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Creation of the GIS Project of Bukantau Mountains (Uzbekistan)

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ABSTRACT: This paper focused on methodology creating a geological GIS project of carefully studied region of Uzbekistan. For this research, all the cartographic and scanned data of the study area were collected and then these datasets were linked to the Lat/Lon projection in geographic coordinate system (WGS 84) and vectorized(digitized). Images of the study area were processed in order to enhance the decryption features of geological objects. Informative images were obtained according to the results of processing by the methods of CC (color composition), PCA, Mincomp, Hydrocomp, ITS, Kirsch, Sobel, Index IV, filtering, segmentation, classification, creating new bands and others. The results of processing by the above methods allowed to mapping all the structural units presented in the geological map of the region, new and alleged discontinuous faults, zones of regional fracture of meridional strike, concentric structures, cuneal blocks and other tectonic faults, as well as geological–substance complexes. Based on the identified structural– substance complexes, discontinuous faults, concentric structures and other cosmogeological objects, a cosmogeological map of the Bukantau mountains was created.

Based on raster and vector data, the results of digital processing of satellite images, including the results of automated and visual decryption, a GIS project of the Bukantau mountains was compiled on a scale of 1:200000. GIS projects were collected in ArcGis 10.5 and Global Mapper 18.0 software and consist of numerous thematic layers. With their help, it is possible to adjust current information in any volume, analyze in an automated mode multidimensional information; visualize data (including in 3D), provide massive and convenient access to cartographic products, facilitate the exchange of information.

KEY WORDS: Satellite image, satellite image processing, scanning, vectorization, projection, lineaments, concentric structures, Cosmogeological map (Satellite image is processed as geological map), GIS project.

I. INTRODUCTION

The use of GIS - technologies allowsto combines large volumes of cartographic and thematic information into a unified system, and thereby creates a consistent data structure for the analysis of available and received information. The designed system increases the efficiency of the solving tasks, simplifies and accelerates the work of making managerial decisions. GIS makes it easy to integrate and analyze remote sensing and field research data. GIS uses in many fields, including geology.

Here is a list of some of the tasks that geologists solve using GIS:

1. Digitization and formalization of geological graphics;
2. Revision and analysis of geological information;
3. Mathematical processing of data from geological exploration and survey work;
4. Creating prognosical maps;
5. Processing and decoding of satellite images;
6. Monitoring of natural and technogenic processes;
7. Projection of exploration and mining;
8. Calculation of reserves of the deposit fields;
9. Management of the mining enterprise.



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The basis of GIS technology is the principle of integration of various objects and processes; a connecting link between geographic information and a topographic basis, which allows to get a general picture of reality, organize existing data and adduct them to a form convenient for analysis. With the help of GIS, it is possible to understand and analyze materials containing important data, present the general infrastructure of the ore field, ore area, etc. GIS is a necessary element of the optimal set system in graphical or digital forms, in two-dimensional and three-dimensional graphical coordinate form of cosmogeological materials which are necessary for studying objects of different hierarchies, scales, types, their analysis and verification. These materials represent the basis for decision-making and contribute to the development of measures to fulfill the geological task.

The use of remote sensing materials and the results of their processing using GIS technology facilitates the analysis and generalization of various electronic material. With a high degree of geological exploration of the territory of the Republic, a lot of materials of different nature and scale have accumulated in the main mining areas. Finding and generalization of this material requires a lot of time. In digital cartography, the use of remote sensing materials and the results of their interpretation using GIS technologies is facilitated. On electronic maps, information is stored as a set of thematic GIS layers. In the set, layers from various sources are combined based on their spatial position. The final result is expressed after statistical analysis, in a convenient form for the user, contributing to the effectiveness of decision-making. In the GIS system, created maps are stored in raster and vector forms. Thematic layers include: space images, topographic bases, geological maps, maps of patterns of mineral distribution, three-dimensional terrain models (based on the use of radar images) and geophysical maps and other thematic maps, schemes.

When analyzing cosmogeological materials in modern GIS technologies, the overlay method is often used which include the integration of data located in different thematic layers of a vector (raster) map. The overlay promotes spatial unification, which allows to integrate data on faults, structurally decrypted complexes of different genesis, composition, age, concentric structures and other cosmogeological objects of a point, linear, areal nature and according to traditional methods and visualize the final results. The type of multi-layer cards allows to process multiple cards as one. Thematic layers permit to analyze maps with high detail.

II. RELATED WORK

Many years of world experience in the use of distance materials in geological research have shown their information content and effectiveness. At present, Uzbekistan also uses remote sensing methods during geological exploration at all stages, especially great attention is paid to automated methods for analyzing space images.

The relevance of the studies is determined by the Presidential Decrees to increase the efficiency of geological exploration based on modern software products and innovative technology, as well as the use of remote sensing data. The use of modern technologies and high-resolution remote sensing materials contribute to the improvement of existing research methods, the study of the geological structure of large regions, the identification of patterns of location and localization of mineral resources.

III. MATERIALS AND METHODS

Mount Bukantau, which is part of Central Kyzylkum, which in turn is one of the richest gold ore regions in the world, was chosen as the object of study (Fig. 1). For the geological structure and ore content of the Bukantau mountains were dedicated numerous works by region researchers from the Academy of Sciences system, universities of the exploration industry and its research centers [Borisov, Glukh, 1982], [Ergashev, Asadov, 2001]. According to some researchers, the leading mining areas, due to changes in the understanding of the geological structure and the accumulation of new data in recent years, have ripened a need for modern geological foundations and reinterpretation of all available geological material.

Source data when creating a geological GIS project of Bukantau mountains are:

- the results of previous geological surveys, cosmogeological, geophysical, geochemical and exploration works completed in the Bukantau mountains (K.K. Pyatkov, A.K. Bukharin, Ya.B. Aisanov, 1961; Ya.B. Aisanov et al. 1984; Yu.I. Loshkin et al. 1985; Yu.S. Savchuk, 1993; Aisanov Ya.B. et al. 1984);
- various topographic, geological, tectonic, geophysical, geochemical, metallogenic, cosmogeological and other maps;
- multispectral satellite images of Landsat, Aster, QuickBird 2010-2019 for different periods;
- scientific publications and other sources of information.

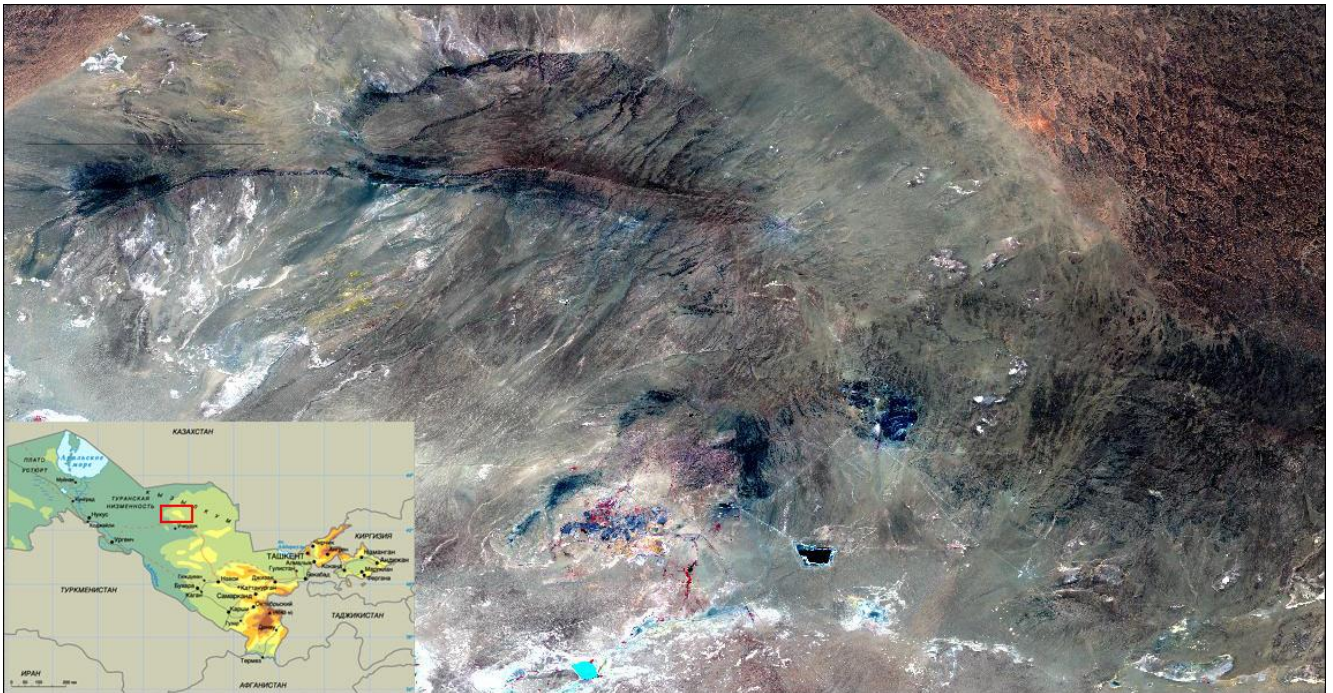


Fig. 1. The study area

A huge amount of materials was processed, while creating a geological GIS project. Using remote sensing materials, their digital processing and analysis, using as a basic base and creating cosmogeological maps is one of the main tasks of creating a geological GIS project. The following work was sequentially performed, when creating a geological GIS project for the Bukantau mountains.

A. Preparation of raster and vector maps

Earlier work on the territory of the Bukantau Mountains was studied using stock materials. Selected, necessary reports were analyzed and summarized the geological and structural structures of the region. The necessary cartographic materials were scanned. During scanning, an analog-digital conversion of the image into a digital raster form was produced using a scanning device. This is the main operation of entering raster images into a computer and one of the stages of digitizing graphic and cartographic sources for their vector representation, preceding the process of raster - vector transformation (vectorization). For spatial reference of raster maps in general geographic projections (Lat / Lon), ERDAS and GlobalMapper software products were used.

B. Processing of satellite images.

At the first stage, satellite images of Landsat 7 and ASTER in the study area were pre-processed in order to improve the visual perception of the image, or to convert it into a form more convenient for further visual or computer analysis [Kronberg, 1998], [Kashkin, Sukhinin, 2001, Chandra, 2008]. The primary processing of remote sensing data in the study area was realized using specific software tools (ENVI 4.5, ERDAS) and the following processes were used:

- improving image quality;
- synthesis of the image;
- image filtering;
- image clipping within the study area;
- convert formats;
- orthotransformation.

The next step in processing satellite images is to enhance the decoding features of geological objects. Digital processing was implemented on the basis of the satellite image processing methods we tested: CC (color composition), ASR, Mincomp, Hydrocomp, ITS, Kirsch, Sobel, Index IV, filtering, segmentation, classification, creation of new channels and others (Fig.2).

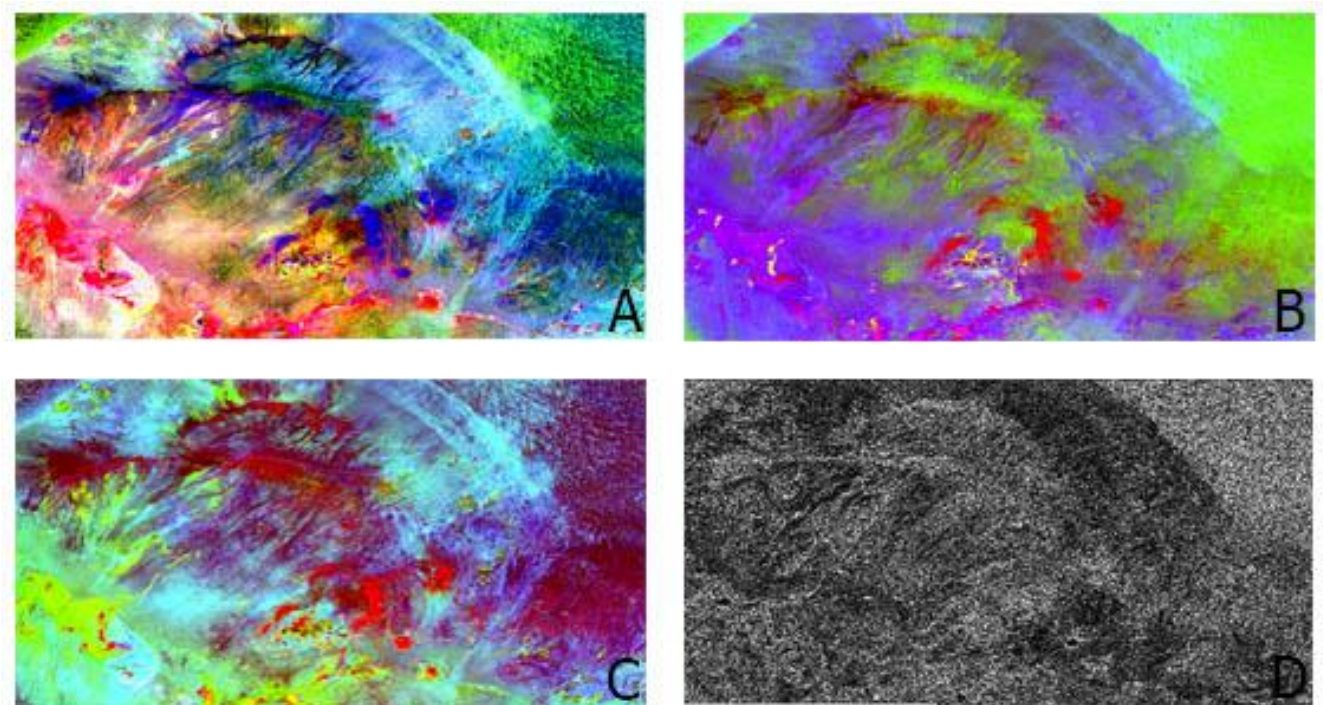


Fig. 2. The results of processing of the Landsat satellite image by various methods:
A-PCA, B-mincomp, C-Hydrocomp, D-Index 4, C. Composition a GIS project

Based on all raster and vector materials, the results of digital satellite imagery processing, including the results of automated and visual decryption, a GIS project was compiled on the Bukantaus Mountains with a 1: 200000 scale. The GIS project is compiled in ArcGis 10.5 and Global Mapper 18.0 software and consists of the following thematic layers:

1. Space images of Landsat 8, Aster, QickBird.
2. Digital elevation model based on SRTM data.
3. Digital elevation model based on Aster DEM data.
4. Surface relief with contours at 100 and 200 m.
5. Topographic map on a scale of 1: 200000.
6. Geological map on a scale of 1: 200000.
7. Tectonic map on a scale of 1: 200 000.
8. Geophysical maps on a scale of 1: 200 000 and 1: 500 000.
9. Map of the location of minerals.
10. 3d models of satellite images and maps.
11. The results of digital processing by various methods.
12. Scheme of automated and visual interpretation of lineaments and concentric structures.

13. Scheme of automated and visual interpretation of geological and material complexes.
14. Vector files of the borders of Uzbekistan with regions (1: 1 000 000).
15. Vector file of nomenclature sheets (1: 200 000) on the territory of Uzbekistan.
16. Vector file of overflights of the Landsat satellite.
17. The boundary of the study area.
18. Vector file of Surface relief with a step of isolines of 100 m.
19. Vector file of ore deposits.
20. Vector file for automatic classification of complex images.

IV. RESULTS AND DISCUSSION

The results of processing by the above methods made it possible to mapping out all the structural units presented in the geological map of the region, new and supposed discontinuous faults, zones of regional fracture of meridional strike, concentric structures, cuneal blocks and other tectonic faults, as well as geological and material complexes. Based on the identified structural-material complexes, discontinuous faults, concentric structures and other cosmogeological objects, a cosmogeological map of the Bukantaus Mountains was created (Fig. 3).

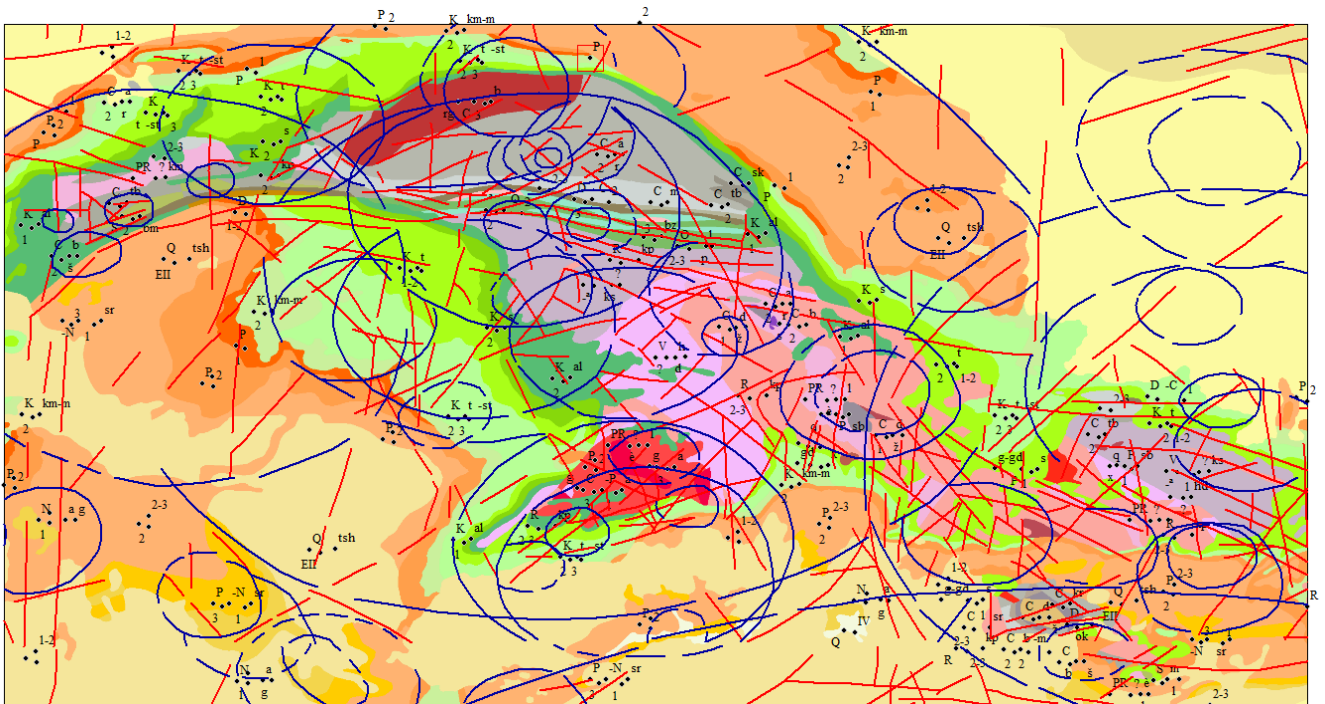


Fig. 3. The cosmogeological map of the Bukantaus Mountains, composed on the basis of an analysis of the processing of space images

The cosmogeological map of the Bukantaus Mountains, created thematic data in the form of layers, were compared by geological and geophysical maps of the studied area and the compositions, age and boundaries allocated during the interpretation of structurally decrypted complexes were clarified, when performing cosmogeological works. The position of structures within the studied areas was specified in the analysis of geophysical data. GIS allowed the integration of huge amounts of data and created new relationships between data stored in heterogeneous databases.

V. CONCLUSION

Thus, the methodology used allowed us to create a single database of geological data, i.e. GIS project for specific areas. With its help it is possible to correct the current information in any volume, to realize the analysis of multidimensional information in an automated mode; visualize data (including in 3D), provide massive and convenient access to



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cartographic products, facilitate the exchange of information. Therefore, the GIS project can be considered as a tool for information support and management of exploration work using satellite imagery.

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