"MODERN ENDOGENOUS REGIMES AND EVOLUTION OF THE EARTH'S CRUST OF UZBEKISTAN"

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ABSTRACT

This paper presents the results of the modeling of the modern endogenous regimes of the earth's crust in Uzbekistan.They were based on a tectonic basis in the form of classification of the earth's crust according to a complex of five features, which included information about the modern structure and state of the crust. Based on the results of comparing this tectonic base with the thresholds of modern endogenous regimes, a formalized map of the modern endogenous regimes of the earth's crust in Uzbekistan was compiled. In the study area, the following are distinguished: three subclasses of the platform regime - with hot, with warm, and with cold crust; orogenic regimes - the first, second, and third stages; superimposed regimes - taphrogen on the second and third stage orogen. The data obtained made it possible to analyze modern endogenous processes occurring in the earth's crust and its evolution at the present stage.

KEYWORDS: *Classification, Cluster Analysis, Modern Endogenous Regimes, Orogen, Taphrogen, Asthenosphere, Heat Flow, Isostatic Anomalies Of Gravity, Crust, Mantle.*

INTRODUCTION

Consideration of the main regularities in the development of the earth's crust shows that endogenous processes - tectonic, magmatic, metamorphic - are manifested in certain regular combinations with each other (Belousov, 1978 **[1]**; Marakushev, 2008 **[5]**). Moreover, as a rule, an increase or decrease in the intensity of these different processes proceeds in parallel. Thus, the internal unity of various endogenous processes is demonstrated, which gives the right to speak about the presence of certain endogenous regimes in the life of the earth's crust. Each of them is characterized by a certain shape, scale, and sequence of tectonic movements, magmatic and metamorphic processes, and exists in a particular area during a particular period of geological time.

The main source of endogenous activity of the Earth is the process of differentiation of its substance. It begins in the lower mantle, from where the heavy and light fractions, respectively, descend into the core and rise to the upper mantle (Marakushev, 2008 **[5]**; Sorokhtin et al., 2002 **[9]**).

The asthenosphere is the level at which material is generated that rises from the lower mantle. With the next portion of hot deep matter, the temperature of the asthenosphere rises. This is the mechanism of "excitation" of the asthenosphere, as a result of which melting in it intensifies, its viscosity and a density decrease, and not only geophysical but also geochemical parameters change (Marakushev et al., 2008 **[5]**; Zubkov, 2000 **[4]**). Consequently, specific endogenous regimes are determined by the ratio of the asthenosphere and lithosphere. The main role in the formation of one or another endogenous regime is played by the heat flow and the permeability of the earth's crust.

Within the framework of this article, the selection of modern endogenous regimes is provided. It is based on the use of data on the modern structure and state of the earth's crust (GI Reisner, MG Reisner, 1986, 1993 **[7,8]**). The classification of the crust based on the complex, and the analysis of the boundaries of the obtained types of the crust makes it possible to identify modern endogenous regimes and predict the development of the earth's crust.

The main role in the formation of one or another endogenous regime and the nature of its manifestation in the earth's crust is played by the heat flux.

METHODS

Heat comes to the upper mantle and crust from below, from the deeper shells of the Earth. It comes mainly by heat and mass transfer, convectively, with melts and fluids. This process of floating up of hot, relatively light material from the deep bowels of the Earth to the surface reflects the phenomenon of general differentiation going in the depths of our planet and continuing to the present time, unevenly in time and space.

Depending on the permeability of the earth's crust, the heat flow heats it in different ways. "The most effective heating of the crust occurs in an environment of high and necessarily diffuse crustal permeability when the hot material of the upper mantle penetrates the crust with a dense net" (Belousov, 1978 **[1]).** In this case, the crust heats up, and the upper mantle cools, giving all its warmth to the earth's crust.

Another way of transferring heat from the upper mantle is observed in rift and orogenic regions. In this case, the material of the upper mantle with deep heat moves along deep faults, and most of the heat is carried to the surface. At the same time, the bark heats up weaker.

Permeability is another of the most important characteristics of the earth's crust. It is determined by the ratio of the thickness of the earth's crust to its consolidated part. The thickness of the earth's crust, due to its heterogeneity, leads to an inhomogeneous distribution of the heat flux, which comes from the depths. At the same time, the heat flux affects the changes in the power of the earth's crust. N.I. Pavlenkova (1987) **[6]** notes that "in many regions, there is clear feedback between the heat flow and the power of the earth's crust: the higher the heat flow, the thinner the earth's crust. The higher the temperature at the "M" border, the shallower it lies. And this means that deep heat is the main reason for the destruction of the earth's crust and movement along with the depth of its bottom ".

The above processes are apparently due to the partial melting of the Earth's Jurassic. This is not just the melting of the bottom of the earth's crust, but more complex processes leading to a significant change in the physical properties of crustal matter.

Uneven heating of the bark leads to disruption of the gravitational equilibrium. Jets of hot fluids, penetrating with a large amount of heat into the rocks of the earth's crust, make them plastic and loosen them. As a result, a density inhomogeneity arises, causing a violation of isostatic equilibrium.

As you can see, the heat flow, the structure of the earth's crust, and inhomogeneities in the earth's crust form a single system of internal interaction. "The main law of the development of this system is the isostatic balance of each of its links. Sedimentary basins are balanced by the rise of the "M" boundary or compaction of the consolidated crust; areas with a thin earth's crust are underlain by a mantle with a lower density "(Pavlenkova, 1987 **[6]**).

The main factors of this system are heat flow, the permeability of the earth's crust, and isostatic equilibrium.

Based on this, the following set of initial information is proposed in the method of classification the earth's crust based on a complex of geological and geophysical data (Reisner et al., 1986 **[7]**):

1. Heat flow

2. The thickness of the earth's crust

3. Modern relief map

4. Isostatic gravity anomalies.

5. Depth of the consolidated foundation.

When solving classification problems, when one has to deal with large arrays of heterogeneous information, with complex combinations of initial data, the best way is its complex comprehensive, and simultaneous analysis. Such an analysis is possible by the method of cluster analysis (Durand, Odell, 1977 **[3]**). In this analysis, the criterion for unification can be a measure of proximity for the entire set of features in a multidimensional space. For a measure of proximity, you can take the Euclidean or Cartesian distance, the logarithmic or racial Pearson criterion, or some other measure. The solution to the problem of cluster analysis is to split an object of the same rank, characterized by a complex of initial data, into objects of a higher rank, each of which can be described by a set of values of the same initial data inherent only to it.

In this study, we used one of the cluster analysis methods - the McQueen k-means method. The classification principle is reduced to some, possibly random, initial partitioning of the set of objects into a given number of clusters (classes, groups, populations), the subsequent assignment of the remaining objects to the nearest clusters, recalculation of new "centers of gravity" of the clusters and the continuation of the described procedure until it is obtained some optimal partitioning. A feature of the method is that the clusters identified as a result of calculations will not intersect - it is guaranteed that each classified object will be assigned to only one cluster.

To carry out cluster analysis by the k-means method, the authors of this study used the STATISTICA v 6.0 program. The program starts with *k* - randomly selected clusters and then changes the belonging of objects to them to: firstly, to minimize the variability within the clusters, and secondly, to maximize the variability between clusters.

Euclidean distance was used as a measure of proximity

$$L_{n,e} = \left\{ \sum_j (X_j^n - X_j^e)^{\frac{1}{2}} \right\}$$

where, X_j^n and X_j^e -the initial characteristics are n and e, respectively.

It is natural to expect that a small value of this distance indicates that the objects are similar or "close" to each other, while a large value indicates a lack of similarity.

The technology of the method consists in performing the following procedures. The entire study area is divided into cells of the same size (20 'x 30' degree grid). This corresponds to one tablet of a 1: 100000 topographic map. The choice of this cell size seems to be optimal. Firstly, it is because all the source maps from which information is taken are small-scale (1: 1,000,000). And if we choose a slightly larger cell size, the initial information will be significantly averaged, while its smaller size will not be provided by the initial information of the taken scale. Secondly, each cell will represent a volume of the earth's crust of the same size with data characteristic only of it.

For each cell, the values of the initial information are taken from each of the five selected features (maps). The initial information obtained in this way is entered in the form of a format file on a computer for further processing. The data format is integers.

When conducting cluster analysis, the territory of the Republic of Uzbekistan is divided into 339 cells, each cell, as already noted, above corresponds to a 20 'x 30' degree grid. Using k-mean cluster analysis, the entire set of input data was divided into clusters into five steps. At the first step of cluster analysis, when the measure of proximity is small, i.e. the distance between the signs is small. The whole territory of Uzbekistan is divided into 200 clusters. For the second, third, fourth, and fifth steps of cluster analysis, 150, 120, 50, and 25 clusters were obtained, respectively.

Based on the results obtained, a formalized map was constructed for 25 clusters (A. Tukhtasinov, D. Khusanbaev, 2021 **[10]**) (Fig. 1).

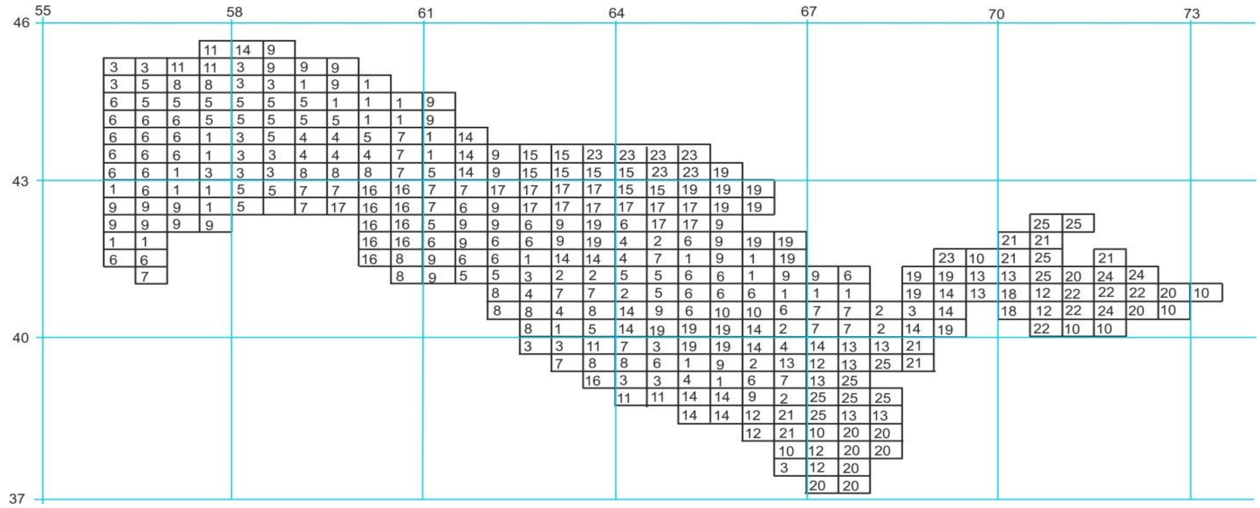

Fig. 1. Formalized map of classification of the earth's crust in Uzbekistan (25 types)

In fig. 1 clearly shows two large structural units divided the study area into the Turan plate and the Tian Shan orogen. The latter has a sublatitudinal elongation, thereby correlating well with the real situation.

Let's consider each of these structural units separately. The Turan plate is characterized by 1, 2, 3, 4, 6, 7, 8, 9, 11, 14, 16, 17, 19 types of crust. This territory as a whole is characterized by a low relief up to 0.4 km., The compensated crust is isostatic anomalies from - 13 to +22 mGal, a small thickness of the earth's crust from 35 to 41 km., And widely varying values of heat flow from 43 to 93 mW / m2.

The Orogen of the Tien Shan is represented by crust types 12, 13, 18, 20, 21, 22, 23, 24, 25. The relief varies in a wide range from 0.5 to 4 km, isostatic anomalies in the Fergana intermountain depression up to - 50 mGal, in Surkhandarya depression up to - 22.5 mGal, for axial parts of mega anticlines up to +20 mGal. The thickness of the earth's crust is from 42 to 50 km, the heat flow values vary widely from 55 to 150 mW / m2.

RESULTS AND DISCUSSIONS

The results of classification of the earth's crust in this step (25 types), when examined, correlate well with the latest tectonics. This situation makes it possible to use the results of classification to solve the set task of identifying modern endogenous regimes.

The main problem in identifying modern endogenous regimes is to determine the relationship between the adjacent types of the cortex. Previous work on the identification of both endogenous and modern endogenous regimes showed that there are three types of boundaries: a constructive boundary, at which the values of the heat flow and the thickness of the earth's crust increase. Destructive boundary, at which the heat flow increases, and the thickness of the earth's crust decreases. With the third type of boundaries, the behavior of the main features (heat flow and thickness of the earth's crust) is usually not maintained, or the change in these features is insignificant or they are noted only for one of them (Belousov 1986 **[1]**, Pavlenkova 2002 **[6**], G.I. Reisner, M.G. Reisner, 1986, 1990 **[7,8]**). At the same time, when identifying modern endogenous regimes, an important task is to determine the boundary values for several signs that allow one or another territory to be attributed to the sphere of manifestation of different regimes.

The analysis of the pattern led to the choice of the following boundary values (thresholds) for the identification of modern endogenous regimes (GI Reisner et al. 1993 **[8]**) (table 1).

TABLE 1. MATRIX OF ENDOGENOUS MODES OF STAGES OF THEIR MANIFESTATION AND PHASES OF STATE (GI REISNER ET AL, 1993 [8])

DT (km)	**R (km)**	**Q (mVt/m^2)**		
		<50	0=50. <70	>70
0 km	<=+0,4 >0,4. <+1,0 >1,0<=2,5 >2,5	P-Ph1 01-Ph1 02-Ph1 03-Ph1	P-Ph2 01-Ph2 02-Ph2 03-Ph2	P-Ph3 01-Ph3 02-Ph3 03-Ph3
-6.0 km>=DT<0	<=+0,4 >0,4.<=1,0 >1,0<=2,5 >2,5	T1- Ph 1 T101-Ph1 T102-Ph1 T103- Ph1	T1-Ph2 T101-Ph2 T102-Ph2 T103-Ph2	T1-Ph3 T201-Ph3 T202-Ph3 T203-Ph3
-15 km>DT<-6,0	<=+0.4 >0.4.<=1.0 >1.0<=2,5 >2,5	T3-Ph1 T301- Ph1 T302- Ph1 T303- Ph1	T3-Ph2 T301- Ph2 T302- Ph2 T303- Ph2	T3-Ph1 T301-Ph3 T302-Ph3 T303-Ph3

Note: 1. Letters denote the names of endogenous modes - P-platform, T-taphrogenic, O-orogenic, T / O - taphrogenic in place of the early orogenic: the stages of manifestation of endogenous modes are indicated in Arabic numerals: the symbol Ph indicates the activity of the regime, and the Arabic numeral next - 1,2,3 phases; DT - deficit of the thickness of the earth's crust in km; R – elevation of relief in km; Q- heat flow in mVt/m^2.

It should be noted that the authors of this article agree. As a result of comparing the results of classification of the earth's crust with the thresholds of endogenous regimes, a map of modern endogenous regimes was obtained (Fig. 2) and the average values of the types of the earth's crust corresponding to various modern endogenous regimes were obtained (Table 2.)

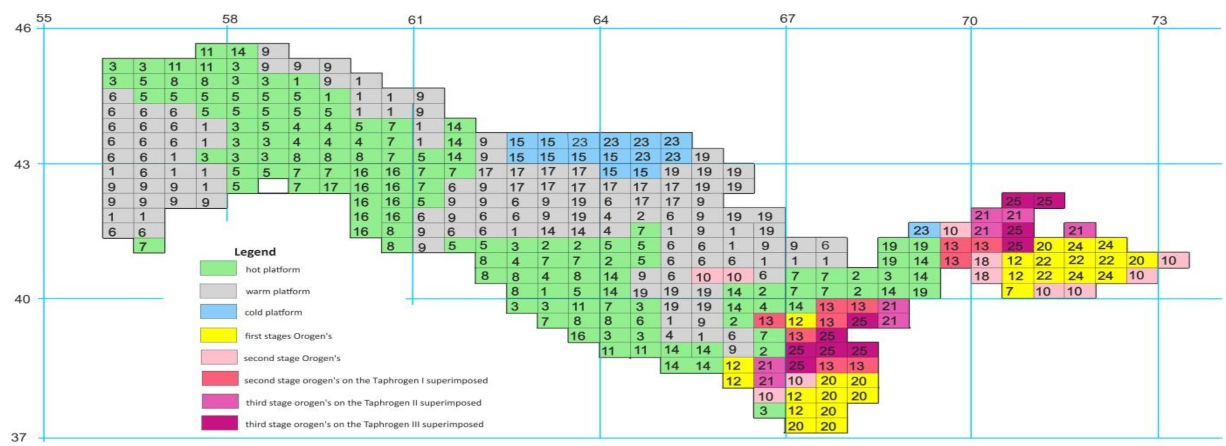

Fig. 2. Formalized map of modern endogenous regimes of Uzbekistan

TABLE 2. AVERAGE VALUES OF THE TYPES OF THE EARTH'S CRUST CORRESPONDING TO VARIOUS MODERN ENDOGENOUS REGIMES

№	Q	R	H	I	F	Tips of MER	DH
Claster1	64,10714	1,61786	39,62250	5,96429	2,29393	Warm platform	1,603
Claster2	69,44444	5,46667	41,72445	2,66667	1,03556	Warm platform	1,280
Claster3	68,25000	1,69000	40,23400	-1,15000	4,16400	Warm platform	2,169
Claster4	75,00000	2,17273	39,50818	1,27273	1,95364	Hot platform	1,139
Claster5	70,00000	1,36400	39,66440	5,36000	2,80040	Hot platform	1,805
Claster6	63,08823	2,44706	39,69765	13,14706	2,44588	Warm platform	1,156
Claster7	73,09524	3,34762	40,74429	15,66667	1,29667	Hot platform	1,635
Claster8	81,42857	1,60000	39,28143	5,57143	2,93143	Hot platform	1,273
Claster9	58,90625	1,43750	39,75938	1,34375	2,42188	Warm platform	1,853
Claster10	60,00000	12,65556	46,17667	4,88889	1,62111	Orogen II	1,203
Claster11	81,66666	1,90000	40,65667	-6,33333	6,10667	Hot platform	2,459
Claster12	79,2857	8,1429	45,2429	-19,7143	5,6286	Orogen I	3,112
Claster13	80,00000	16,09000	46,48900	2,80000	1,83500	Orogen II /Taphrogen I	-0,647
Claster14	67,36842	3,90000	41,96368	-8,78947	2,39526	Warm platform	2,506
Claster15	43,12500	2,16250	39,87875	3,75000	0,94125	Cold platform	1,516
Claster16	98,00000	1,56000	38,98600	16,70000	1,66600	Hot platform	1,003
Claster17	50,38462	2,83846	39,23000	23,76923	0,57385	Warm platform	0,441
Claster18	120,0000	14,0000	48,1000	-21,0000	3,2000	Orogen II	2,28
Claster19	56,5000	3,3200	40,8870	-10,6500	1,1985	Warm platform	1,795
Claster20	54,4444	8,8000	45,7578	-18,8889	8,4244	Orogen I	3,213
Claster21	66,2500	21,4125	47,7788	-11,6250	1,1588	Orogen III /Taphrogen II	-2,711
Claster22	62,5000	4,7500	46,9250	-52,5000	7,9750	Orogen I	6,932
Claster23	43,5714	2,4857	40,9200	-19,8571	1,1343	Cold platform	2,354
Claster24	58,3333	7,1667	48,0500	-32,3333	5,7167	Orogen I	6,534
Claster25	80,50000	30,77000	49,05700	4,50000	0,37300	Orogen III /Taphrogen III	-7,328

The spatial distribution of modern endogenous regimes in Fig. 2 shows that within the studied region, 8 varieties of modern endogenous regimes are distinguished, which are currently in different phases of activity. There are only 3 main modern endogenous modes-platform, orogenic and taphrogenic.

The platform regime in the studied area passes through several stages in its development, including those associated with thermal excitation of the earth's crust and upper mantle. But structural changes in the earth's crust (change in thickness, relief height, etc.) have not yet occurred.

The platform mode in the calm phase (cold platform) is distributed partially mainly in the northern part of the Republic of Uzbekistan (Kokayaz depression). In contrast, the platform regime in the transitional phase (the platform is warm) is widely developed on the Ustyurt plateau, in the Central Kyzyl Kum, the Pritashkent depression, partly in the Bukhara and Chardzhou tectonic steps. The platform regime in the active phase (hot platform) is also widely developed and covers the central part of the Ustyurt plateau, the Aral depression, the Bukhara and Chardzhoi tectonic stages.

The orogenic regime on the territory of Uzbekistan manifests itself only in the active phase, and the action of this regime affects the earth's crust both constructively and destructively with the imposition of a taphrogenic regime of various stages on it.

The first stage of the manifestation of the orogenic regime spreads along the Nurata ridge, the northwestern spurs of the Turkestan and Zeravshan ranges, the Surkhandarya and Fergana depressions. These areas are, in fact, currently active areas of the transition from the platform to the orogen.

The second stage of manifestation of an active orogenic regime is developed in the western end of the Zeravshan ridge, in the southwestern spurs of the Gissar ridge, in the Chatkal-Kuramin, and Turkestan-Alai systems of uplifts in fragments. In some parts of these orogenic systems, the orogenic regime of the second stage was replaced by the taphrogenic regime in the first stage (cluster 13). Geomorphologically, these are the southwestern spurs of the Chatkalo-Kuramin mountains, the northwestern and southeastern spurs of the Gissar ridge.

On the axial parts of the ridges of the Chatkalo-Kuramin mega anticline and the Zeravshan-Gissar mega anticline, the orogenic regime of the third stage in the active phase was replaced by the superimposed taphrogenic regime of the second (cluster 21) and third stage (cluster 25), which actively affects the formation of a deficit in the thickness of the earth's crust.

CONCLUSION

Based on the materials obtained, the following conclusions can be drawn. At the end of the Middle Cretaceous, there is a decrease in the gradient of vertical movements, and this entire huge area becomes a platform. The next, orogenic regime began in almost the entire eastern part of the considered territory in the Neogene. Within the study area, the newest orogenic regime replaced the platform regime, in the part where, as a result of endogenous activity in the upper mantle, the thickness of the earth's crust increased. This constructive orogenic regime continued approximately until the end of the Pliocene when the formation of structures and mountainous relief was completed. An abrupt change in the endogenous environment occurred at the beginning of the Quaternary period when development along the taphrogenic line began to dominate. This is observed in the deficit of the earth's crust, which is on the axial parts of the ridges of the Chatkalo-Kuraminmeganticline and Zeravshan-Gissarmeganticline (clusters 21 and 25), respectively, minus 2.7 and 7.3 km. from normal. But in the areas of development of the orogenic regimes of the second and third stages, which are superimposed on taphrogenic regimes, there are no elements of crustal extension. Under lateral compression, the pure rift process becomes impossible. The compressed continental crust does not diminish its thickness. Partially molten material of the mantle, reaching the bottom of the crust, differentiates; molten material is localized in the form of magma chambers under the crust.Light mantle cumulates, formed as a result of differentiation and corresponding in composition to the earth's crust, solidify, join the crust with the displacement of the Mohorovichich surface to a new, deeper hypsometric level. A body light in comparison with the mantle in the lower crust, striving to restore isostatic equilibrium, lifts the earth's crust with the formation of mountains (Atabaev, Khusanbaev, 2020 **[11]**).

The data presented show that in the southeastern part of Uzbekistan (Western Tien Shan), there is a spatial combination of different modern endogenous regimes and their overlap with previously developing ones. The processing of the previously created orogenic structure by the modern taphrogenic regime occurs, apparently, by capturing its parts, which does not change its spatial position with the neighboring ones, as evidenced by the preservation of a single structure. The presence of taphrogenesis in the earth's crust under these mountain structures was pointed out at different times by many researchers.

In contrast, only the platform regime is developed within the Turan plate, characterized mainly by high values of the heat flow, which indicates large energy, and, consequently, the endogenous and tectonic potential of the earth's crust of this territory, ready for transformations.

REFERENCES

1. Belousov VV. Endogenous regimes of continents. M.: Nedra, 1978. 232p.

2. Belousov VV, Pavlenkova NI. Types of the Earth's crust. Geotectonics, 1985;(1):3-14.

3. Durand K, Odell F. Cluster analysis. M.: Statistics, 1977. 239p.

4. Zubkov VS. On the question of the influence of hydrocarbon-inorganic fluid on deep geodynamics and processes in the lithosphere. Geochemical processes and useful minerals. Bulletin of GeoIGU, 2000;(2):10-28.

5. Marakushev AA, Marakushev SA. Hydrogen respiration of the Earth - its origin, geological and biological consequences. Alternative energy and ecology. 2008;1(57):156-174.

6. Pavlenkova NI. The structure of the earth's crust, upper mantle and global tectonics. Controversial aspects of plate tectonics and possible alternatives. M.: IPE, 2002, pp.64-72.

7. Reisner GI, Reisner MG. Modern endogenous regimes. Reports of the ANSSSR, 1986;291(6):1336-1339.

8. Reisner GI, Ioganson LI, Reisner MG, Baranov YE. Classification of the earth's crust and modern geological processes. NIIEIR. M.: IPE RAN, 1993, 210 p.

9. Sorokhtin OG, Ushakov SA. Development of the Earth. M.: Moscow State University, 2002, 506p.

10. Tukhtasinov AKh, Khusanbaev DD, Atabaev DKh. Classification of the earth's crust in Uzbekistan based on a complex of geological and geophysical data. Science and innovative development, Tashkent, 2021. pp. 43-54.

11. Atabaev DKh, Khusanbaev DD, Atabaeva NE, Israilova ZU. Some Peculiarities of the Tectonic Development of the Jointing Area of the Turanian Plate Origened Tien Shan Structures. Solid State Technology. 2020;63(4).