of the Altai into two groups, similar in operation (1900: 280–281). The locals showed him the elaborate irrigation systems built by the "Chinese", and the simple canals that the locals believed had been dug by the more "ancient people".The researcher wrote that the former represented a regular and more complex network (these were the canals in the interfluve of the right tributaries of the Chuya-Bilgebash and Sarduma rivers). Irrigation systems called "more ancient" consisted of one or two ditches.

Complex systems include such irrigation objects as Bilgebash-Sarduma (Chuya valley), Karasu-Chulcha (Chulyshman valley), and Tötö (Kurai basin), as well as some irrigation systems in the central Altai. These were apparently large agricultural centers. This assumption is supported by the large millstones found near one of these systems at the Karasu River, in the Chulyshman valley.

The complex irrigation systems mentioned above may have been created centrally by one of the medieval states. However, until a series of dates is obtained, it is not possible to establish which state formation was associated with the construction of canals.

Conclusions

Irrigation systems are widespread in the Altai Mountains. As shown by the 19th century ethnographic sources, the canals were used mainly for watering cultivated areas with grain crops. To a lesser extent, they served to irrigate haylands.

Archaeological materials indicate that the Altai population has practiced agriculture since at least the Early Scythian times. However, it is still difficult to understand what the level of development of this economic activity in different historical periods was. It is also not clear whether irrigation was used in the early days of agriculture. According to ethnographic observations, even small plots, cultivated by hoeing, were irrigated with water coming through long canals (Ledebour, Bunge,

Mayer, 1993: 204). Owing to the low precipitation, high water permeability, and low moisture capacity of soils in the areas suitable for cultivation and sowing, irrigated agriculture was the only onethat could be practiced in the Altai (Soenov, 2003: 171). Possibly, the earliest and the simplest irrigation systems of the Altai were created by the first farmers.

In the Early Middle Ages, agriculture flourished in the Altai, as evidenced by such finds as plows and hand mills, as well as traces of agriculture at the Kozholyu-1 settlement and the construction of irrigation system in Tötö, Kurai basin. It is likely that the construction of other complex irrigation systems was associated with this period.

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References

Andrianov B.V. 1969
Drevniye orositelniye sistemy Priaralya (v svyazi s istoriyey vozniknoveniya i razvitiya oroshayemogo zemledeliya). Moscow: Nauka.

Ashak-ool A.C. 2005
Zemledeliye Tuvy s drevneishikh vremen do mongolskogo zavoyevaniya: S kontsa III tysyacheletiya do n.e. po XIV v. n.e.: Cand. Sc. (History) Dissertation. Kyzyl.

Bobrov V.V., Vasyutin A.S., Vasyutin S.A. 2003
Vostochniy Altay v epokhu Velikogo pereseleniya narodov (III–VII veka). Novosibirsk: IAET SO RAN.

Derevianko A.P., Molodin V.I. 1994
Denisova peshchera, pt. I. Novosibirsk: Nauka.

Evtyukhova L.A., Kiselev S.V. 1941
Otchet o rabotakh Sayano-Altaiskoy arkheologicheskoy ekspeditsiy. In *Trudy GIM*. Moscow: Izd. GIM, pp. 75–117.

Galieva Z.S. 2007
Aerometody v rekonstruktsii evolyutsii istoricheskikh landshaftov Vostochnogo Priaralya. *Arkheologiya i geoinformatika*, iss. 4. URL: https://www.archaeolog.ru/media/periodicals/agis/AGIS-4/Galieva/page1.html

Gavrilova A.A. 1965
Mogilnik Kuderge kak istochnik po istorii altaiskikh plemen. Moscow, Leningrad: Nauka.

Grumm-Grzhimailo G.E. 1926
Zapadnaya Mongoliya i Uryankhaiskiy kray. Vol. 2: Istoricheskiy ocherk etikh stran v svyazi s istoriyey Sredney Azii. Leningrad: Izd. Ucheniy komitet Mongolskoy Narodnoy Respubliki.

Haslam M. 2004
The decomposition of starch grains in soils: Implications for archaeological residue analysis. *Journal of Archaeological Science*, iss. 31: 1715–1734.

Hutschenreuther A., Watzke J., Schmidt S., Büdel T., Henry A.G. 2017
Archaeological implications of the digestion of starches by soil bacteria: Interaction among starches leads to differential preservation. *Journal of Archaeological Science: Reports*, iss. 15: 95–108.

Igonin N.I. 1968
Issledovaniye arkheologicheskikh pamyatnikov po materialam krupnomasshtabnoy aerofotosyemki. In *Istoriya, arkheologiya i etnografiya Sredney Azii*. Moscow: Nauka, pp. 257–267.

Kiselev S.V. 1949
Drevnyaya istoriya Yuzhnoy Sibiri. Moscow, Leningrad: Izd. AN SSSR.

Kubarev G.V. 1997
O zemledelii na Altaye v drevnetyurkskuyu epokhu. In *Izvestiya Laboratorii arkheologii*, No. 2. Gorno-Altaisk: Gorno-Alt. Gos. Univ., pp. 154–157.

Kungurov A.L. 1994
Verkhniye kulturniye sloi poseleniya Tytkesken-3. In *Arkheologiya Gornogo Altaya*. Barnaul: Alt. Gos. Univ., pp. 43–58.

Ledebur K.F., Bunge A.A., Meier K.A. 1993
Puteshestviye po altaiskim goram i Dzhungarskoy Kirgizskoy stepi. Novosibirsk: Nauka.

Levasheva V.P. 1965
Ostatki drevney orositelnoy sistemy v doline r. Abakana. In *Novoye v sovetskoy arkheologii*. Moscow: Nauka, pp. 242–244. (MIA; No. 130).

Li Y., Storozum M., Wang X., Guo W. 2017
Early irrigation and agropastoralism at Mohuchahangoukou (MGK), Xinjiang, China. *Archaeological Research in Asia*, vol. 12: 23–32.

Marinin A.M., Samoylova G.S. 1987
Fizicheskaya geografiya Gornogo Altaya. Barnaul: Barnaul. Gos. Ped. Inst.

Molodin V.I., Borodovsky A.P. 1994
Kamenniye ruchniye zhernova v drevney pogrebalnoy obryadnosti Zapadnoy Sibiri. *Altaica*, No. 4: 72–79.

Orlova L.A. 1994
Radiouglerodnoye datirovaniye peshchery Denisova. In *Derevianko A.P., Molodin V.I.* Denisova peshchera, pt. I. Novosibirsk: Nauka, pp. 202–207.

Polosmak N.V., Dyadkov P.G. 2021
Arkheologicheskiye issledovaniya Katandinskoy doliny. In *Problemy arkheologii, etnografii, antropologii Sibiri i sopredelnykh territoriy*, vol. XXVII. Novosibirsk: Izd. IAET SO RAN, pp. 600–607.

Prudnikova T.N. 2005
Prirodniye zakonomernosti razvitiya oroshayemogo zemledeliya v drevney Tuve: Cand. Sc. (Geography) Dissertation. Krasnoyarsk.

Prudnikova T.N. 2018
On ancient agriculture in arid regions of Central Asia: The case of the Uvs Nuur basin. *Archaeology, Ethnology and Anthropology of Eurasia*, vol. 46 (1): 66–75.

Radlov V.V. 1989
Iz Sibiri: Stranitsy dnevnika, K.D. Tsivina, B.E. Chistova (trans. from German). Moscow: Nauka.

Rodevich V.M. 1912
Uryankhaiskiy kray i yego obitateli. St. Petersburg: [Tip. M.M. Stasyulevicha].

Rudenko S.I. 1960
Kultura naseleniya Tsentralnogo Altaya v skifskoye vremya. Moscow, Leningrad: Nauka.

Shulga P.I. 2015
Skotovody Gornogo Altaya v skifskoye vremya (po materialam poseleniy). Novosibirsk: RIC NGU.

Shvetsov S.P. 1900
Gorniy Altay i yego naseleniye, vol. I. Iss.: Kochevniki Biyskogo uyezda. Barnaul: Gl. Upr. Alt. okr.

Smirnov V.V., Akimova T.A. 2014
Opyt primeneniya malykh bespilotnykh apparatov v arkheologicheskikh tselyakh. *Izvestiya Altaiskogo otdeleniya Russkogo geograficheskogo obshchestva*, No. 35: 114–117.

Soenov V.I. 2003
Zemledeliye na Altaye v drevnosti i srednevekovye. In *Istoricheskiy opyt khozyaistvennogo i kulturnogo osvoyeniya Zapadnoy Sibiri*. Barnaul: Alt. Gos. Univ., pp. 169–172.

Soenov V.I., Konstantinov N.A., Trifanova S.V. 2018
Mogilnik Stepushka-2 v Tsentralnom Altaye. Gorno-Altaisk: Gorno-Alt. Gos. Univ.

Sunchugashev Y.I. 1973
Iz istorii oroshayemogo zemledeliya v Khakassii. *Sovetskaya arkheologiya*, No. 3: 238–239.

Surazakov A.S. 2003
Otchet po ekspeditsii na Chulyshman v avguste 2000 g. In *Arkheologiya i etnografiya Altaya*, iss. 1. Gorno-Altaisk: Inst. altaistiki im. S.S. Surazakova, pp. 90–98.

Surazakov A.S., Tishkin A.A. 2007
Arkheologicheskiy kompleks Kyzyk-Telan I v Gornom Altaye i rezultaty yego izucheniya. Barnaul: Azbuka.

Tolstov S.P. 1962
Po drevnim deltam Oksa i Yaksarta. Moscow: Izd. vost. lit.

Torushev E.G. 2017
Traditsionnoye zemledeliye altaitsev (XIX – pervaya tret XX v.). Gorno-Altaisk: Izd. Poligrafika.

Vdovina T.A. 2004
Izucheniye orositelnykh system Gornogo Altaya v 2003 godu. In *Arkheologiya i etnografiya Altaya*, iss. 2. Gorno-Altaisk: Inst. altaistiki im. S.S. Surazakova, pp. 116–131.

Vdovina T.A. 2005
Orositelniye sistemy Chemalskogo rayona. In *Izucheniye istoriko-kulturnogo naslediya narodov Yuzhnoy Sibiri*, iss. 1. Gorno-Altaisk: Agentstvo po istoriko-kulturomu naslediyu Respubliki Altai, pp. 174–178.

Vdovina T.A. 2007a
Metodicheskiye aspekty arkheologicheskogo izucheniya ostatkov irrigatsionnykh sooruzheniy Gornogo Altaya. In *Izucheniye istoriko-kulturnogo naslediya narodov Yuzhnoy Sibiri*, iss. 5. Gorno-Altaisk: Agentstvo po istoriko-kulturnomy naslediyu Respubliki Altai, pp. 144–153.

Vdovina T.A. 2007b
Obsledovaniye ostankov irrigatsionnykh system Gornogo Altaya v 2006 g. In *Poleviye issledovaniya v Verkhnem Priobye i na Altaye. 2006 g. Arkheologiya, etnografiya, ustnaya istoriya*. Barnaul: Barnaul. Gos. Ped. Univ., pp. 62–65.

Vdovina T.A., Trifanova S.V. 2003
Obsledovaniye orositelnykh system Gornogo Altaya v 2003 godu (predvaritelniye itogi). In *Gorniy Altai: Istoriya, sovremennost, perspektivy*. Gorno-Altaisk: Gorno-Alt. Gos. Univ., pp. 239–243.

Yadrintsev N.M. 1883
Opisaniye sibirskikh kurganov i drevnostey. In *Trudy Mosk. arkheol. obshchestva*, vol. 9 (2/3). Moscow: pp. 181–205.

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