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Use of geophysical methods for research of urban development and necropolis of the ancient city Kesken Kuyuk kala

Results of georadar scanning of the oguz ancient city Kesken Kuyuk kala IX-XII cc. and its necropolis — Kesken 1 are given in article. Use of geophysics researches in archaeological works gives possibility to receive information on object of research before the excavation works during which they can be lost. Analytical data processing was carried out with use of results of decoding of aero photos, and the supervision received during excavation of the ancient city. Result of works on Kesken Kuyuk kala ancient city was identification subsurface structures of the rooms which are the remains of walls, streets. On a necropolis Kesken 1 the remains of three funeral designs are revealed.

Key words: Kesken Kuyuk kala, necropolis Kesken 1, medieval archeology, oguz cities, geophysical methods in archeology, urban development.

Archaeological works of the last years allowed to characterize original city culture of the oguz tribes of East Aral which left a considerable trace in the history of Kazakhstan and Central Asia. Under the certificate of the Arab sources oguz tribes in the end of the IX-X centuries created own state and subsequently took part in formation of the modern Turkic people [1; 314–322]. From sources we know of existence of the oguz cities from which the old and new capitals — Dzhuvara (Huvara) and Yangikent (Dikh-i Nau) are identified now with ancient city Kesken Kuyuk kala and Dzhankent [2; 26–28].

The ancient city Kesken Kuyuk kala was discovered and surveyed by S.P.Tolstov in 1946, but large-scale archaeological works on a monument began only in the middle of the 2000 efforts of «Archaeological expertise» LLC (Almaty, the Republic of Kazakhstan) and «Societies of studying of Eurasia» (Hergisvil, Switzerland) [3, 57–71]. During the carried-out works considerable materials the characterizing economy, life, material and spiritual culture of the oguz tribes were saved up [2; 29–43, 4; 110–117].

Use of modern methods of documenting of the archaeological objects which allowed to receive more exact information became important advantage of the conducted researches and also considerably to simplify procedure of research and to lower labor costs. Application of a method of rectification of photos with use of total station and high-precision GPS receivers was allowed to record, with an accuracy of 1 mm revealed during excavation of a structures and layers. Topographical plan of the ancient city was made.

The results of research works are the database of the geo-information system (GIS) of the ancient city of Kesken Kuyuk kala made on the basis of data of remote sensing: the aero and satellite images and also the old topographic maps.

Use of contactless, nondestructive technologies — georadar sounding of buried structures became other direction. Remote researching of archaeological structures very important because during excavation some archaeological objects can be irrevocably lost, and the geophysics allows to receive information on object of research before archeological excavations [5; 92].

Results of the geoscanning which is carried out in 2014 on the ancient city Kesken Kuyuk kala and necropolis Kesken 1 are reflected in the this work.

Kesken Kuyuk kala ancient city is located on the left coast dried up deltoid channels in the Kazalinsk region of Kyzylorda area. This ancient city of roundish outlines, the sizes of 830x710 m stretched from the East to the west. Perimeter the ancient settlement is surrounded with the wall which turned into the shaft reaching in height of 2 m. In topography it is allocated square in the plan shahristan, the sizes of 220x220 m towering over the general level of ancient city on 3 meters. On its surface «the street network» and districts are traced. In a south-west corner of a shahristan there is a subsquare citadel of 60x60 m in the plan [2; 32]. The date of the ancient city IX–XII centuries.

From the south and the south-east the ancient settlement is adjoined by strongly dispelled necropolis. Kurgan hills remained on insignificant height and are badly recognized on a surface, but are well recognized on aero photos.

Operating Principle

Ground penetrating radar was designed for identification of subsurface structural-material inhomogenuities of different origin related to unequal watering of soil deposits, different composition of the soil, particularities of rock structures and textures (soil openness and banding), inhomogenuity of soil deposits and materials, jointing and deformity of the soil environment, and inclusion of foreign objects [5; 93].

Usage of ground penetrating method of shallow geophysics also known as subsurface radiolocation or radar probing is the representation of highly-accurate electromagnetic signal from the border of the section in the upper part of the cut — from the stratigraphic border, levels of water saturation, outlines of studied objects, foundations etc [6; 149].

Interpretation of ground penetrating data is a quiet complicated creative task due to the fact that the theoretical part of the method realization and mathematic device used for data interpretation are underdeveloped. Moreover many studied territories with radar-location method represented by industrial cuts of quaternary deposits, cultural layers, underground engineering constructions, archaeological sites and other areas that can be characterized by complicated and unhomogeneous structure, inclusion of different inhomogenuities, unhomogeneous and noncontinuous watering that creates complicated wavy pictures on the radiogram and aggravates comparison of geophysical anomalies with real subsurface sites [5; 93].

As the result, the aim of the interpretation of radar data is the radiogram transformation into stratigraphic deposit cuts, identification and separation of natural and industrial buried inhomogenuities, their comparison with real sites and identification of their parameters (depth, size, conservation status etc.).

Ground penetrating radar GSSI SIR-3000 with antenna frequency of 270 Mmhz that permits to scan on the depth of 5 meters was used during the geomagnetic scanning process.

The aim of the research works was the geomagnetic scanning of the district's housing system on the territory of the settlement's 'shakhristan' and one kurgan for identification of buried archaeological sites.

Research works with the ground penetrating radar were made on the territory of 4 different sites with the total surface of 3600 m².

Disposition of Sites (fig. 1)

Figure 1. Scheme of geo scanning

Sites 1, 2 and 3 adjoin each other and form one bigger site with the total square of 2400 m². This site is situated on the north of the excavation site of 2009–2014. Modern dirt road is situated in the northern part of the site along the ancient inter-district street. The hummocky surface of this area is covered with holes, which was complicating the scanning process. Constructions on this territory were partially visible from satellite photos (fig. 2).

Forth site is situated on the territory of the burial ground situated on the south of the settlement. Scanned area covers 1200 m². The even surface of the site was covered with few brush woods. The kurgan was slightly visible from the topographical point of view; the height of the kurgan is about 0.3 m.

Figure 2. The territory of geo scanning with results of decoding of aero photos

The geomagnetic scanning was realized on the depth of 75 ns (2 meters) on the territory of the site № 1, which had 30 x 60 m in size.

Few anomalies of average density were identified on the depth of 0,63 m. A hollow was identified in the northern part of the site that covers the inter-district street. Few anomalies of high density were identified up to the south; it might be the beginning of the district's housing system. One premise of square form also visible on satellite image was identified in the southern part of the site on the depth of 0, 21 m. No anomalies were identified on the rest of the site (ill. 3).

The geomagnetic scanning was realized on the depth of 75 ns (2 meters) on the territory of the site № 2, which had 30 x 60 m in size. From the east this site adjoins the site № 1.

Section of the inter-district street was identified in the northern part of the site. Few anomalies of high density that belong to the district's housing system were identified up to the north; they were also visible on the satellite image. Constructions with the width of 3–4 cm in the southern part of the site stand along the street and go beyond the site area. The extension of constructions found on the territory of the site № 1 was identified in the southern part of the site. Two premises situated on the axis from the north to the south can be identified on the plan. Southern premise has the size of 9 x 7 m, northern premise was badly visible, and there is a certain structure inside the premise. An anomaly of high density of 8 x 3 m in size was visible up to the south-east of the southern premise; it might be the extension of the housing system. Two spots of high density that follow in eastern direction up to the area of the site № 3 were visible in the eastern part of the site. No important anomalies were identified in the southern part of the site; it proves the absence of any construction (ill. 3).

The geomagnetic scanning was realized on the depth of 75 ns (2 meters) on the territory of the site № 3, which had 28 x 40 m in size. This site adjoins the site № 2 from the east.

Anomalies that represent two constructions that adjoins each other were identified in the north-western corner on the depth of 0, 63 m. Western construction of 13 x 9 m in size consists of two premises that stands on the axis from the north to the south; northern part of this construction is more visible. Second construction adjoins the first one from the east. It consists of the wall that stands on the axis from the north to the south and three adjoined walls that stand on the axis from the west to the east. This construction became visible on the depth of 0, 42 m. A few square constructions that form a premise 6 x 6 m in size and a wall that adjoin to its south-eastern corner stand on the axis from the west to the east were identified up to the south-east.

Two anomalies that continue anomalies on the site № 2 were identified along the western border of the site. These anomalies have a round form. Northern and southern spots have 5 and 6 m in size. Anomalies of 2, 6 m in width were identified along the southern border of the site; their origin might be related to augmentation of soil moisture (fig. 3).

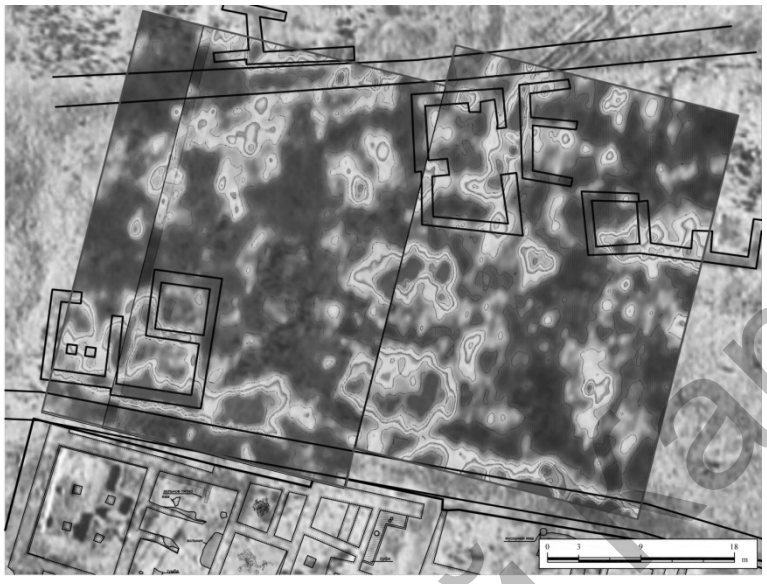

Figure3. The plan of the revealed structures with results of decoding of aero photos

The geomagnetic scanning was realized on the depth of 75 ns (2 meters) on the territory of the site № 4, which had 30 x 40 m in size. The site is situated up to the south of the settlement on the territory of the burial site.

Contour of the kurgan of oval form and 19 x 11 m in size was identified as the result of scanning process in the western part of the site. There are a few anomalies in northern and eastern parts of the site that resemble to sections of kurgan circles that go beyond the site area. On the western part of the site only the kurgan itself was visible (fig. 4).

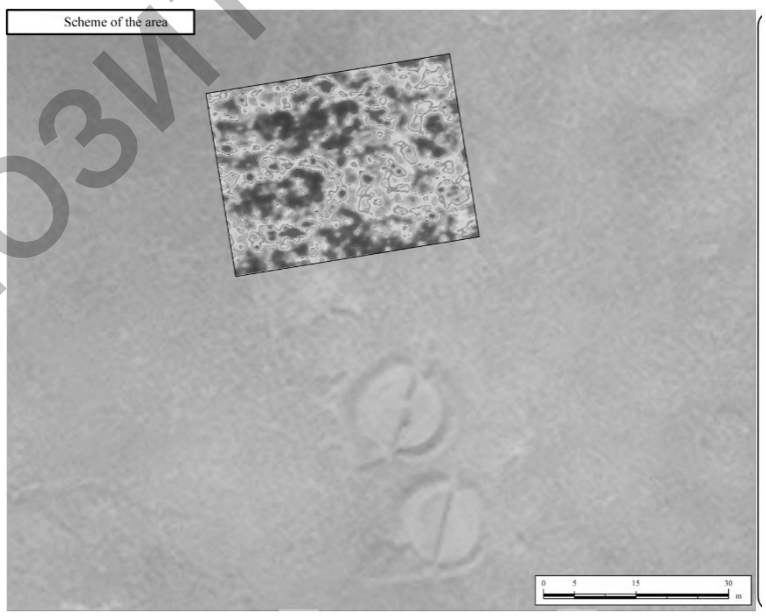

Figure 4. The plan of the revealed structures on a necropolis Kesken

Identification of subsurface structures was the main task during the site scanning process. Total scanned surface covers 3600 m² and goes up to 2, 5 m in dept.

The fragment of the inter-district street was identified as the result of the analysis of scanned data from the northern part of sites 1–3. Anomalies identified up to the north and the south from the street proves the presence of adjoined constructions. Contours of three premises that form a part of district's housing system were identified in the south-western part of the site. The line of an inter-district street is visible up to the south of these constructions. Contours of five premises that form a part of district's housing system were identified on the north-eastern part of the site. Anomalies of round form were identified in the central part of the site.

Contour of one kurgan and contours of two other kurgans that go beyond the scanned territory were identified as the result of the scanning process on the territory of the burial site.

Realization of additional research works during the period of minimal moistness can be recommended.

World experience of ground penetrating researches is shown by advantage of carrying out repeated researches, seasonally and according to humidity of soil (Коробов 148). Need of these researches is caused by working off of methods of ground penetrating researches that will allow to get high quality of archaeological interpretation of geophysical data.

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Кескен Күйікқала қалашығынның қорымы мен қалалық құрылысын геофизикалық әдістерді қолдану арқылы зерттеу

Мақалада IX–XII ғғ. оғыздардың Кескен Күйікқала қалашығын және Кескен–1 қорымын георадарлы сканерден өткізудің нәтижесі келтірілген. Геофизиканы археологиялық жұмыстар кезінде қолдану зерттелініп отырған нысанға қазба жұмысына дейінгі жоғалып кету қаупі бар мағлұлатты сақтап қалуға мүмкіндік береді. Аналитикалық деректерді өңдеу қазба барысында алынған аэросуреттердің нәтижесін пайдалану арқылы жүзеге асырылды. Жұмыс нәтижесі бойынша Кескен Күйікқала қалашығының жер бетіндегі құрылымы қалашықтың сақталып қалған құрылыс қабырғалары, көшелері екені белгілі болды. Кескен–1 қорымында үш жерлеу құрылысының қалдықтары анықталды.

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Использование геофизических методов для исследования городской застройки и некрополя городища Кескен Куюк-кала

В статье приводятся итоги георадарного сканирования огузского городища Кескен Куюккала IX–XII вв. и его некрополя — Кескен 1. Использование геофизики в археологических работах дает возможность получить информацию об объекте исследования до начала раскопочных работ, в ходе которых они могут быть утеряны. Аналитическая обработка данных проводилась с использованием результатов дешифровки аэрофотографий и наблюдений, полученных в ходе раскопок городища. Итогом работ стало выявление на городище Кескен Куюккала подповерхностных структур, являющихся остатками помещений, стен, улиц. На некрополе Кескен 1 выявлены остатки трех погребальных конструкций.

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