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METHOD OF GEORADIOLOCATION IN COMPLEX SCIENTIFIC APPLIED RESEARCHES

Abstract. In this articleare presented results of geophysical studies condition of low-pressure dams wastewater reservoir «Sorbulak», ponds and reservoirs right discharge channel «Sorbulak». For production survey used of a multi-purpose radar "Oko-2" (manufactured by LLC "Logis" of the RF) with field computer type "notebook". GPR sensing results were treated by the processing system «Geoscan 32». The results conductedof geophysical studies show that the application of the georadiolocation method as part of a complex scientifically applied research allows one to unambiguously solve problems in determining: lithological section of the study site, both from the water surface and from the surface of the earth; zones of moisture saturation; zones of soil decompaction; sections of soils with broken structure; depth and relief bottom of water bodies; depth of underground communications.In comprehensive overview analysis of the results engineering surveys, GRL-sensing unambiguously shows the ways of concentrated and directed filtration, spatial position and size of landslide bodies, level of groundwater within the depths of the study.

Keywords: method of georadiolocation, georadar, geophysical research, GRL-sensing, applied research.

To date, thanks to the use of one of the unique and modern geophysical instruments - georadar, which provides the opportunity to work, so-called, environmentally non-destructive method of subsoil research in various structures [1] successfully solved a wide range of tasks, laid down in the principle of its operation. GPR method is based on the study of reflection artificially generated electromagnetic impulses from the boundaries of media having different electrical properties - dielectric permittivity and electrical conductivity. The frequency of the electromagnetic field used in the GPR is typically in the range 10^7-10^9 Hz. These frequencies are considerably higher than frequencies used in electromagnetic geophysical classical methods, which allows increase much detail studies, but limits the depth method. The attenuation of the electromagnetic field depends, first of all, on the frequency and electrical conductivity of the medium in which this field propagates. The lower the frequency and the lower the electrical conductivity, the more electromagnetic pulses penetrate into the medium [2].

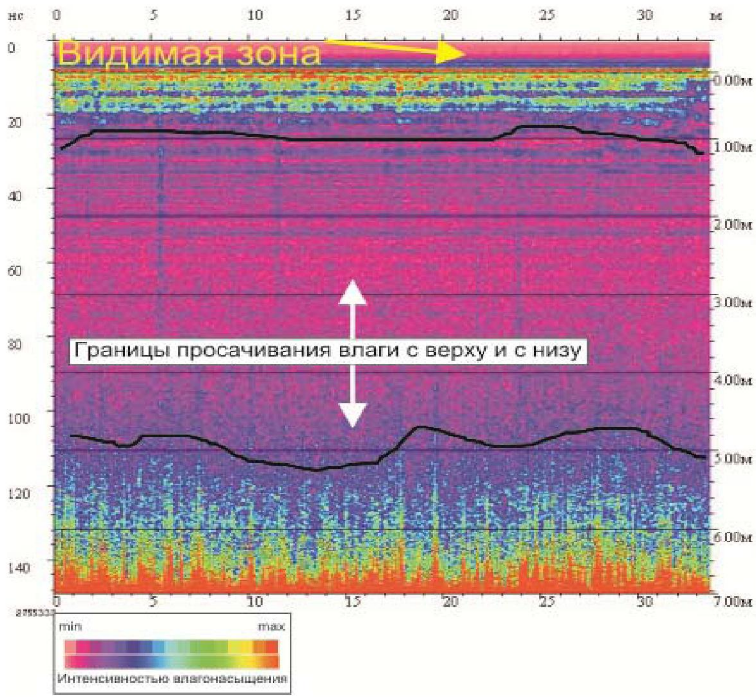
Since 2012, Institute of Hydrogeology and Geoecology, in the process of carrying out scientific, applied and engineering-technical complex studies uses the method of GRL sounding [3].

In the second half of 2012 and in 2013, geophysical studies were carried out on the condition of low-pressure dams «Sorbulak» wastewater reservoir and the ponds and reservoirs of the right discharge channel «Sorbulak». The method of carrying out the work was determined by the technical specification [4] of the hydrotechnical and geomorphological conditions objects research. For production of research, artists used a multi-purpose radar "Oko-2" (manufactured by OC "Logis" of the RF) field computer type "notebook". Processing of the results of georadar sounding sounding was carried out with the help of the processing system "Geoscan 32" [5].

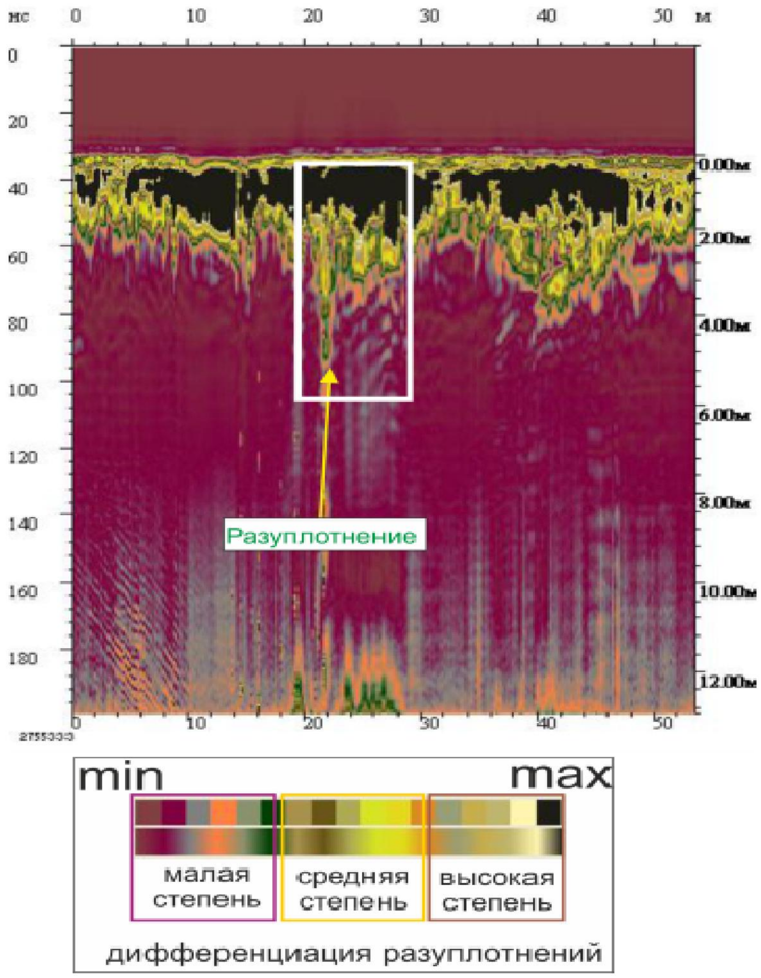
Following the reconnaissance surveys was decided to conduct GRL-sensing in the system of the two longitudinal profiles, one of which is located on the boundary of the dam crest and adjoining upstream slope and second longitudinal profile is located at the border ridge and the adjacent downstream slope. Longitudinal profiles supplemented dam system of transverse profiles that match the piezometric target.An example of the arrangement of geophysical profiles is shown in picture 1. GPR surveys were used for the following tasks (picture 2, 3):

– lithological dissection of the section;
– determination of the boundaries of moisture saturated soils;
– assessment of soil filtration properties;
– determination of groundwater level;
– suffocation changes;
– definition of zones of directed and concentrated filtration;
– distance between pickets is standard, equal to 100 meters.

Picture 1 – Schematic layout of geophysical profiles on the 1st dam wastewater reservoir«Sorbulak»



Picture 2 – An example of saturation zones isolation moisture in the dam body 1 according data GRL-sensing



Picture 3 – An example of saturation areas decompaction in the dam body 1 according data GRL-sensing

After processing and isolation of interference waves, the results of sounding were interpreted on the obtained radar patterns.

The research results obtained during GRL-sensing element dams №1 and 2, supplemented system radarogram transverse profiles coincide with the target piezometric showed:

1. Lithology dams № № 1 and 2 has a uniform consolidated character. The zones of soil decomposition and associated flows of concentrated filtration, both on longitudinal and transverse soil profiles, were not detected;

2. On radargrams of the upper horizons of all sections in the depth range from the surface and up to 0,5 m there is a zone of increased moistening, which is due to precipitation precipitated the day before. The layer of precipitation falling in the form of rain in the previous two decades of October amounted to about 15-20 mm.

3. In the lower horizons forming dams №1 and 2, at depths from 4,5 to 5,0 m there is a zone with increased soil moisture, coinciding in most cases with the position of the piezometric curve.

It also indicates the position of the piezometric levels determined synchronously with the geophysical investigations (GRL-probing). The distance between pickets is 100 m.

In the process of scientific and applied research to study and identify the causes of flooding of communal and industrial facilities in the city of Zhanaozen and development of recommendations for localizing negative impact of groundwater discharged in 2015-2016, geophysical work was carried out using the GRL-sensing method to determine actual lithological structure of soils and their engineering-geological characteristics, revealing direction, character of watering and the presence of ways of concentrated filtration [6, 7].

The processing of georadar data was performed in the environment of a specialized licensed software package Geoscan32 (GC LOGIS-GEOTECH, RF, Moscow). In this case, the following processing sequence was applied:

– removing the constant component
– zero offset time
– revision of tracks
– removal of background
– amplitude correction
– vertical filtration
– spatial filtration
– introductionofstaticcorrections.

As a result of the processing of the primary radargrams (picture 6), temporal sections were obtained with the filtered noise waves, which were then geo-geophysical interpreted (picture 8) using drilling data on the site and stock materials [5].

In total, 12 profiles have been passed through the indicated section of visible and hidden flood zones of the railway line in the region KazGasRefinery, mosque in the city of Zhanaozen (~ 3,5 km) (picture 4).

Picture 4 – Scheme location GPR and numberinggeophysical profiles on the area underflooding in the regoin GPP

As a result, interpretation of the processed radargram revealed:

1) a lithological difference consisting of sandy loam and clay marly;

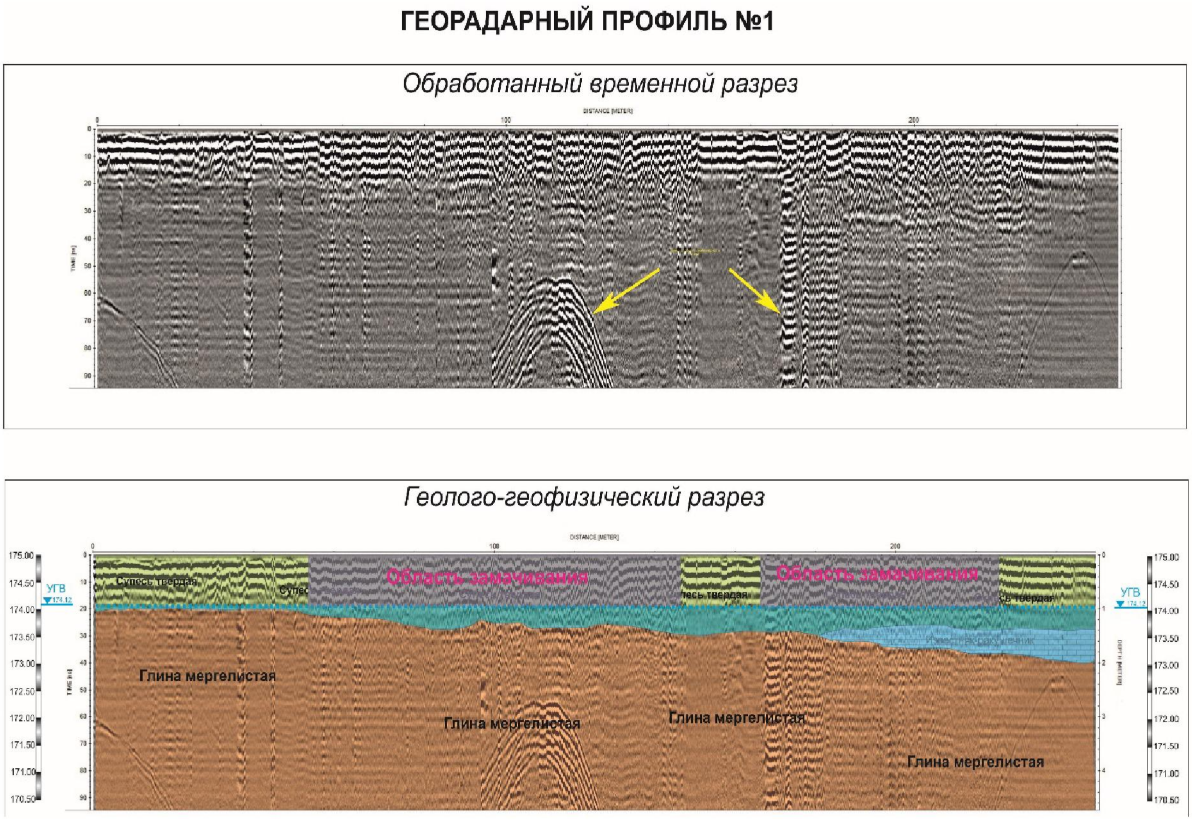
2) The area of soaking, ie the zone of high humidity, is detected in the central part of the section;

3) Zone low humidity detected by the cut edges, which corresponds to the data decoding satellite images and geological boreholes.

4) GL (groundwater level) was detected at the level of 174 m. According to the data of geological wells, GL was detected at the level of 174,12 m.

5) The geophysical section is located at absolute elevations in the range 175.0-176.0 m with an insignificant height difference of about 1,5 m.

As a result of geophysical studies, were obtained wave georadar sections. Based on detailed analysis structure of the joint of the reflected wave field, data on the drilling site, and stock materials previously conducted research in the area performed of geological and geophysical interpretation.



Picture 5 – An example processed GPR profile №1

In the wave pattern is quite clearly distinguished in phase electromagnetic axis of the reflected waves related to lithological boundaries in the thickness of the investigated rock mass, such as boundary "loamy sand-limestone", "limestone-clay" and "sandy loam, clay."

Also on the local features of the wave pattern are distinguished soaking areas in the upper part of the section and the boundary between water-saturated and un watered.

In November 2016, during the execution of project surveys on the topic "Construction of a bridge over the Buhtyrma reservoir in the Kurchum region of the East Kazakhstan area"was carried out GRL-sensing of the bottom of the Buhtyrma reservoir (representing the valley of the Irtysh River). Central morphology, located in the vicinity of the settlement Kuygan according to drilling data, is presented:

A) from the right bank of Middle-Upper-Quaternary sediments, represented by sands of medium size to a depth of 30 m.

B) from the left bank sediments of the Middle-Upper Quaternary age, represented by pebble soils up to a depth of 1,80 m, clays hard with the inclusion of gruss to a depth of 18.50 m, loam semi-hard with inclusions of gruss to a depth of 30 m [8].

GRL technology on the water surface involves the use, as a rule, of low-frequency antennas that are located and moved directly over the water surface using a rod-handle or a cable connected to the antenna and the vessel (picture 6) [9].

GRL works was carried out to perform the scanning bottom of the Irtysh River, to measure the depth and outline bottom of the reservoir at the site of the future bridge crossing over three morphostructures, dividing boundaries surface bedrock (if any) under loose sediments and determining the boundaries between the layers of the identified geological elements with using the radio-engineering device of subsurface sounding (GRL) "Oko-2", with the antenna unit ABDL "Triton" produced by Logic Systems OC (Moscow), in advance chennym profiles on the map [10].

A total of 3 profiles along the entire length (each profile length ~ 1300 m from shore to shore) according to the program of work.

Electrical conductivity of water is a factor limiting possible depth of sounding for the used antenna [11].

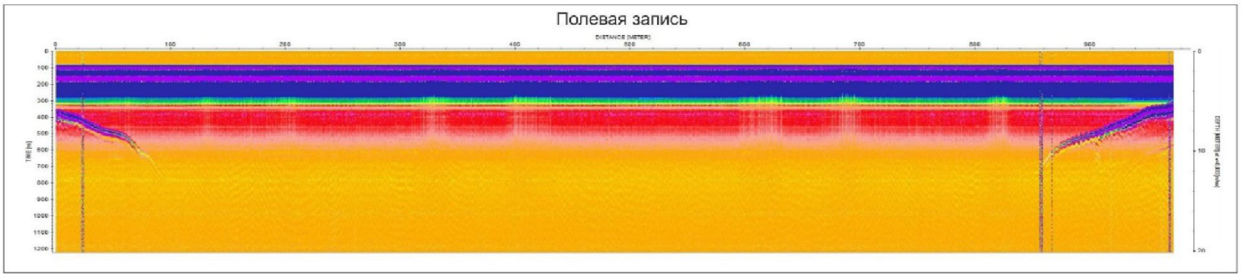
Picture 6 – The antenna unit ABDL «Triton»

Position on the profile and depth monitored by a GPS navigator combined with a GRL and recorded as a file on a secure portable computer such as Panasonic CF-18 (laptop).Profiling was carried out on a 5 local motor boat of the "Silverado" type. The work of the georadar carried out in a continuous mode at frequencies of 50 MHz with the antenna unit ABDL "Triton", placed on the water surface and connected to the boat by cable and rope.

Radar sensing low frequency unit ABDL "Triton" with a center frequency of 50-100 MHz is conducted in a continuous manner along the entire length the study site. Particular emphasis was placed on the central morphorange (picture 7) through which the projected axis of the bridge channel through Buhtyrma reservoir. Using of a low-frequency block gives gain in the overall depth with the loss of the resolving power of the sounding.

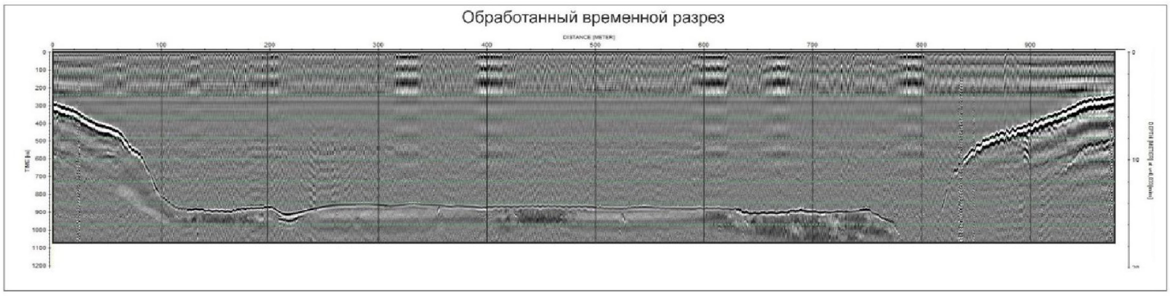
Picture 7 – Scheme location central profile of georadar survey

In pictures 8–10 show field record of the radarogram of the central morphology.



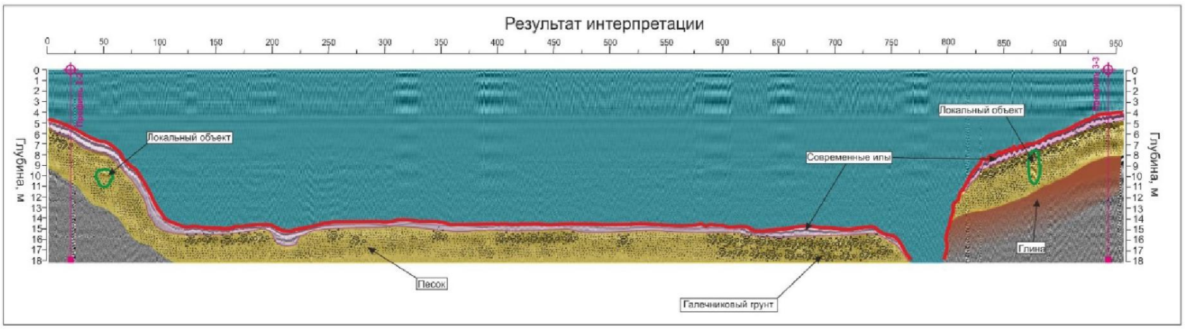
Picture 8 – Field record of the central morpho-stock of the Buhtyrma reservoir, untreated. ABDL "Triton" 50-100 Mhz

Picture 9 showed radar profile of the profile after preliminary processing.



Picture 9 – Radarogram of the site. (I-I profile, central morphology). Time layer. Antenna ABDL "Triton" 50-100 Mhz

Analysis of the radargram shows that the depth of sounding is about 18-20 m. The radargram clearly shows the relief of the bottom of the Buhtyrma reservoirs, as well as the bottom sediments represented by the silt that underlie the sands of medium size with the inclusion of pebbles.



Picture 10 – Result interpretation georadiolocation of the central morphological alignment

Analysis interpreted radarogram shows clearly be seen that the bottom relief with bottom sediments represented, according to the interpretation, modern silt, sand, clay and pebble ground with sand filling.

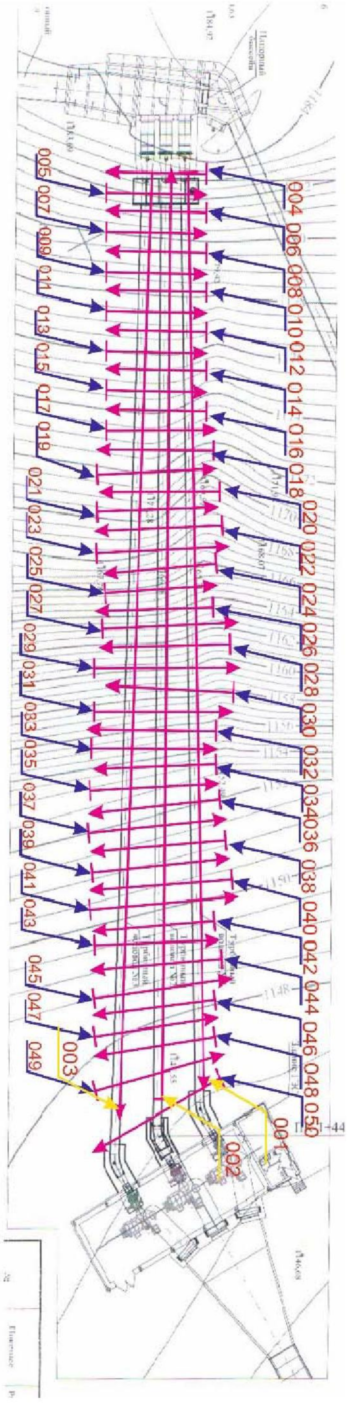
Depths along the entire length of the central morphorange consistent with a data received from the customer taken with a Garmin sounder using GPS satellite navigation system.

In February 2017 conducted geophysical studies applied by GRL-sensing, in the territory of the Upper Baskan GES-1 in Sarkand district of Almaty region.

The research tasks included the definition and localization of anomalous zones of decompression of the backfill site of three turbine water conduits in the regime of continuous operation [3].

The soils of the study area are represented by solid and semisolid grayish-brown loesslike macroporous loams [12].

During the work 3 meridional profiles were traversed, with a step from 2 to 5 meters, 47 latitudinal profiles with a step of 1.5-2 meters (picture 11).



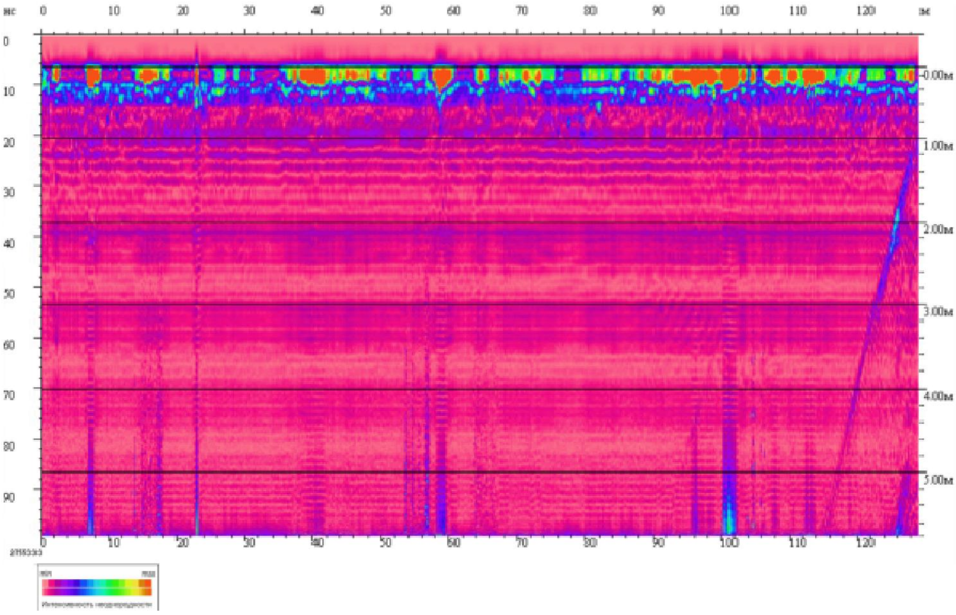
Picture 11 -Scheme of longitudinal and transverse profiles № 001-050

GRL sounding was carried out by the antenna unit AB-400. Interpretation results of the work was carried out in the environment software Geoscan32 (GC LOGIS-GEOTECH, RF, Moscow) (picture 12, 13).

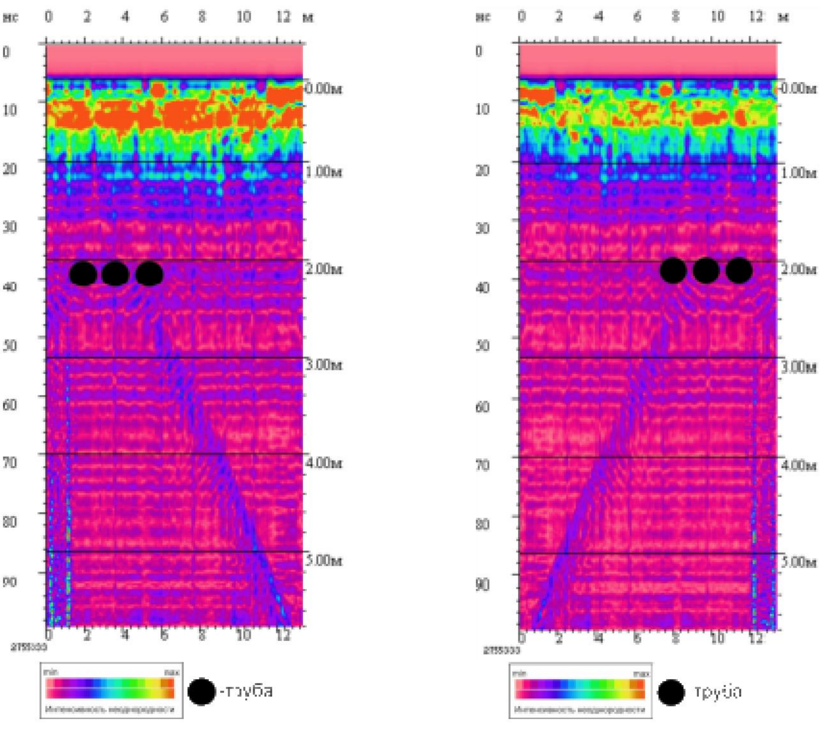
On the georadar profile, inhomogeneities of natural origin are distinguished at a depth of 20-25 cm. The investigated site is stable.

Conclusion to profile 008 and 009: On GRL profile shown anomalous zones with their volume to length and depth. Inhomogeneities were found at a depth of 20-25 cm. Ofnaturalorigin. In the transverse profile, deep anomalies were not recorded across the pipes. The pipes of the Baskan HPP-1 were found at a depth of up to 2 meters. The examined site is stable.

As a result of the interpretation of the obtained data, the following is noted.



Picture 12 – ProcessedlongitudinalGRprofile



Picture 13 – Georadar profile 008 and 009

All the radar patterns of the longitudinal profiles clearly show the upper layer of heterogeneous soils. The thickness of the layer is up to 50 cm. This anomaly is caused by the zone of high humidity and glaciation of the infiltration moisture formed as a result of freezing.

In the lower part of the plot, in a depth interval of 3.5 and more than 6 m, a layer of boulder-pebble is identified.

On all transverse profiles, a sinusoidal signal is reflected from the base of the water conduit pipes. Depth of bedding pipes varies from 2 to 4 m.

Zones of anomalous heterogeneity of soils, associated with anthropogenic or hydrodynamic influences, were not revealed during the sounding.

In May 2017 carried out comprehensive study of the landslide slope located in Medeu district of Almaty.

The order and scope of work were determined by the tasks of the study and by the features of the site of work [6].

In total, 5 longitudinal and 4 transverse profiles were passed, including the accompanying ones (picture 14). GRL-sensingcarried out by the antenna unit AB-400. Interpretation of the results of works was carried out in the environment of the software Geoscan32 (GC LOGIS-GEOTECH, RF, Moscow).

Picture 14 – Scheme location geophysical profiles

By interpreting the results of sensing GRL-slope portion immediately behind the main retaining wall, parallel to its base is noted:

from the surface to a depth of 1,5 m - bulk ground;

1,5 m - 3,7 m - loam;

3,7 m - 6 or more - pebble soil.

At a distance of 10.5 m - 18 m from the southern boundary of the site is a zone of ground with a broken structure, the roof of the zone lies at a depth of 1.5 m and coincides with the lower boundary of the bulk soil. Power zone more than 6 m. The entire array was saturated pebble soil abundantly, loam outsole blurred.

Based on the interpretation of data of main information profiles GRL- sensing the following conclusions:

Geological section of the slope portion of the test consists of 3 geotechnical elements (picture 15):

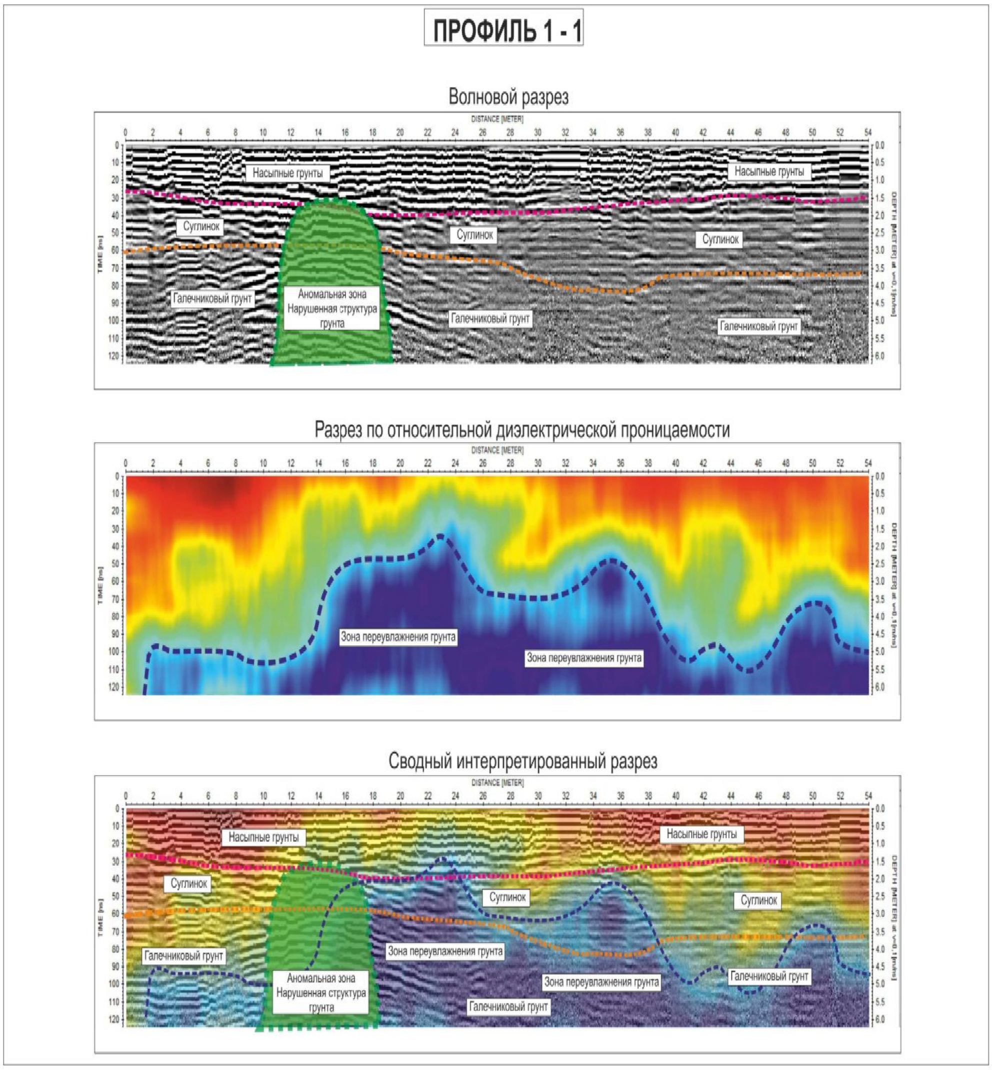
IGE - 1 Bulk ground, power up to 2,0 m.

IGE - 2 Loam, power from 1m up to 3,5 m.

IGE - 3 Pebble ground with capacity from 2,5 m to 6 m and more.

In the body slope observed 2anomalous zone with broken soil structure disposed between the first and second retaining walls.

The first (from the southern border) zone is oriented to the south-west rises from the first retaining wall, to the surface in the region of the second. The second zone, located to the north of the first, has smaller dimensions, is localized at the boundary of the pebble and loam at a depth of 3.5 m - 5 m.The entire array of abnormally pebble soil too wet. The sole layer loams is blurred.



Picture 15 – The processed profile of the GRL behind the first retaining wall

The results carried outof geophysical studies show that application of the GRL method as part of a complex of scientifically applied research makes it possible unambiguously to solve problems by definition:

lithological section of the study site, both from the water surface and from the surface of the earth;

zones of moisture saturation;

zones of soil decompaction;

sections of soils with broken structure;

depth and relief reservoirs;

depth of underground communications.

In complex engineering research overview analysis results GRL-sensing clearly shows the way a concentrated and directional filtering, spatial location and magnitude of sliding bodies, the groundwater level within the depths of investigation.

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КЕШЕНДІ ҒЫЛЫМИ ҚОЛДАНБАЛЫ ЗЕРТТЕУЛЕРДЕГІ ГЕОРАДИОЛОКАЦИЯЛЫҚ ӘДІС

Аннотация. «Сорбұлақ» оң жақ түсіру каналының тоғандары мен су қоймалары, «Сорбұлақ» ағын суын жинақтаушы төмен қысымды бөгетінің жағдайын геофизикалық зерттеу нәтижелері келтірілген. «Notebook» типтік далалық компьютері арқылы зерттеу жүргізу үшін «Око-2» көп мақсатты радары қолданылды (РФ, «Логис» ЖШҚ фирмасы). «Geoscan 32» өңдеуші жүйесінің көмегімен георадиолокациялық зондылау нәтижелеріне өңдеу жүргізілген. Жүргізілген геофизикалық зерттеу нәтижелерінде, кешенді ғылыми қолданбалы зерттеулердің құрамында георадилокация әдісін қолдану, анықтау бойынша едәуір мәселені шешуге мүмкіндік беретіні көрсетілген: су беті, сондай ақ жер беті аймағының литологиялық қимасын; ылғал қаныққан зоналар; топырақтың босаңсу аймақтары; бұзылған құрылымды топырақ учаскелері; су қоймалардың тереңдігі мен жер бедерінің түбі; жерасты коммуникациясының ену тереңдігі. ГРЛ зондылаудың инженерлік іздеу жұмыстарының нәтижелерін кешенді шолу кезінде талдау, шоғырланған және бағытталған фильтрация жолдарын, кеңістіктегі орнын және көшкін денелерінің мөлшерін, зерттеу тереңдігінің шегінде грунт суларының деңгейін көрсетеді.

Түйін сөздер: георадиолокация әдісі, георадар, геофизикалық зерттеулер, ГРЛ-зондылау, қолданбалы зерттеулер.

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МЕТОД ГЕОРАДИОЛОКАЦИИ В КОМПЛЕКСНЫХ НАУЧНО-ПРИКЛАДНЫХ ИССЛЕДОВАНИЯХ

Аннотация. Приведены результаты геофизических исследований состояния низконапорных плотин накопителя сточных вод «Сорбулак», прудов и водохранилищ правого сбросного канала «Сорбулак». Для производства изысканий использовался многоцелевой радар «Око-2» (фирмы ООО «Логис», РФ) с полевым компьютером типа «notebook». Обработка результатов георадиолокационного зондирования производилась при помощи обрабатывающей системы «Geoscan 32». Результаты проведенных геофизических исследований показывают, что применение метода георадиолокации в составе комплекса научно прикладных исследований позволяет достаточно однозначно решать задачи по определению: литологического разреза участка исследования, как с водной поверхности, так и с поверхности земли; зон влагонасыщения; зон разуплотнения грунтов; участков грунтов с нарушенной структурой; глубины и рельеф дна водоемов; глубины залегания подземных коммуникаций. При комплексном обзорном анализе результатов инженерных изысканий ГРЛ-зондирование однозначно показывает пути сосредоточенной и направленной фильтрации, пространственное положение и величину оползневых тел, уровень грунтовых вод в пределах глубин исследования.

Ключевые слова: метод георадиолокации, георадар, геофизические исследования, ГРЛ-зондирование, прикладные исследования.