Experience of cosmogeological research on the basis of GIS-technologies (in case of South Nuratau)

Isomiddin Togaev¹, Rakhimjan Umurzakov², Anvarbek Nurkhodjaev³, Sayfulla Romanov¹, Shamshodbek Akmalov⁴

¹National University of Uzbekistan named after Mirzo Ulugbek, Tashkent, Uzbekistan
²Tashkent State Technical University named after Islam Karimov, Tashkent, Uzbekistan
³Institute for Advanced Studies and Retraining of Geological Sector Workers of the State Committee for Geology of the Republic of Uzbekistan, Uzbekistan
⁴Tashkent Institute of Irrigation and Agricultural Mechanization Engineers, 39, Kari Niyazi str., M.Ulugbek distr.100000, Tashkent, Uzbekistan

E-mail: shamshodbekjon@mail.ru

Abstract. The purpose of the study is the creation of a new generation of cosmogeological maps-remote fundamentals of the study area based on the integrated use of satellite imagery using GIS technologies. Earth remote sensing (ERS) materials in the form of aerial photographs have been widely used for a long time in regional geological surveys, structural and geological studies, mineral exploration, hydrogeology and engineering geology, and many other areas of fundamental and applied geology. On their basis, thematic methods of geological interpretation of remote sensing materials were developed. As a result of the scientific and technological revolution, space research already significantly affect the acceleration of the pace of development of geological science and technology and bring a great economic effect. At present, the materials of digital satellite images obtained from Landsat 7.8 TM, Aster, etc. satellites and the method of their interpretation have led to the creation of a new type of cosmogeological maps - remote bases. The purpose of the research is the creation of a new generation of cosmogeological maps-remote fundamentals of the study area based on the integrated use of satellite imagery using GIS technologies. The article provides information about the remote basics of the cosmogeological map based on GIS technologies.

1. Introduction
The use of high-resolution remote sensing materials of various sizes should increase the objectivity and reliability of geological information and contribute to the solution of applied geological problems. To characterize the cosmic-structural features of the mountains of South Nuratau, we used Landsat and Aster satellite images based on the software ENVI 4.7, ERDAS 9.2 and ArcGIS 9.2, etc [13,14].

Advanced cosmogeological studies with the creation of medium-distance remote foundations on the territory of the South Nuratau Mountains were conducted to search for solid mineral deposits based on modern GIS technologies (Geographic Information Systems) [1].

Geology as a high-tech industry needs a variety of types of analysis and modeling to solve applied problems. Already in the 70s of the last century, the foundations of integrated technologies for processing and representing spatial geological information were determined, which took shape with the creation of modern GIS software [14,12].
Geology, as a science about the Earth, actively uses all the advantages of GIS and itself contributes to the development of GIS technologies. Although the beginning of the development of GIS dates back to the 60-70s of the XX century, they gained rapid spread only in the last decade, which is associated, first of all, with the improvement of the hardware and software base. The development of network and telecommunication resources, a significant expansion of access to spatial data has made available the use of geoinformation technologies to a wide range of users [2,14].

GIS - a system for collecting, storing, analyzing and graphically visualizing spatial (geographic) data and related information about the necessary objects. GIS includes the capabilities of database management systems, editors of raster and vector graphics and analytical tools and is widely used in geology and many other fields [7,8].

Effective methods of forecasting, prospecting and exploration of mineral resources, the use of MDS and computer technology are firmly included in the practice of exploration and move on to the stage when GIS technology is used as part of it [9,10,11].

The development of modern geological exploration production cannot be imagined without new technologies and developments that allow obtaining new information that serves as a criterion for assessing prospective areas and that allow for the local forecast of ore content with minimal cost. One of these areas is the use of Earth remote sensing data (ERS) to solve applied and scientific-thematic problems of geology. Remote sensing materials carry objectively information that allows mapping geomorphological indicators of structural forms formed as a result of endogenous and exogenous processes and the deepest buried structures combined with geophysical data [11,12].

The method of decoding geological objects in images is the detection, recognition and interpretation (interpretation) of an object or phenomenon based on certain criteria.

At the present stage, a methodology for the use of remote sensing materials for studying the geological nature of mountainous and foothill territories has been developed and successfully implemented in geological exploration. Extensive experience in cosmogeological research in various mining regions has been accumulated, the shooting time, the range of the spectrum and the scale range of the most suitable for solving problems of applied geology have been experimentally established [14].

With the advent of digital images, the work performed on the basis of remote sensing materials was of a completely different nature and is widely used at regional and local levels of geological research. Naturally, along with this, the possibilities of using remote sensing materials expanded much and the method of geological interpretation was significantly improved.

However, a change in the direction vector of prospecting and assessment work towards territories hidden by soil and vegetation cover, loose sediment (sedimentary cover) requires completely different criteria, based on modern software tools, to analyze Earth remote sensing materials using geological, geophysical and geochemical data to study closed territories and the discovery of potentially promising “blind” geological structures in depth. This is one of the priority areas of modern geology. The advantage of the remote basis — the cosmogeological map — is that it explains the geology of the area from a new perspective and helps to identify elements that cannot be distinguished by other methods. The main geological units identified on the remote sensing materials are linear and ring structures, structurally decryptable complexes (SDK), which make up the framework of the endogenous structure of the study area, which is the basis for the compilation of geological, cosmogeological and other maps of a new generation [1,5].

Remote sensing of the Earth (from the English term “remote sensing”) means, in a broad sense, the study of the surface of the Earth or other planets at a considerable distance using images from aircraft and space carriers in order to study and thematically map the objects under study. Among the various aspects of remote sensing, air and space surveys of the Earth in geological studies are of particular relevance.

Remote methods in geology are a set of technologies and methods for studying the laws of the structure and development of the lithosphere from airplanes, spacecraft and other carriers visually or by various instruments by decoding the recording of the physical field of the Earth. In the scientific
literature, the term "remote methods in geology" is often replaced by a similar concept of "aerospace geological methods" [2].

2. Methods
Using space methods in geological research, geological problems can be solved promptly. Modern satellite images from various satellite systems and methods for processing data from remote sensing of the Earth's surface were used to conduct this study. The experience of cosmogeological studies using GIS technologies in the South Nurata region on the creation of cosmogeological maps-distant foundations showed the following.

The materials, as a rule, are presented in the form of spectrozonal images of the earth's surface and are given in the cartographic projection on which the distance base is based. The advantage of the remote base is that it explains the geology of the area from a new perspective, and helps to identify elements that are not distinguished by other methods. The main geological units that are distinguished by remote sensing materials are linear and ring structures, structurally decryptable complexes (SDK), which make up the endogenous framework of the structure of the study area, which is the basis for compiling geological, cosmogeological and other maps of a new generation. With the advent of the possibility of obtaining digital photographs of the Earth, a new era began in the use of satellite imagery (ISS) materials to create distance bases - cosmogeological maps.

For the analysis of remote sensing data, the most convenient geographic information systems (GIS) - allowing you to effectively work with spatially distributed information (maps, plans, aerospace images, diagrams in combination with texts, tables, etc.) [3,6]. Practically any field of activity has to deal with data of this kind [6].

The experience of cosmogeological studies using GIS technologies in the South Nurata region on the creation of cosmogeological maps-remote basis showed the following.

The materials, as a rule, are presented in the form of spectrozonal images of the earth’s surface and are given in the cartographic projection on which the distance base is based. The interpretation part of the remote basis is the decryption scheme, created on the basis of cosmogeological and field materials.

The advantage of the remote base is that it explains the geology of the area from a new perspective, and helps to identify elements that are not distinguished by other methods. The main geological units distinguished by remote sensing materials are linear and ring structures, structurally decryptable complexes (SDK), which make up the endogenous framework of the structure of the studied territory, which is the basis for compiling geological, cosmological and other maps of a new generation. With the advent of the possibility of obtaining digital photographs of the Earth, a new era began in the use of satellite imagery materials (ISS) to create distance bases - cosmogeological maps (Figure 1). Creating a remote basis - a cosmogeological map includes several basic methods, such as: comparing and comparing objects within the same image and their logical interpretation [4,5].

Figure 1. Preliminary and final distance basis with fragments of satellite images.
When creating the remote base of the South Nuratau Mountains, remote sensing materials were used to solve the following problems:
- the allocation of areal and linear geological structures - complexes and their boundaries (structurally decryptable complexes);
- the study of structural and tectonic elements (discontinuous violations, tectonic blocks, crushing zones, fractures, ring and folded structures, etc.);
- integration of materials of cosmogeological, geophysical and geochemical data in the environment of GIS projects;

The solution of these problems was carried out on the basis of satellite images Landsat 7, Aster (TERRA), Quick Bird and radar satellite imagery SRTM based on software tools - ERDAS Imagine, ENVI, etc.

3. Results and Conclusion
The results of geological studies conducted by cosmological research are a remote basis used in the relevant industries, and also provide an opportunity to obtain additional information and serve as the main sources for subsequent geological research and also when planning further geological exploration. Designating the tectonic disturbances and ring structures, as well as summarizing the cosmogeological information, we can distinguish the predicted areas; using the analysis of satellite imagery channels, it is possible to solve various relevant geological problems.

Based on satellite imagery from the territory of South Nuratau, the geological structure of the territory was clarified, new information was obtained on the localization and structure of mineral objects, a zone of regional fracture was identified, buried intrusions and structures of linear types were discovered. They allowed the authors to formulate the following conclusions:
- on a remote basis, decryption identified structural-decryption complexes, structural-tectonic disturbances, reflected magmatic factors, cosmogeological objects of search value;
- by combining the results of cosmogeological and previously conducted geological, geophysical work, potentially promising areas in the study area have been identified;
- a unified remote basis was created for the South Nuratau mountains and forecast areas were identified for further exploration;
- substantiated and characterized new terms in cosmogeological research - structural interpretation systems: granitoid, volcanic-carbonate-terrigenous, terrigenous, carbonate, siliceous-carbonate, etc., as well as mixtite complexes.

Assessing the role of Earth remote sensing materials using GIS technologies to create a remote basis, it should be noted that this method, especially in combination with geophysical, geochemical, geomorphological methods, is used to solve all the main problems that geologists face in regional geological works. All the results obtained from decrypted satellite imagery and field work, faults, structural decryption complexes and their boundaries form the basis for creating a remote basis for the territory of the South Nuratau Mountains. It is one of the base maps for planning and conducting further exploration.

References
[1] Borisov O M, Glukh A K 1982 Ring structures and lineaments of Central Asia (T.) p 123
[2] Gubin V N 2004 Remote Methods in Geology: Textbook. manual for students, special (Mn.: BSU) p 138
[3] Kashkin V B, Sukhinin A I 2001 Remote sensing of the earth from space. Digital Image Processing: A Study Guide (M.: Logos)
[4] Nurkhodjaev A K, Togaev I S, Shamsiev R Z 2017 A methodological guide for compiling a cosmogeological map of the Republic of Uzbekistan based on digital space images (T.: SE "IMR")
[5] Nurkhodjaev A K, Togaev I S 2017 Materials of scientific and technical. conf. Institute of Geology and Geophysics named after Kh.M. Abdullaev (Tashkent: ANRUz)
[6] 1992 Geoinformation systems. Overview information (M.: TsNIIGAIK) p 52
[7] Asrar Ghassem 1989 Theory and applications of optical remote sensing (New York: Wiley)
[8] Dong Xinfeng, Bokun Yan, Fuping Gan and Na Li 2019 Fifth Symposium on Novel Optoelectronic Detection Technology and Application, International Society for Optics and Photonics 11023 11023Y
[9] Pal Mahendra K, Rasmussen Thorkild M, and Abdolmaleki M 2019 10th Workshop on Hyperspectral Imaging and Signal Processing: Evolution in Remote Sensing (WHISPERS) IEEE
[10] Akram M S, Mirza K, Zeeshan M and Ali I 2019 Journal of the Geological Society of India 93(5) 607
[11] Arifjanov A, Akmalov Sh, Akhmedov I, Atakulov D 2019 IOP Conf. Series: Earth and Environmental Science 403 012155(b)
[12] Arifjanov A, Samiev L, Apakhodjaeva T, Akmalov Sh 2019 IOP Conf. Series: Earth and Environmental Science 403 012153(d)
[13] Arifjanov A, Apakhodjaeva T, Akmalov Sh 2019 International Conference on Information Science and Communication Technologies (ICISCT) IEEE
[14] Togaev I, Nurkhodjaev A, Akmalov Sh 2020 E3S Web of Conferences 164 07027