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Research Article

REMOTE SENSING RESEARCHES OF TAKHTATAU MOUNTAINS (WESTERN UZBEKISTAN)

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ABSTRACT
This article discusses the results of remote sensing and geological researches of the territory of Takhtatau mountains, which are located in the Eastern part of the Bukantau mountains of the Central Kyzylkum region of Western Uzbekistan. Bukantau mountains are known for numerous deposits and ore occurrences of metallic minerals, mainly for gold and tungsten, non-metallic minerals are also known - cacholong, turquoise, phosphorites, etc. Takhtatau mountains are the eastern continuation of the Bukantau mountains and are potentially perspective for ore minerals.

Keywords: *Satellite Images, Materials of Remote Sensing (RT), Photointerpretation, Structural Photointerpretable Complex (SIC), Fault, Ring Structure, Base of Remote Sensing*

INTRODUCTION
Within the territory of Uzbekistan remote sensing researches were provided in many regions such as Nurata, Chatkal-Kurama, Gissar and Central Kyzylkum also (Figure 1). As a result of the research, with the highlighting of main geological structural elements of the research areas, for example: structural photointerpretable complex, faults, ring structures, regional fracturing zones, bases and maps of remote sensing were compiled. Geologically, the study area is composed mainly of terrigenous and carbonate-volcanic structural-material complex of the Takhtatau Formation (C_2m_2), complicated by faults which have northeastern strike. The eolian SIC is identified to the north of the Paleozoic outcrops as fixed sands and to the south - transported sands. A structural photointerpretable complex means an object of geological nature (these are strata of sedimentary, volcanogenic and metamorphic rocks formed in certain geodynamic settings and subsequently dislocated in a certain way, intrusive rocks that compose bodies of different shapes and formed at different stages of the development of the earth's crust), displayed on the materials remote sensing and interpreted depending on the phototone, its brightness, the reflectivity of the object and the structure of the pattern (image texture) of the satellite image (Shortsman, 2004).
Medium-scale remote sensing works in this area was carried out in conjunction with previously provided geological and geophysical studies, which made it possible to identify perspective areas for or mineralization.

MATERIALS AND METHODS
Study Methods
A modern remote sensing geological map reflects a new level of organization of source data, and involves a vast territory and previously unknown or unused factors, which proceed from non-traditional methods of studies. This is the benefit of distance bases as they explain the structure of geological complexes but also contribute to revealing new elements that cannot be established using traditional methods of geological studies (Borisov *et al.*, 1982).
The application of GIS technologies in geological exploration including mapping of remote sensing geological bases represents new trend in space-geological studies. GIS technologies are a multifunctional tool of input, visualization, analysis and output of information necessary for achieving geological objectives. They enable a prompt processing of geological information for various territories and levels – from a province to ore area or deposit.

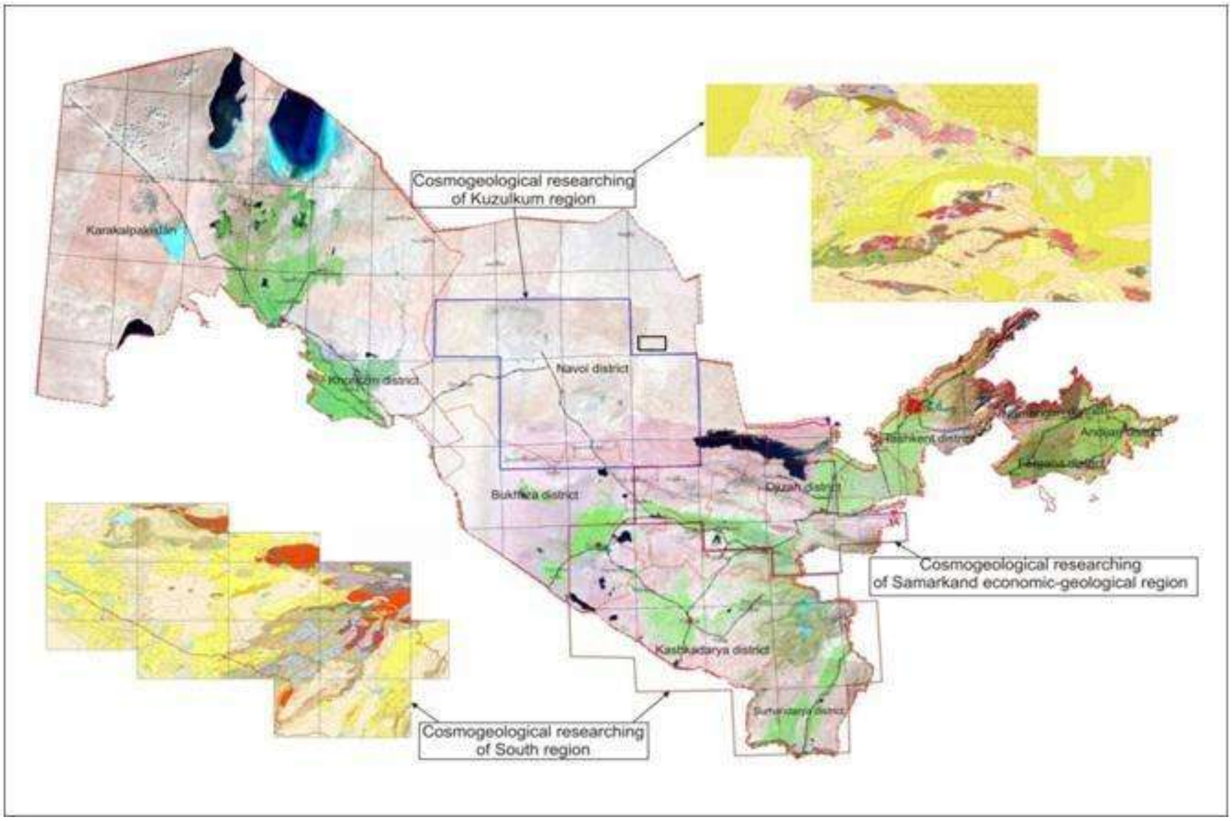

Figure 1.Regional remote sensing geological studies in the territory of Uzbekistan. Black rectangle indicates the situation of study area.

The methodology of processing using GIS technologies in space-geological studies consists of the following stages: collection and analysis of information on the structure of the area under study an preliminary processing of materials of space survey (visualization of objects in different zones of electromagnetic range or their combinations, analysis of structure and texture of image, computer processing of materials of remote sensing); visual and automated decoding; building distance bases on the basis of topographic and geological map; making schemes of faults and maps of density fields of the tectonic deformations. GIS packages of materials are available and extensible with new data and opportunities of their processing. It is possible to integrate data obtained using different methods of their transformation (Glukh *et al.*, 2002).

Methods of data overlaying are used at the analysis of materials by remote sensing geological studies on the basis of GIS technologies. These data are placed onto different thematic layers of the GIS packet, which enable a spatial union and integration of data of spot, linear and area space-geological objects and materials of traditional geological methods. The GIS packet of multi-layered maps enables the processing of several maps as one. Thematic layers enable the analysis of highly detailed maps and the results can be visualized.

Information needed to take decisions is expressed in the digital cartographic form and supplemented with texts in the legends of remote bases. During the production of a digital map, information is grouped into thematic layers. One layer reflects linear objects; the other layer, areas and the third (the major one) reflects the topographic basis. Other layers reflect structural-substance complexes of different geneses, composition, age, etc (figure2). Cartographic bases based on GIS can be continuous or not connected with

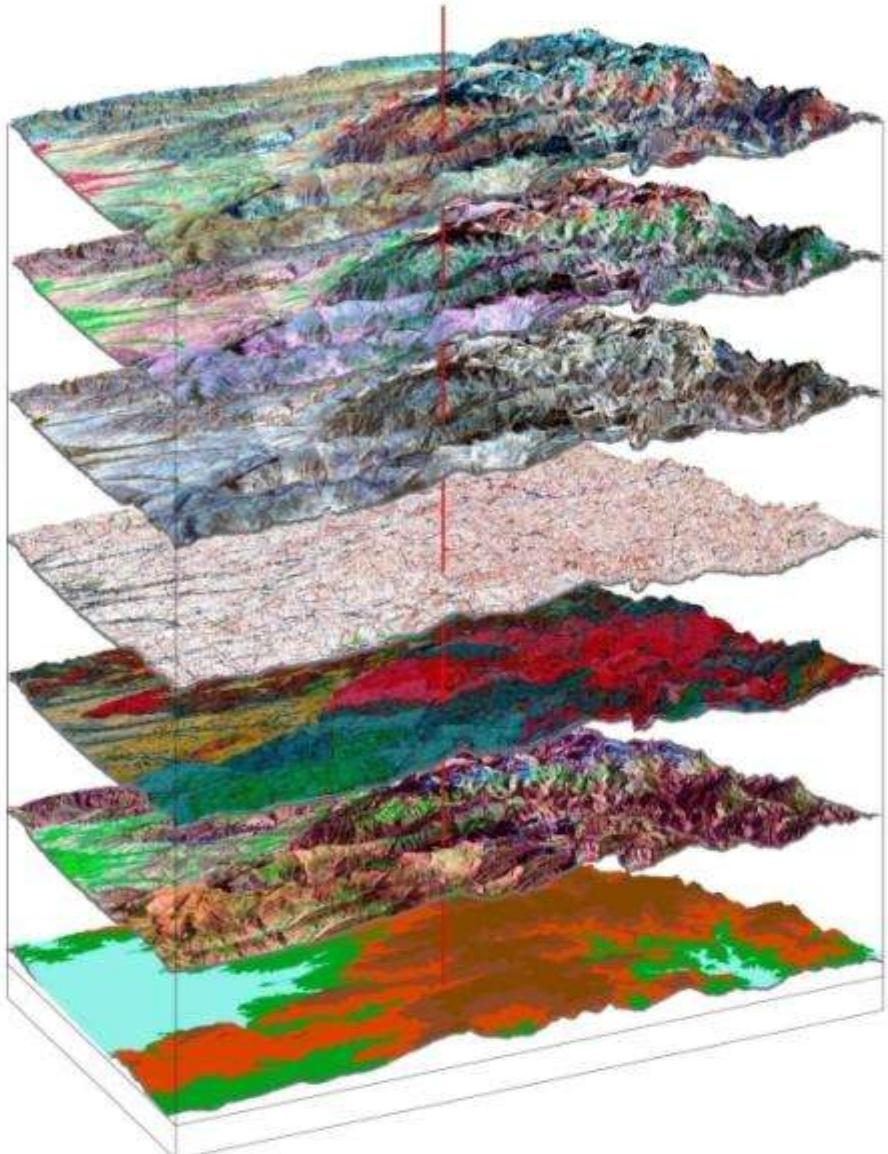

Figure 2: GIS project with thematic layers

a specific scale. Electronic maps or hard copies are made on this basis with a required load on any territory and at any scale. New data can be added to these maps, which can be used by different organizations of State Committee on Geology and mineral resources of the Republic of Uzbekistan.

RESULTS

We provided interpretation of multispectral digital space images of territory of Takhtatau mountains. In the process of interpretation we used digital data from space imagery Landsat TM, QuickBird, Aster, RadarSat and used software products Global Mapper, ENVI, ERDAS, ArcGis10.1 and GIS technologies (Figures 3and 4).

Preliminary photointerpretation of space images.

According to the instructions and methods for remote sensing researches (Borisov *et al.,* 1982), preliminary photointerpretation of space images consists of the following stages:

- preparation of materials for remote sensing, checking and increasing of the geological information content for photointerpretation;

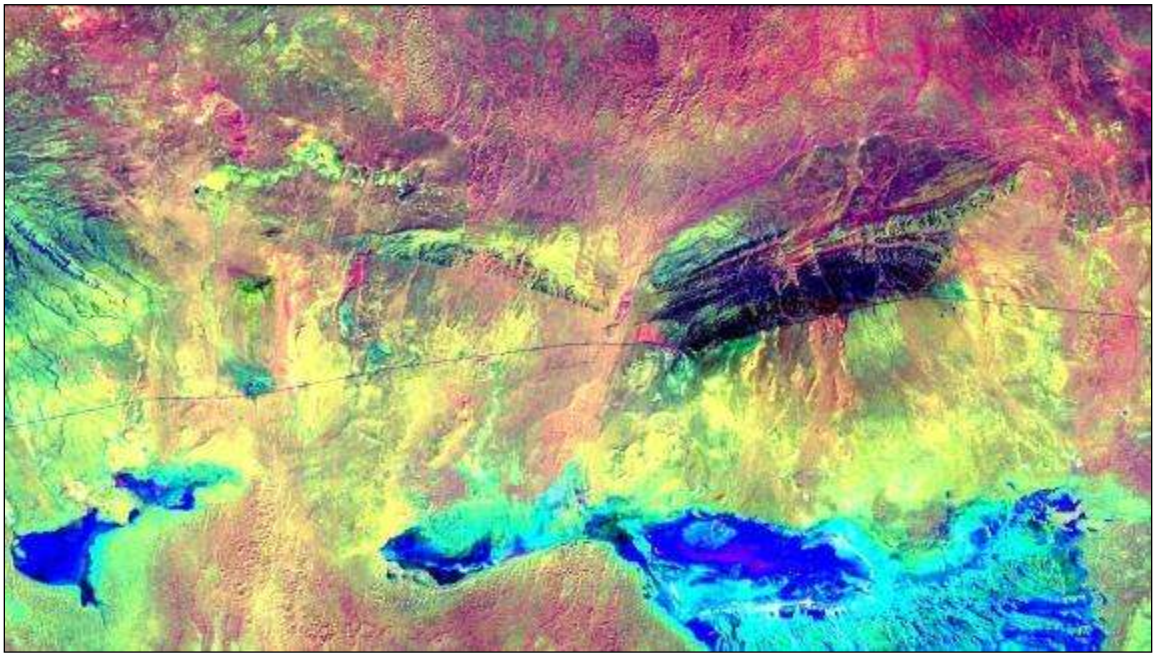

Figure 3: Space image of Landsat of Takhtatau mountains area.

Figure 4: Interpreted 7 channel space image of Landsat of Takhtatau mountains area.

- photointerpretation of structural and tectonic elements within the study area using modern software products Global Mapper, ERDAS, ArcGIS;

- creation of a preliminary version of the remote sensing scheme of the research area by photointerpretation of space images using the results of geological and geophysical studies on software products Global Mapper, ERDAS, ArcGIS;

Preparation of remote sensing materials.

For creating the transformed satellite image, the ratios of the spectral channels were used in various combinations. The first three channels correspond to the mineral composition in a combination of channel ratios:

-red b5/b7 - clay minerals;
-green b3/b1 - iron oxides;
-blue b5/b4 - iron-containing minerals;
-combined b5/b7, b3/b1, b4/b3 - hydrothermal composites, etc.

For mapping substance complexes, we used the optimal combinations of the R b5/b1, B b3/b1, G b5/b4 channels. Other channel ratios are created based on the color gamut of the image and the reflectivity of objects.

In addition to the algorithm of spectral channel ratios, the image was processed by the program for the analysis of principal components. Principal Components Analysis (PCA) is often used as a data compression method. This analysis allows compose redundant data into fewer channels. The resulting channels of images of PCA data are not interconnected and independent, and are often better interpreted than the original data (Glukh, 1982).

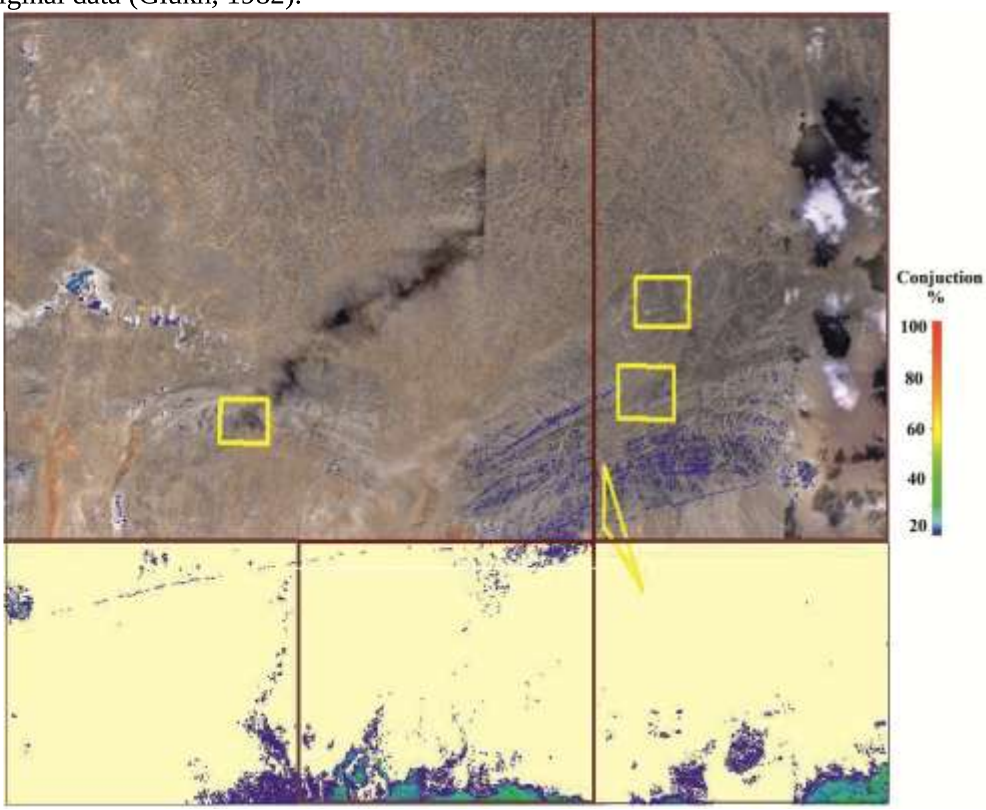

Figure 5: Development of the arsenopyrite mineral over the surface of the Takhtatau mountains and adjacent territory.

As a result, the main components of the geological structure of the surface sensing were identified. Polytypic, uneven-aged rocks, including Quaternary and modern, reflect different spectral brightness, expressed in a satellite image in different tones and shades (RGB) in combination with image texture.

At the second stage of researches, we provided field works on the base of results of preliminary photointerpretation of satellite images over the study area and adjacent territories to establish the geological nature of the identified structures for determining their expression in spaces. During the field works we did identification of objects and their features on outcrops of these rocks. Field works were carried out with referencing of geological observation points (material complexes, tectonic structures, zones of inter-fault crushing, contacts between strata of different ages, geological situations, etc.) with a GPS navigation device.

At the third stage of researches, we did post-field interpretation over the study area. In the process of these types of work, we used the results of visual and automated interpretation and materials of field verification. When performing post-field work, the objects were corrected on a remote basis. As a result of post-field interpretation, a remote decoding scheme was compiled with the specified coordinates of the identified objects, which can be used as additional material for providing geological exploration on this area. Areas of intersection of the main tectonic structures: nodal fault zones, as well as their intersections with ring structures, are recommended for geological exploration in order to confirm their productivity.

There are deposits of gold, gold – arsenic (gold – pyrite – arsenopyrite type), gold – sulfide – quartz formations in the Bukantau mountains. The main minerals of these ore occurrences are arsenopyrite and quartz. In this regard, remote sensing and geological studies were provided on the distribution of these minerals within the Takhtatau mountains.

Remote sensing materials were created based on the processed Landsat satellite images and the spectral library data with the distribution of arsenopyrite and quartz minerals over the surface of the studied territory (Figures. 5 and 6). Zones of accumulation of the studied minerals and their removal by erosion of rock layers in a given area were identified.

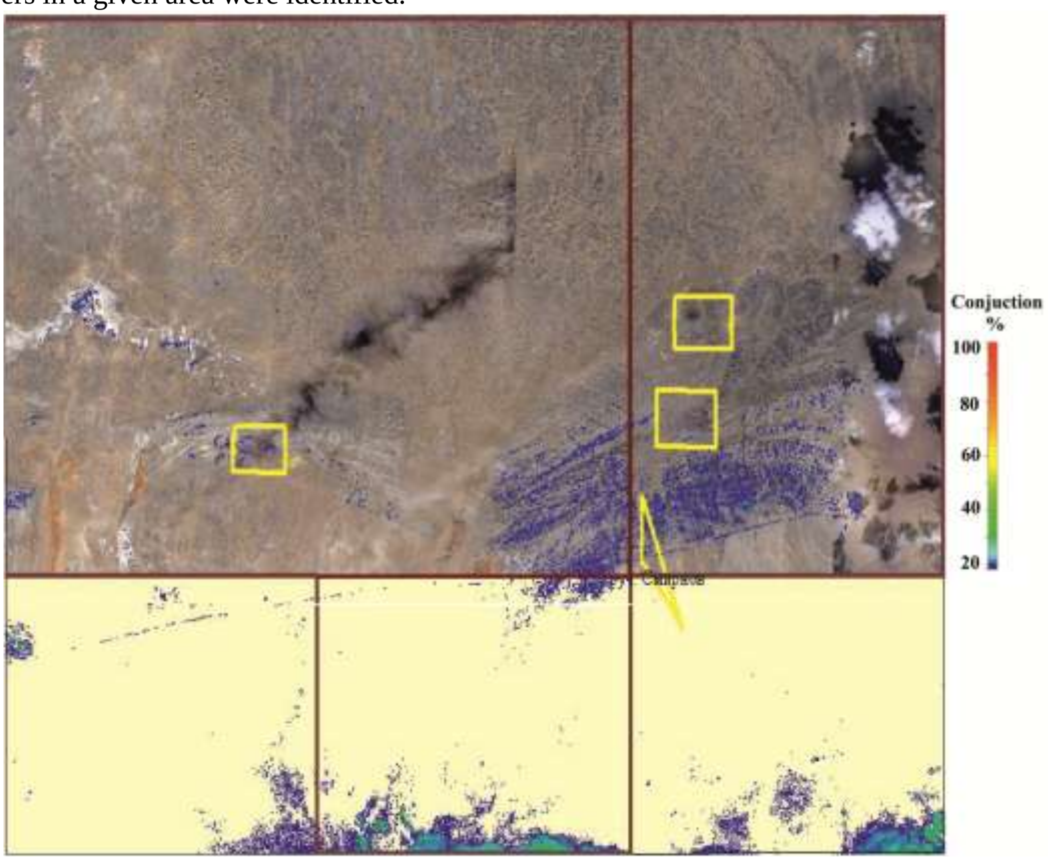

Figure 6: Development of the quartz mineral over the surface of the Takhtatau mountains and adjacent territory.

At the third stage of research, several versions of remote sensing bases were collected in one final resulting map. As a result of the aggregation of the results of remote sensing researches with geological and geophysical data, perspective areas were identified (Figure 7).

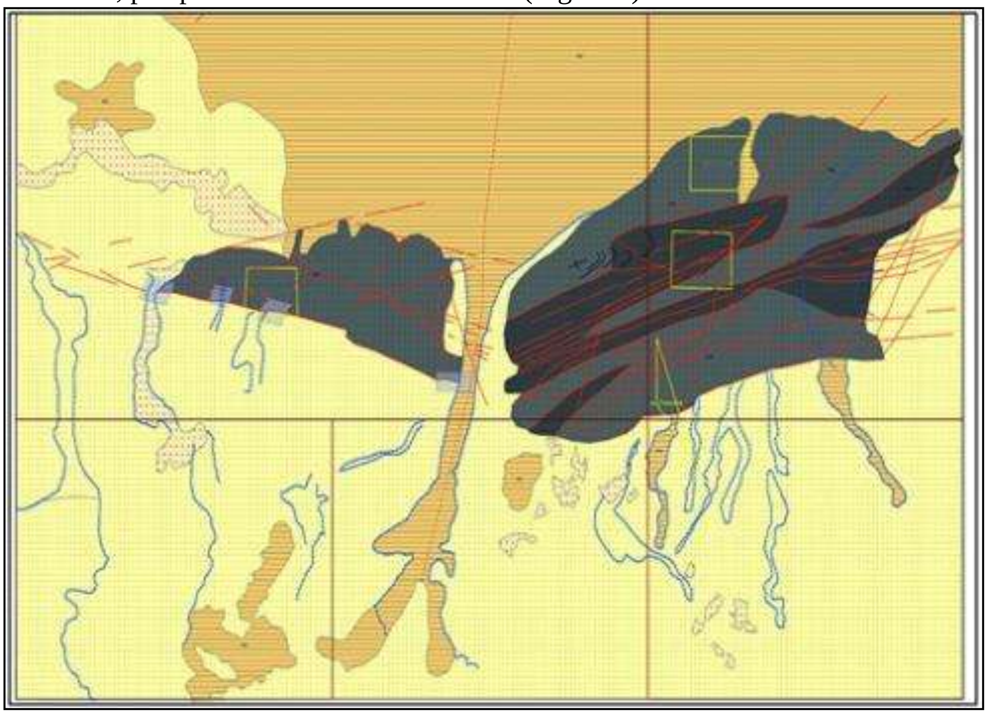

Figure 7: Remote sensing base with identified perspective areas. For legend see figure 8.

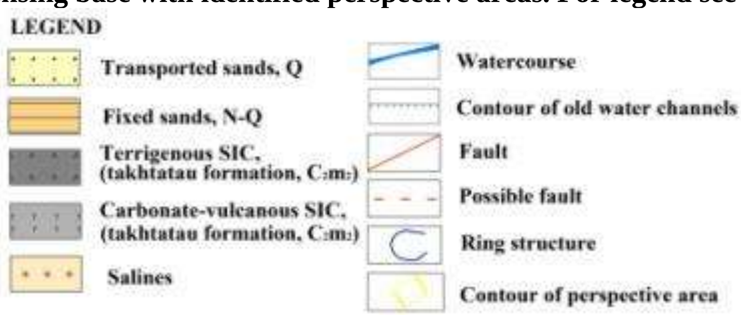

Figure 8: legend for figure 7.

CONCLUSION

The research results are collected in the form of thematic layers (GIS & RS projects), which included: satellite images; remote sensing basics; topographic and geological maps, satellite images with the development of arsenopyrite and quartz minerals over the surface of the study area.

On a remote sensing basis (Figure 7), remote sensing objects were identified, which are complicated with tectonic faults and have exploration value.

The nodes of intersection of tectonic structures of different strikes with zones of fracturing of the meridional direction, as well as areas of simultaneous accumulation of the studied minerals, are recommended as sensing criteria for searching endogenous mineralization.

Thus, on the basis of visual and computer geological interpretation, analysis of the geological structure of the region using a 3D relief model, study of the location of mineralization, ore-concentrating elements, conducive geological and structural positions have been identified that have exploration value.

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