Results of application of frequency-resonance methods of satellite images processing at the site of an ancient burial location

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SUMMARY

The results of application of direct-prospecting methods of satellite images frequency-resonance processing at site of ancient burial location are analyzed. During a satellite image processing of site with burial, responses were recorded from surface at resonant frequencies of phosphorus, carbon, silver, and gold. At the surface of 50 m from upper part of cross-section, responses from gold, silver, carbon, phosphorus, copper, and diamonds were also recorded. By scanning the cross-section from surface, step of 10 cm, responses from silver were recorded in depth interval 18-39 m. The responses at the gold frequencies were recorded from two intervals 20-25.60 m and 32.50-35.80 m when scanning from 18 m with step 1 cm. On the surface of 25.20 m, signals from diamonds, gold, silver, carbon, and phosphorus were obtained from the upper part of cross-section. The experiments carried out showed that during research of an archaeological nature, it is advisable to carry out measurements at survey sites in areal version. The results of experimental work indicate that mobile methods of satellite images frequency-resonance processing can be used to search for combustible and ore minerals, aquifers, as well as when performing archaeological research in areas of ancient settlements for detecting local objects that are promising for further excavations carrying out.
Introduction
The being developed direct-prospecting technology of frequency-resonance processing and decoding of satellite images and photographs undergoes targeted testing during the various geological and geophysical problems solving. This report presents some research materials of such character. Experimental studies were carried out within the area of the ancient burial.

Research methods
Search-type experimental studies at the survey site were carried out using the technology of frequency-resonance processing and decoding of satellite images and photographs and the methodology of integrated assessment of the prospects of oil and gas potential within local areas and large blocks (Yakymchuk et al., 2019; Yakymchuk and Korchgin, 2019). The modified methods of this technology purposefully use bases (sets, collections) of chemical elements, minerals, oil and condensate samples, as well as sedimentary, igneous and metamorphic rocks, the resonant frequencies of which are used during the satellite images processing. The collection of oil samples in the database includes 117 samples, gas condensate - 15 samples (Yakymchuk et al., 2019).

The base of sedimentary rocks consists of 11 groups: 1) psephitis, monomineral conglomerates (22 samples); 2) psammites (18); 3) siltstone, mudstone, clay (6); 4) kaolinite mudstones (6); 5) kaolinite clays (10); 6) sedimentary-volcaniclastic rocks (9); 7) limestones (24); 8) dolomites (11); 9) marls (10); 10) siliceous rocks (13); 11) salt (3).

The collection of photographs of igneous and metamorphic rocks includes 17 groups: 1) granites and rhyolites (29 samples); 2) granodiorites and dacites (7); 3) syenitis and trachytes (18); 4) diorites and andesites (14); 5) lamprophyres (14); 6) gabbro and basalts (32); 7) feldspar ultramafic rocks (20); 8) feldspathic syenites and phonolites (23); 9) feldspar ultramafic and mafic rocks (10); 11) kimberlites and lamproites (20); 12) nonsilicate carbonatites (8); 13) metamorphic granulites (10); 14) metamorphic gneisses (26); 15) metamorphic crystalline schists (44); 16) metamorphic microcrystalline schists (phyllites) (11); 17) metamorphosed aspid schists (2).

Photos of the listed sets of samples of sedimentary, metamorphic and igneous rocks are taken from an electronic document on the website http://rockref.vsegei.ru/petro/.

Some results obtained with the used set of direct-prospecting mobile methods are given in articles (Yakymchuk et al., 2019; Yakymchuk and Korchgin, 2019).

When conducting research in local areas or within large blocks (as well as their smaller fragments), the following sequence of actions is performed.

1. At the initial stage of the work, using the available frequencies of hydrocarbon samples (oil, gas condensate and gas), the presence (or absence) of possible accumulations of oil, gas and condensate within the block (area, local site) of the survey is established. At the same step of image processing, the presence in the cross-section of some other minerals and chemical elements — amber, coal, water, shale gas, gas hydrates, carbon, hydrogen, oxygen, is evaluated.

2. The groups of sedimentary rocks that are present in the cross-section of the area are determined.

3. The groups of igneous and metamorphic rocks present in the cross-section are identified.

4. Using the methods of vertical scanning of cross-section, the depths of the groups of sedimentary, as well as igneous and metamorphic rocks established within the survey sites are determined.

5. Depths of occurrence (intervals of presence) and thicknesses of individual types of fluids and minerals are estimated, the presence of which in the cross-section was established at the initial steps of image processing.

Research results
The coordinates of the point were transmitted to the performers of the work with the proposal to determine which “substance” may be found on the local site of this point in the interval of depths 0-50 m. Other data, except for the coordinates of the point and the depth of research, were absent.

At the initial stage of work a satellite image of a relatively large area in the vicinity of a given point was prepared for the survey. This image is slightly larger by area than the image in Figure 1. Satellite image in Figure 1 is a fragment of this image. Frequency-resonance processing of prepared image was carried out using a standard set of procedures.
During the image processing no responses were received from hydrocarbons (oil, condensate and gas), amber, coal, hydrogen, water, dead water, salt. Signals from 8 and 9 groups of sedimentary rocks, as well as 7, 8, 9 and 10 groups of igneous rocks were recorded. On the surface of 5 km from the lower part of the cross-section, responses were received only from the 7th group of igneous rocks; signals from 8 and 9 groups of sedimentary rocks were recorded only from the upper part of the cross-section.

By fixing the responses at various depths (50, 150, 250, 350, 200, 216, 217, 218 km), the root of the volcano of the 7th group of igneous rocks was established at a depth of 217 km. On the surface of 20 km no responses were received from water, dead water, and potassium-magnesium salt.

Responses from the following chemical elements were obtained from the surface: nickel, phosphorus, ytterbium, lutetium, hafnium, tantalum, tungsten, platinum, gold, plutonium. When processing a local fragment of the image in the region of a given point (blue rectangle in Figure 1), responses from 8 and 9 groups of sedimentary rocks were recorded. At a surface of 50 m, signals from the 8th group of sedimentary rocks were obtained from the upper part of the cross-section. On the surface of 100 m from the lower part of the cross-section signals from the 8th group were received, and at a depth of 200 m from the bottom part responses were already absent, and from the upper part were recorded.

On the surface of 200 m weak signals from the 7th group of igneous rocks were obtained from the upper part of the cross-section, and responses at the surface of 100 m were already absent.

Figure 1 The position of the local areas of research on satellite image. The marker indicates the position of a given point

Figure 2 Photo of a kaolin sample

The results obtained made it possible to suggest that kaolin deposits are located at the site of the given point in the depth interval up to 50 m. To verify this assumption we used a sample of kaolin clay, shown in Figure 2. At a given point, from the surface, the responses at the frequencies of this kaolin sample are fixed. Signals were also received from kaolin on the surface of 50 m from the upper and lower parts of the cross-section, and on the surface of 100 m only from the upper part.

Figure 3 Satellite image of the kaolin clay quarry in the Zhytomyr region (Ukraine)

To further confirm the results obtained, a small amount of research was performed at the site of the location of the famous kaolin quarry in the Zhytomyr region (Ukraine) (Figure 3). During the
frequency-resonance processing of this image, signals were obtained only from the 8th group of sedimentary rocks; there were no responses from igneous rocks. By fixing the responses at various depths (50, 150, 250, 350, 450, 470 km), the root of the volcano, filled with the 8th group of sedimentary rocks (limestones), was determined at a depth of 470 km.

**The second stage of work.** After receiving additional information about the existence of an ancient burial site in the area of the previously transmitted point, additional work was carried out in the local area of the survey. In the process of research, the following features were taken into account.

Firstly, since carbon and phosphorus are present in the bones of human remains, separate procedures for fixing responses at the resonant frequencies of these chemical elements were carried out during the frequency-resonance processing of satellite images.

Secondly, during excavations of ancient burials, jewelry from precious metals and stones - silver, gold, platinum, diamonds - is found quite often. In this regard, during the experiments, the procedures of fixing responses (signals) at frequencies of precious metals were also performed.

During additional work, the frequency-resonance processing of individual fragments of the satellite image shown in Figure 1 was performed.

At the very beginning of the work, a satellite image was processed of a local fragment of the site, indicated in Figure 1 by blue rectangular outline with dot marker.

During the frequency-resonance processing of this image, responses at the frequencies of silver, gold, carbon, and phosphorus were not obtained.

In this regard, the position of a given point on the ground was more thoroughly analyzed. In the immediate vicinity of this point, no visible signs of an ancient burial were found. However, to the west of this point, forms were found in the topography of the locality that suggested the existence of a burial site in this area. In Figure 1, this area is indicated by an orange rectangular outline.

When processing an image of this fragment from the surface, responses were recorded at the resonant frequencies of phosphorus, carbon, silver, and gold. From a surface of 50 m, signals from gold from the lower part of the cross-section were not recorded, but recorded from the upper part.

Responses from silver, carbon, phosphorus, copper, and diamonds were also obtained at a surface of 50 m from the upper part of the cross-section; there were no signals from these elements from the lower part of the cross-section.

By the cross-section scanning from the surface (0 m) with a step of 10 cm, responses at silver frequencies were recorded in the depth interval of 18-39 m. From the surface of 18 m, signals from silver were recorded from the lower part of the cross-section, and they were absent from the upper part. On the surface of 18 m from the upper part of the cross-section there were also no responses from carbon, phosphorus, and gold.

Signals from gold, silver, carbon and phosphorus were not received at the surface of 38 m from the lower part of the cross-section, and responses from these elements and platinum (optionally) were recorded from the upper part of the cross-section.

By a cross-section scanning from 18 m with 1 cm step, responses at gold frequencies were recorded from two depth intervals: 1) 20-25.60 m; 2) 32.50-35.80 m.

When refining these values by scanning with a step of 1 mm, signals from gold were obtained from the following intervals: 1) 20.22-25.24 m; 2) 32.60-35.60 m.

Responses from platinum, silver, phosphorus and carbon (strong) were recorded at a surface of 32.60 m from the lower part of the cross-section; there were no responses from diamonds. There were no responses from platinum on a surface of 32.60 m from the upper part of the cross-section, but responses were recorded from diamonds.

At a surface of 25.20 m, signals from diamonds, gold, silver, carbon, and phosphorus were obtained from the upper part of the cross-section; there were no signals from platinum.

In addition, processing of a small fragment of the image within the larger one, indicated in Figure 1 with a rectangular outline in purple, has been conducted.

When this fragment was processed on a surface of 25 m, signals from diamonds were obtained from the upper part of the cross-section, and responses were already absent on a surface of 20 m. No signals were also received from diamonds from the lower part of the cross-section on a surface of 32 m.
Signals from gold from the lower parts of cross-section were obtained on surfaces 22 m and 32 m, and responses were already absent on a surface of 35.60 m. No signal from gold was detected at a surface of 22 m from the upper part of the cross-section.

**Some comments on the presented results.** We note at the very beginning that all experimental studies conducted with the aim of testing the direct-prospecting technology of the satellite images and photographs frequency-resonance processing provide new information useful for improving the measurement techniques during the specific search problems solving. New and useful information was also obtained during the described work.

It is also advisable to pay attention to the position of the discovered burial to the west of the point location with the transmitted coordinates (Figure 1). This discrepancy can be explained either by the inaccuracy of determining the coordinates, or the incorrectness of their use. To the above, we add that the performers of work were not informed in which system the coordinates of survey point are given.

Evidence that kaolin clay deposits (quarries) are located within the channels (volcanoes) of the migration of chemical elements, fluids, and mineral matter with roots at depths of 217 km (Figure 1) and 470 km (Figure 3) can also be considered important. These volcanoes are filled with sedimentary rocks of the 8th group (dolomites). In this regard, additional work on the well-known deposit (quarry) of kaolin clay in the Zhytomyr region can be considered expedient (Figure 3). The results of work in this quarry can be considered as additional confirmation of the materials and conclusions, obtained at the local site of the survey with the given coordinates.

And it is advisable to dwell on one more circumstance related to the kaolin quarries - the roots of volcanoes are located at different depths. In the survey area (Figure 1), the root of the volcano is located at a depth of 217 km in the layer of the plastic state of the rocks, which is recorded almost everywhere in the depth interval 194-219 km. Here we can say that this is a relatively "young" volcano. In the Zhytomyr region, which is located within the Ukrainian shield, the root of the volcano is recorded at a depth of 470 km. This is the "old" volcano. The problem of the existence or absence in this area of a “young” volcano with a root in the range of 194-219 km can be solved by conducting additional detailed studies.

The facts of recording responses at the resonant frequencies of carbon, phosphorus, copper, silver, gold, platinum and diamonds within the area discovered (by the performers) (it is possible that this is a well-known object) of an ancient burial survey can (and should!) be considered as additional evidence in favor of a sufficiently high sensitivity of individual methods of direct-prospecting technology of frequency-resonance processing and decoding of satellite images and photographs. It is quite understandable that the volumes and mass of ancient burials are not comparable with the volumes of deposits of precious metals and stones and the mass of minerals in them. And even in this case, signals (responses) from precious metals and stones are recorded with the methods used!

In the methodological plan, the experiments showed that when performing archaeological studies it is advisable to carry out measurements at the survey sites in the areal version.

**Conclusion.** The results of experimental studies indicate the information content of satellite images and photographs, as well as the efficiency and effectiveness of the frequency-resonance technology of their processing. Mobile methods of this technology can be used to search for combustible and ore minerals, aquifers, as well as when performing archaeological research at sites of ancient settlements in order to detect and localize local objects that are promising for further excavations.

**References**
