



UDK:550.83 (075.8)

Davron KHUSANBAYEV,

National University of Uzbekistan Associate Professor of the Department of Geophysics

E-mail: shark_24@mail.ru

Akhmadjon TUKHTASINOV,

National University of Uzbekistan Head of the Department of Geophysics

Bohodir MELIBAYEV,

National University of Uzbekistan Associate Professor of the Department of Geophysics

University of Geology (PhD) A.Abduazimxodjayev taqrizi asosida

“HAZARDOUS NATURAL PROCESSES AND MODERN GEODYNAMIC ACTIVITY OF THE TERRITORY OF UZBEKISTAN”

Annotation

The article is aimed at identifying modern geodynamically active areas of the territory of Uzbekistan using methods of complex interpretation of geological and geophysical data and cluster analysis. In this research work, geodynamic activity is considered as one of the geodynamic ecological functions of the lithosphere. It is substantiated that modern endogenous regimes underlie geodynamic activity, as well as the occurrence of strong earthquakes in zones of alternation of the hot platform (Pi), orogenic stage 1 (O1), orogenic stages 2 and 3 with the taphrogenic regime (T/O2, T/O3). Ways to predict dangerous natural processes occurring as a result of a particular endogenous regime and their ecological consequences have been proposed.

Keywords: geodynamic activity, geodynamic ecological functions of the lithosphere, statistical analysis, cluster analysis, Earth's crust, anomaly, modern endogenous regimes.

“HAVFLI TABIIY JARAYONLAR VA O‘ZBEKISTON HUDUDINING ZAMONAVIY GEODINAMIK FAOLLIGI”

Annotatsiya

Maqola geologik-geofizik ma'lumotlarni majmuaviy talqin qilish va klaster tahlili usullaridan foydalanib O'zbekiston hududining zamonaviy geodinamik faol hududlarini ajratishga qaratilgan. Ushbu tadqiqot ishida geodinamik faollik Litosferaning geodinamik ekologik funksiyalaridan biri sifatida ko'rib chiqilgan. Geodinamik faollikning asosida zamonaviy endogen rejimlar yotishi, issiq platforma (Pi), bundan tashqari orogen 1-bosqich (O1), orogen 2- va 3-bosqichlarning tafrogen rejimi (T/O2, T/O3) bilan almashgan zonalarida kuchli zilzilalar sodir bo'lishi asoslab berilgan. U yoki bu endogen rejim natijasida sodir bo'ladigan havfli tabiiy jarayonlar va ularning ekologik oqibatlarini prognoz qilish yo'llari taklif etilgan.

Kalit so'zlar: geodinamik faollik, Litosferaning geodinamik ekologik funksiyalari, statistik tahlil, klaster tahlili, Yer qobig'i, anomaliya, zamonaviy endogen rejimlar.

“ОПАСНЫЕ ПРИРОДНЫЕ ПРОЦЕССЫ И СОВРЕМЕННАЯ ГЕОДИНАМИКА ТЕРРИТОРИИ УЗБЕКИСТАНА”

Аннотация

Статья направлена на выявление современных геодинамически активных зон территории Узбекистана с использованием методов комплексной интерпретации геологических и геофизических данных и кластерного анализа. В данной работе геодинамическая активность рассматривается как одна из геодинамических экологических функций литосферы. Основой геодинамической активности является возникновение сильных землетрясений в зонах, где расположены современные эндогенные режимы, горячая платформа (Pi), а также чередуются орогенная стадия 1 (O1), орогенные стадии 2 и 3 с тафrogenным режимом (T/O2, T/O3). Предложены методы прогнозирования опасных природных процессов и их экологических последствий в результате того или иного эндогенного режима.

Ключевые слова: геодинамическая активность, геодинамические экологические функции литосферы, статистический анализ, кластерный анализ, земная кора, аномалия, современные эндогенные режимы.

Introduction. In the study of modern geodynamic activity of the territory of Uzbekistan, the application of modern geoinformation technologies through the comprehensive interpretation of geological and geophysical data is of great importance. Geodynamic zones are tectonic structures active during the Quaternary period of geological development, and the most pronounced manifestation of their activity is seismicity. The model of geodynamically active zones is close to the linear-domain-focal (LDF) model of earthquake occurrence zones, which consists of four levels of earthquake sources: a large region, including the regional seismic regime of earthquake sources; lineaments (axes of three-dimensional seismically active fault structures), domains (geodynamically quasi-uniform volumes of the geological environment) and potential earthquake foci (most dangerous areas).

Geodynamically active zones constitute one of the geodynamic ecological functions of the lithosphere. The geodynamic ecological function of the lithosphere is understood as a function reflecting the lithosphere's ability to influence the state of the biota, the safety and comfort of human life through natural and anthropogenic (technogenic) geological processes and phenomena. The manifestation and development of these functions in natural conditions are associated with external cosmic factors, as well as changes in the geophysical fields of the Earth, the influence of geological processes on the biota - the movement of matter of the

Earth's crust and changes in the relief. Consequently, the geodynamic ecological features of the lithosphere are related to the dynamics of the energy component of the lithosphere and its material composition, including relief-forming factors.

Currently, there are two approaches to assessing the influence of the geodynamic factor of the lithosphere on biota [Trofimov, Ziling, 2002] [1]. The first of them is related to the analysis and assessment of the influence of individual geological processes or their paragenetic complexes, mainly on humans, and mainly to determine the ecological consequences of the manifestation of these processes. The second approach is related to the study of modern geodynamic zones and lithospheric anomalies and their integral impact on biota, including humans. These zones determine the peculiarities of the distribution of the stress state of rock massifs, the development of faults and permeability zones, which, in turn, influence the characteristics of the groundwater cycle, the intensification of unfavorable geological and environmentally hazardous technogenic processes. Active geodynamic anomalies can control the penetration of physical and chemical pollutants into the lithosphere, affect the surrounding landscape, biological objects, human health, and significantly reduce the value of Earth's resources.

Methods and materials. The object of the research is the lithosphere as part of the ecological-geological system, geodynamic movements - endogenous and exogenous geological processes. It is known that processes occurring in the deep parts of the Earth due to the energy released as a result of the development of matter are called internal or endogenous, and the processes of interaction of the Earth's crust with the planet's outer shell are called external or exogenous. The article focuses exclusively on endogenous processes.

Observations show that not only rocks that emerge from the underground layer to its surface erode and change. Similar changes occur when rocks formed on the surface fall under conditions characteristic of deeper zones: for example, when sedimentary rocks come into contact with magma coming from underground layers, that is, when they fall under conditions of high temperature and pressure, or when the Earth's crust is deformed under the influence of endogenous processes (folds, faults form, blocks move, etc.), and in connection with this, pressure and temperature rise sharply. In such cases, surface formations (sedimentary and often igneous rocks) turn out to be unstable. A new redistribution of matter occurs, resulting in the formation of new rocks completely different from the original.

This clearly shows the greatest dialectical law of the unity of struggle and contradiction, in which the entire history of the development of our planet since its formation is embodied. Due to this, the constant redistribution of matter occurs with the emergence of its new forms and varieties, leads to the flow of rivers, sets mountains and seas in motion, and supports life due to the penetration of ever-new materials from the depths of the Earth. As a result of the interaction of endogenous and exogenous geological processes, relief is formed. The most important feature of geological processes is their uneven manifestation on the Earth's surface in different regions, territories, and areas.

Currently, there are several directions for solving geodynamic problems, one of which is the study of endogenous regimes. Classification of the Earth's crust into quasi-homogeneous regions (Reissner G.I. et al., 1993; Tukhtasinov et al., 2023) opens up wide opportunities for the study of endogenous processes. In this case, it is necessary to establish connections between the types of shells. If the selected types of the Earth's crust are selected in such a way that they reflect different types of crustal development, i.e., different endogenous regimes, we will gain knowledge about the laws of the Earth's crust's development [Tukhtasinov A.] [3].

To a certain extent, endogenous regimes, in particular modern ones, seismicity of the Earth's crust, magmatism, accumulation of oil and gas deposits, etc., are associated with similar processes and phenomena. Therefore, the classification of the Earth's crust should be based on the use of initial data characterizing the modern structure and state of the Earth's crust.

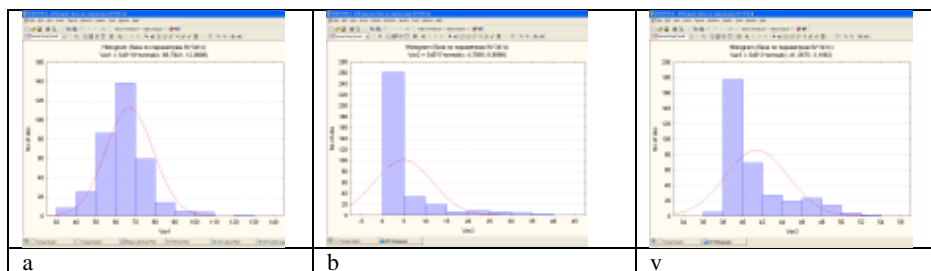
Results and discussions. In the research work, the following complex of geological and geophysical data determining the current state of the Earth's crust was used to distinguish modern endogenous regimes: Heat flux density; Earth's crust thickness; Heights of modern relief; Isostatic anomalies of gravity; Depth of deposition of the consolidated Paleozoic foundation; ΔT magnetic anomalies; Fault density; Amplitude of neotectonic movements. [Tukhtasinov A.] [3].

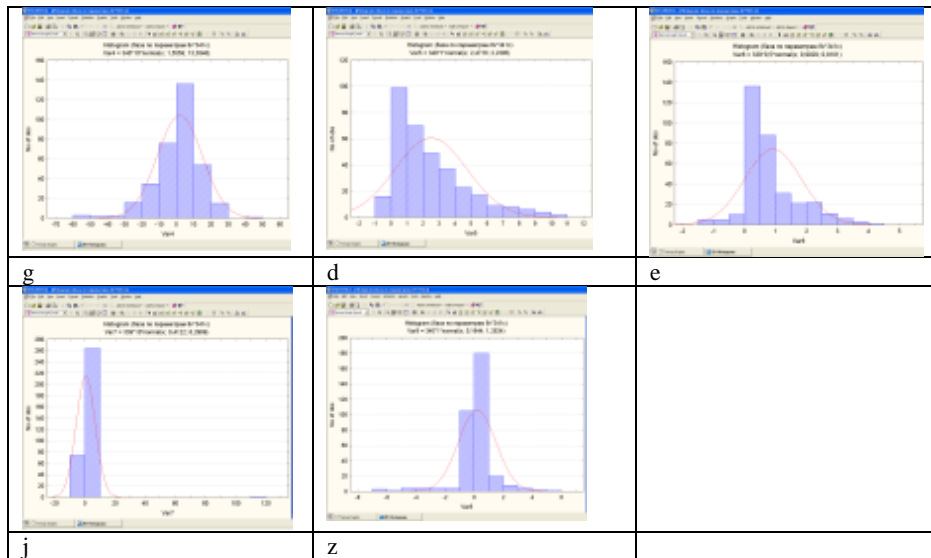
Cluster analysis was used to classify the Earth's crust into quasi-homogeneous types, and the territory of Uzbekistan was divided into 339 cells according to the 20' x 30' minute degree (geographical) grid. The statistical characteristics of individual indicators of the initial sample data for the study area are presented in Tables 1-2 and Figure 1.

Table 1

Statistical characteristics of selected geological and geophysical data

Descriptive statistics				
Parameter	Number of minced meat	Average	Minimum	Maximum
Q (mW/m ²)	339	66.91011	40.0000	130.000
R/10 (km)	339	4.72753	0.2000	38.2000
H (km)	339	41.34663	36.1500	53.1100
I (mGal)	339	1.46067	-56.0000	42.0000
F (km)	339	2.48739	0.0000	10.7600
T (ersted)	339	1.28465	-1.300	4.500
L (km/km ²)	339	0.43544	0	0.880
N (km)	339	1.23454	-6.000	5.500





a (var1) -heat flow Q , b (var2) -relief height R , v (var3) -deepness of the Mohorovičić surface N , g (var4) -isostatic anomalies I , d (var5) -deepness of the Paleozoic surface F , e (var6) -magnetic anomaly ΔT , j (var7) -density of active faults L , z (var8) - amplitude of neotectonic movements H histograms of occurrence of values.

Fig. 1. The histogram accurately shows the frequency of occurrence of indicators of a certain geological and geophysical parameter.

Table 2.

Correlation matrix of initial data

Parameter	Q (mW/m2)	R (km)	H (km)	I (mGal)	F (km)	T (ersted)	L (km/km ²)	N
Q (mW/m2)	1.00							
R (km)	0.21	1.00						
H (km)	0.12	0.81	1.00					
I (mGal)	0.10	-0.15	-0.43	1.00				
F (km)	0.06	0.15	0.10	-0.42	1.00			
T (ersted)	-0.04	0.04	0.01	0.04	-0.24	1.00		
L (km/km ²)	0.23	0.39	0.39	-0.07	0.07	-0.08	1.00	
N (km)	0.09	0.50	0.15	0.39	-0.47	0.02	0.14	1.00

In this study, the k-mean McQueen method of cluster analysis was used. The classification principle serves for the random, initial splitting of many objects into a certain number of clusters (classes, groups, populations) until some optimal splitting is achieved, with subsequent redistribution of other objects to the nearest clusters, recalculation of new "gravity centers" of clusters, and continuation of the described procedure. The peculiarity of the method is that the clusters separated as a result of calculations do not overlap, each separated object is guaranteed to belong to only one cluster [Reissner G.I.] [2].

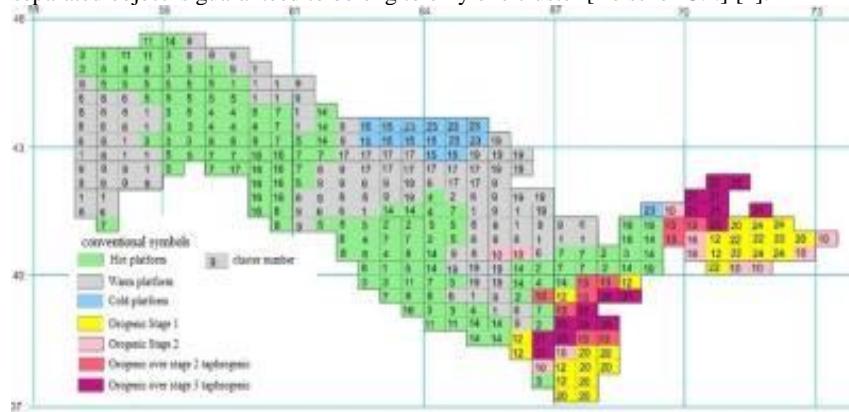


Fig. 2. Digital schematic map of modern endogenous regimes of Uzbekistan.

The first stage of solving the classification problem was used to conduct general zoning of the Earth's crust in the territory of Uzbekistan. This made it possible to identify the general patterns of spatial distribution of types of the Earth's crust. This corresponds to the total number of structural elements separated by tectonic zoning on a traditional scale, corresponding to the scale of the analyzed initial data. For the territory of Uzbekistan at this stage, shell types were divided into 25 clusters, and the analysis of the boundaries of shell types made it possible to determine modern endogenous regimes, as well as to predict the development of the Earth's crust (Fig. 2).

The spatial distribution of modern endogenous regimes shows that within the studied territory, 7 types of modern endogenous regimes are currently distinguished, located in different phases of activity. The main modern endogenous regimes are platform, orogenic, and taphrogenic (Tukhtasinov et al., 2024).

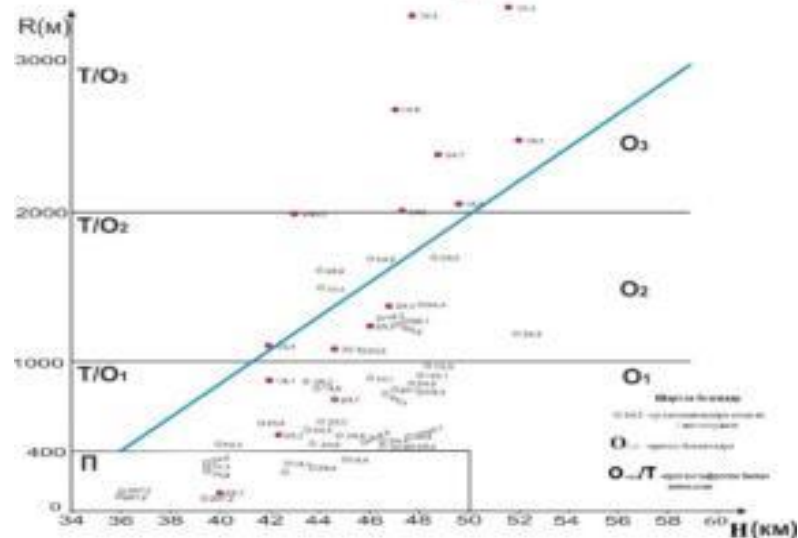


Fig. 3. Location of earthquake epicenters at different stages of modern endogenous regimes.

In the Map of Modern Endogenous Regimes of the territory of Uzbekistan, compiled according to the classification of the Earth's crust, a catalog of earthquakes that have occurred to date with an indicator of more than $M=4.0$ was created. All earthquakes with $M=4.0$ were plotted on the $R(H(Q))$ diagram, characterizing one or another modern endogenous regime (Fig. 3).

Analysis of modern endogenous regimes and the occurrence of strong earthquakes in the territory of Uzbekistan shows that in the zones of alternation with the hot platform (P_i), in addition, with the orogenic 1st stage (O_1), with the taphrogenic regime of the orogenic 2nd and 3rd stages (T/O_2 , T/O_3), high heat flow was observed and strong earthquakes occurred. High heat flows in most of the area indicate extreme geodynamic activity of the area.

If we look at the map of modern endogenous regimes, then the largest part of the population of the Republic of Uzbekistan, 79%, corresponds to regions with high geodynamic activity, where the regimes P_i , O_1 , T/O_2 and T/O_3 are developed. Most of the republic's industrial enterprises are located in these sectors. In the territory of the platform, geodynamic activity is associated not only with strong earthquakes (Kunya-Urgench, 1208, $M=6.1$; Gazli, 1976 and 1984, $M=7.3$ and $M=7.2$), as well as the rise of the Earth's crust, a decrease in the groundwater level, etc. In orogenic areas (O_1 , T/O_2 and T/O_3), in addition to strong earthquakes, landslides, emerging faults, etc., increase seismic risk.

Conclusion. The research results show that to study the geodynamic and, especially, seismological stability of the geological environment, it is necessary, first of all, to determine its geological and geophysical properties, and then to assess the dynamics of their changes through seismic monitoring. The physico-geological basis of seismic monitoring is the high sensitivity to stress and fluid resistance of the boundaries of lithospheric blocks, which usually transition to endogenous and exogenous impacts through tectonic faults. The methodology of continuous monitoring of the studied areas, in addition to determining the physical-mechanical and stress characteristics, should provide micro-seismic zoning, designed to clarify existing general seismic zoning maps in terms of changing the expected earthquake magnitude.

REFERENCES

1. Trofimov V.T., Ziling D.G. Ecological Geology. Textbook. Moscow: Geoinformark, 2003. - 278 p.
2. Reissner G.I., Johansson L.I., Reissner M.G., Baranov Yu.E. Typing of the Earth's Crust and Modern Geological Processes. M.IFZ RAN:NIIEIR, 1993. - 208p.
3. Tukhtasinov A., Khusanbayev D., Atabayev D., Abdullaev N. Forecast of provisional earthquake fields in the territory of Uzbekistan. *Scopus Joint Plenary Session of International Conferences "Construction Mechanics, Hydraulics and Water Resources Engineering - CONMECHYDRO 2023AS."* - 342-351.
4. Tukhtasinov A., Khusanbayev D. Assessment of the seismotectonic potential of the territory of Uzbekistan. *International Journal of Geology, Earth & Environmental Sciences* ISSN: 2277-2081 An Open Access, Online International Journal Available at <http://www.cibtech.org/jgee.htm> 2024 Vol. 14/. - P. 209-218.