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***Research Article***

# THE ALLOCATION OF STAGES OF RELIEF FORMATION USING COSMOGEOLOGICAL RESEARCH METHODS (ANGREN DEPRESSION, CHATKAL-KURAMA REGION, UZBEKISTAN)

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**ABSTRACT**
This article discusses the author's method for processing automatic lineament analysis in Win LESSA software using as example the space imagery material of the Angren depression. As a result, this made it possible to distinguish the stages of the formation of the relief within the Angren depression

***Keywords:*** *Depression, Block, Uplift, Faults, Neotectonics, LESSA, Space imagery, Interpretation*

## INTRODUCTION

Angren depression with its brown coal deposit and kaolin clays as a structure formed as a result of complex tectonic-sedimentation and deformation processes attracts the attention of a wide range of researchers studying its tectonics, the history of development, occurrences of cyclicity and the frequency of geological phenomena (Zakharevich, 1965). Most of them consider its formation and the flow of cyclic processes in it in a purely isolated graben-shaped downfold, or a gentle geosynline or in the subsidence moulds of the inherited structures of the Paleozoic calderas (Klimanov, 2003). At the same time, the issues of interregional correlation of the stages of epiplatform orogenesis or the actual orogenic movements of this area, so necessary for the correct understanding of tectonics and the history of the geological development of the region, are left without due attention.

The territory of the Angren depression is part of the Middle Tien Shan, which is represented as a Hercynian folded structure, which has been subjected to a powerful alpine orogenesis, as a result of which a currently observed structure was formed. Sadikova L.R. distinguishes it as an epiplatform alpine orogenesis (Sadikova, 2022). V.S. Burtman identifies four stages of orogenesis in the Tien Shan: embryonic, early, middle and late (Burtman, 2006).

The latest structure of the Angren depression is represented by a system of large blocks (East-Angren, Iertash, Central-Angren, Telyau, Akhangaran-Almalyk), pressed by the blocks of the Chatkal and Kurama uplifts. In the north, this system of blocks is limited by the North Angren thrust, on which the Paleozoic blocks of the Chatkal uplift are thrust over on the Mesozoic-Cainozoic sediments of the Angren depression in the southeast direction. In the south – it is limited by the Naugarzan fault, where the Paleozoic blocks of the Kurama uplift are thrust over to the Mesozoic-Cainozoic sediments of the depression in the north-west direction. The mechanism of convergence of the Chatkal and Kurama paleozoic blocks and the contractions of the transverse size of the Angren depression is currently explained by the action of submeridional compression stresses, as a possible echo caused by collision of European and Hindustan lithospheric plates. The fault-line nature of the Angren depression and the thrust of the Paleozoic foundation on the Mesozoic-Cainozoic deposits allow it to be classified as "closed" structures of medium scale, which have preserved the relics of submerged zones.

Quaternary deposits are widely developed within the Chatkal-Kurama region. They are characterized by the great heterogeneity of the composition, structure and origin (Pinhasov, 1984). They are developed

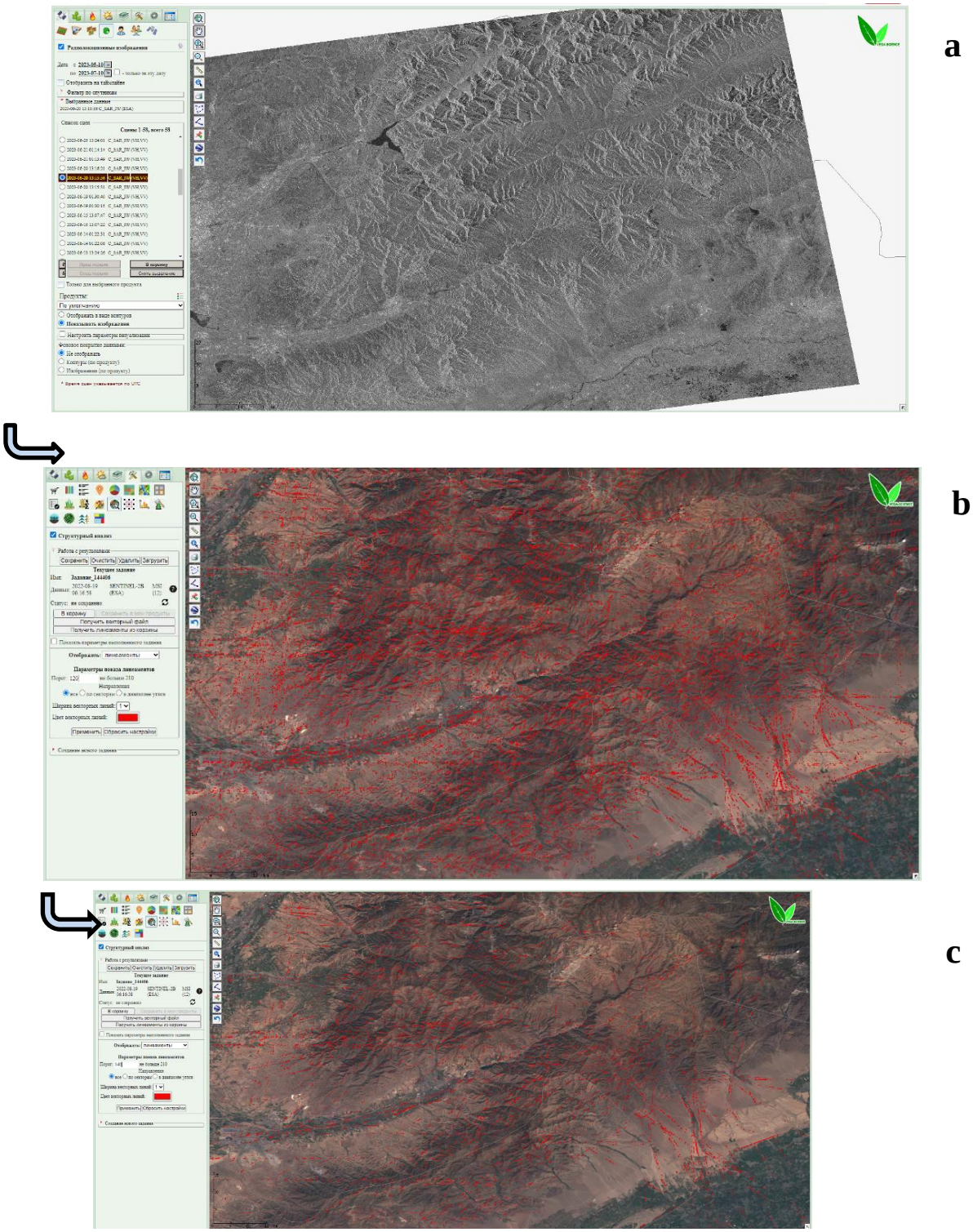


**Figure 1: Processing stage in the Win LESSA program. a) Alos-Palsar radar space image; b) linear objects of primary linear orientation; c) selected lineaments.**

along the river valleys, in intermountain depressions, forming a thick trail along the periphery of the mountain ranges of the Tien Shan. In the described territory, deposits of all series of the Quarternary system are developed, starting with an Eo-pleistocene and ending with a latest link, and, inside the series, complexes and formations with local geographical names are distinguished. The deposits of the Quarternary system represented by continental formations are developed everywhere (Korchuganova, 2006).

## MATERIALS AND METHODS

Various methodologies were used for the research on the elements of the neotectonic cycle and their expression in the latest relief. These methodologies integrated various remote sensing techniques, geospatial analysis tools, and geological interpretations to investigate the neotectonic cycle and its influence on the latest relief in the Chatkal-Kurama region.

## RESULTS AND DISCUSSION

Elements of the neotechtonic cycle are usually clearly expressed in the latest relief, so they can be distinguished through structural intepretation of the Earth remote sensing materials.

According to a well-known understanding, lineaments are the result of tectonic processes, expressed in the relief by long and linear-oriented objects. To date, extensive experience has been accumulated in the application of the results of lineament analysis in various areas and directions of the earth sciences. The results of automated lineament analysis with a methodological sequence are given in Figure 1.

To identify linear structures, ALOS-PALSAR space images with high radar resolution were used, as well as the infrared range of space images of Landsat-8, Sentinel-2A was also used at parallel.

By comparison of the received data with a tectonic map geoblocks are distinguished, this is explained by a different degree of tectonic activity and the lithological composition of the studied territory. To identify these blocks, a rose diagram is used to highlight the boundaries of tectonic blocks, as well as the directions of local tectonic structures in a particular area of various orientations (Figure 2).

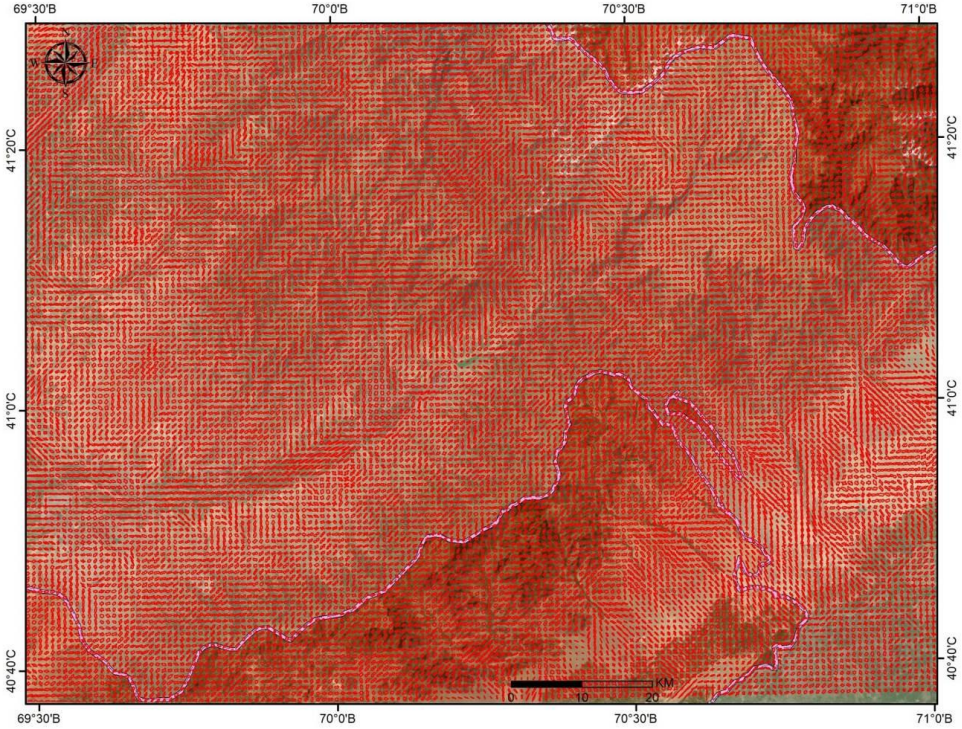


**Figure 2: Rose diagram of the study territory.**

The display of a special network of lineaments of various structurally interpreted complexes identified in the Lessa program (DCS by the Landsat-8 space images), regional and local levels of generalization (by the ALOS-PALSAR radar data) will serve as the basis of the study scheme (Figure 3).

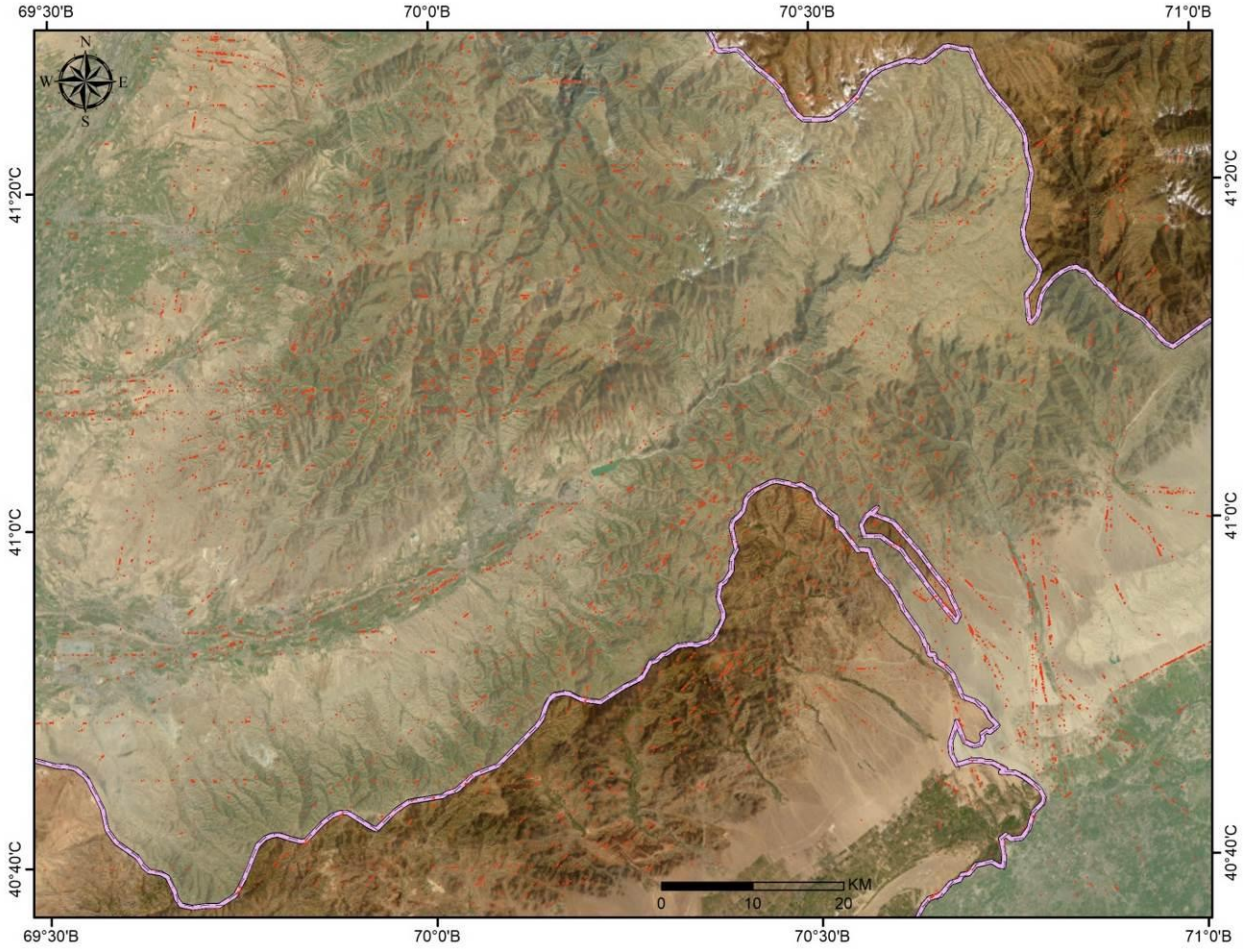


**Figure 3: Results of automatic lineament analysis in LESSA software (after filtration)**

LESSA was developed with customized presets, which allow to sort lineaments with different step and length. This task is performed with changes in the "Threshold" value.

A characteristic diverse orientation of the lineaments developed in the study territory is visible on the given above map. The main parameter of the location and orientation of lineaments are a complex geomorphological relief.

In the morphological appearance of the Chatkal-Kurama region, the features of relief relationships with structures are clearly expressed. The nature of the occurence of the latest tectonic movements is ubiquitous, which determines the features of the latest relief.

A change in the appearance of the relief occurs as a result of tectonic activity, showing in large areas, leading to the formation of large arch-like structures and vast peneplanation planes on their wings and arches.

Finally, another advantage of LESSA is to create a tectonic displacement density map (Figure 4).

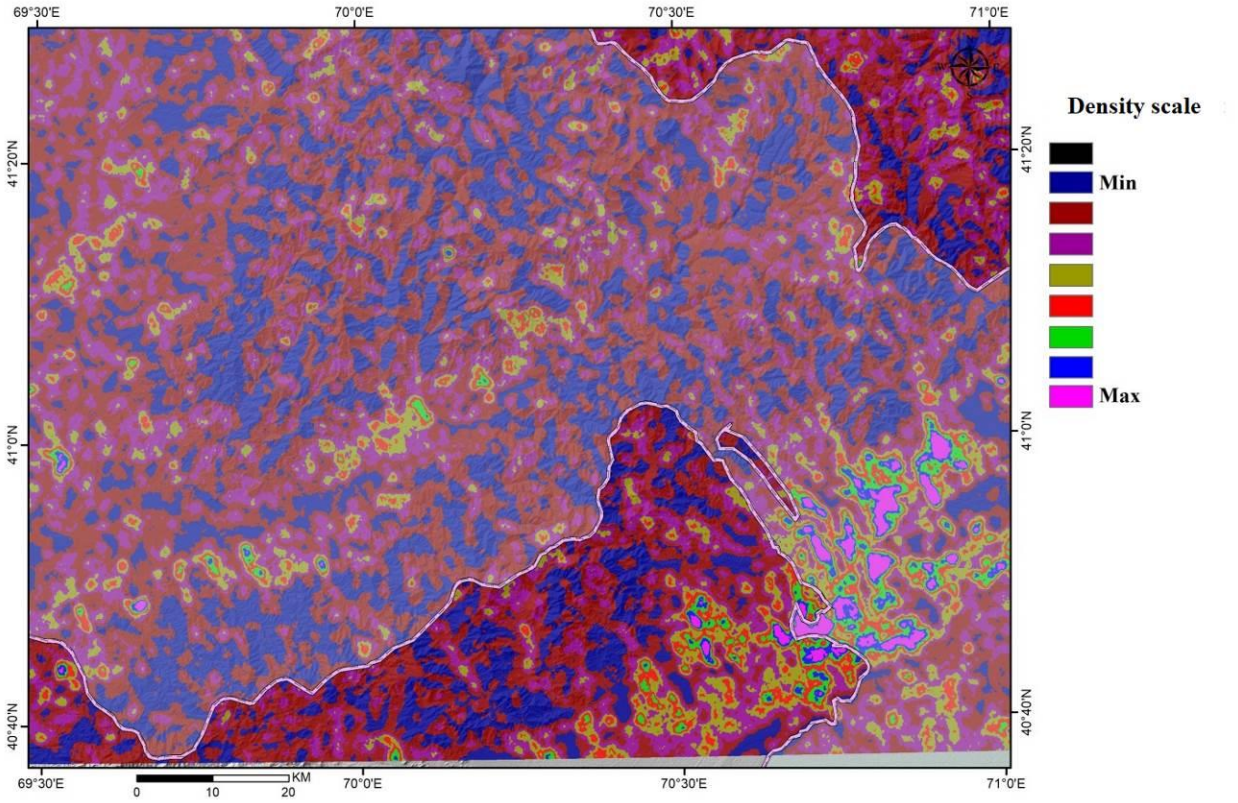


**Figure 4: Density map of tectonic displacement created in LESSA software.**

To eliminate the probability of random errors, the ArcMap program with the ArcToolBox module → Line Density, which allows you to create a tectonic displacement density map according to the existing data on linear structures, was used (Figure 5). As a result, we get a tectonic displacement density map taking into account the data of the neotectonic cycle.
It should be noted that when building a tectonic displacement density map, the data of the stock materials, as well as the results of automated and visual interpretation of space images, were taken into account.

It is known that the relation of the latest relief with neotectonics is part of the base of the method of geological interpretation of the space sensing materials, especially the interpretation of structural forms. The trend and intensity of tectonic movements leads to a variety of geomorphological characteristics and varying degrees of geological interpretation (Korchuganova, 2006).
Digital relief model of the Chatkal-Kurama region (with a resolution of 30 m) was created using radar survey data.
Structural interpretation of a topographic map of a scale of 1: 100,000 (author's version). A comprehensive interpretation and static analysis of all available digital materials made it possible to build a map of the latest tectonics of a scale of 1: 100,000 representing block and rupture tectonics of the studied territory.
As a result of a scientific task and experimental analysis, the map shows the regional and local tectonic elements of the region such as: uplifts, depressions, rupture displacements of different orders (Figure 6).

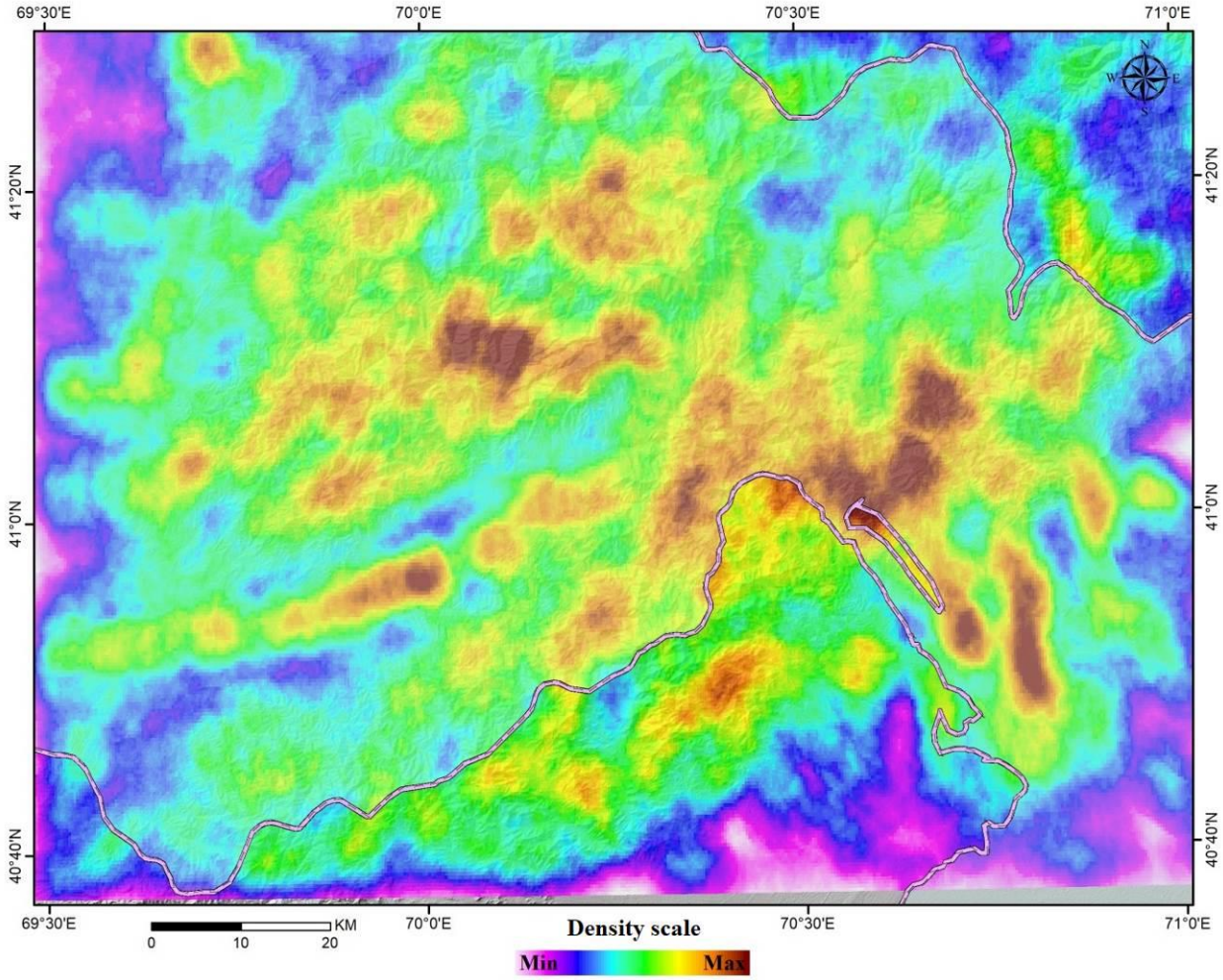


**Fig. 5. Tectonic displacement density map created in ArcMAP software (Line Density).**

The most common type of movements in the latest tectonics are rupture deformations, which are more clearly interpreted on the materials of the RES (Figure 6).

The tectonic structure of the region differs not only by the history of tectonic development, the nature of the occurence of the latest movements, the deformation of the Paleozoic foundation, but also the regularities for the location of the folds and their morphology. The area is characterized by a combination of both positive and negative elements of various order, limited, as a rule, by rupture discontinuties.

Maping of peneplanation plane clearly interpreted on the space images of a different range allows you to restore to the arch structure, the central part of which forms a morphological unit - the Angren plateau. On the sides of the plateau and the northern slope of the Karzhantau and Ugam ridges, the Mesozoic and Cenozoic deposits and the peneplanation plane were preserved, which determines the pre-Paleogene age of the surface of the plateau.

Thus, the district belongs to the tectonic area, which has undergone repeated deformations, up to the latest and modern. The region itself represents the area of block tectonics with the expression in the relief of the latest and updated faults inherited from the ancient and periodically updated at various stages of the development of the earth's crust of the region. The area is characterized by spatial continuity in the

development of young structural forms from more ancient. Almost all faults are in the region inherited and renewed.

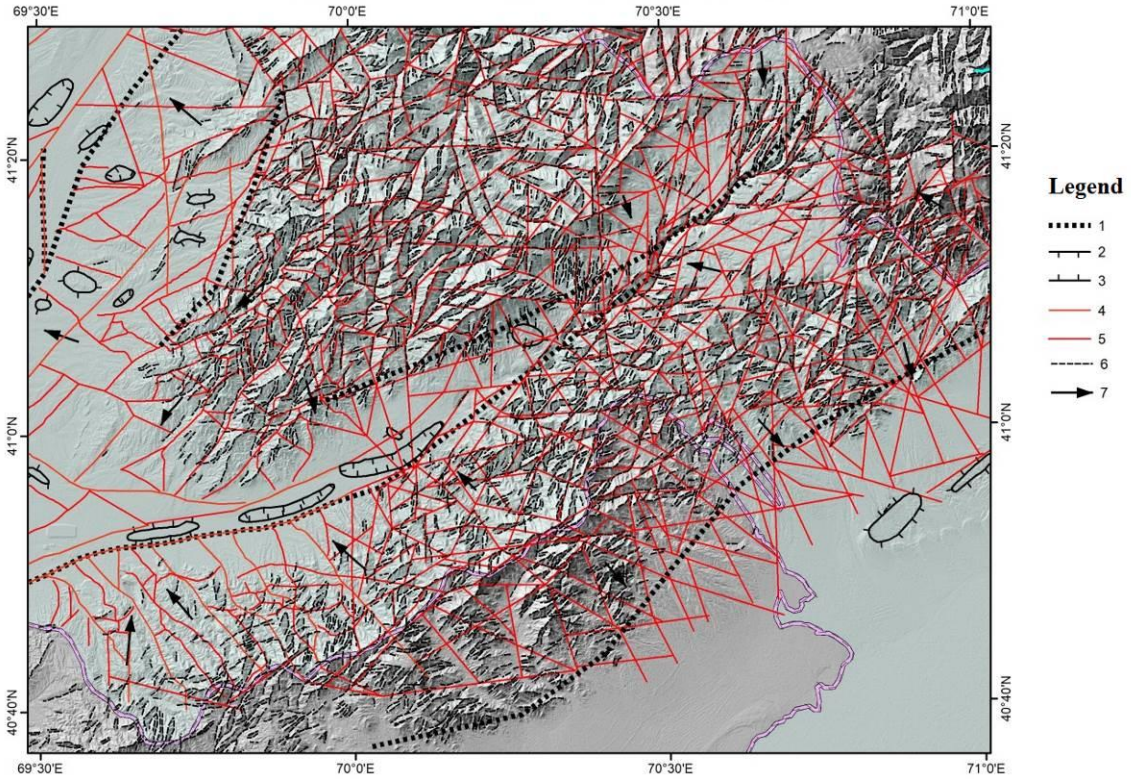


**Figure 6: Latest tectonics map of the study area**

*Legend: 1 – boundaries of main uplifts and depressions; 2 – neobrachyanticlines;3 – neobrachysynclines; 4 – main neofaults; 5 – secondary faults found by morphometric methods; 6 – results of automatic lineament analysis on the base of relief drawing; 7 – directions of stresses;*

The age of the relief of the studied territory can be considered as Hungry-steppe; from the relief of the Sokh time almost nothing has been preserved; the loesses of Tashkent time filled the irregularities in the relief and did not create it; in the Hungry-steppe time there was washaway of the deposits of the Tashkent complex and the formation of $Q_{III}$ rocks, and in $Q_{IV}$ a large area of sediments of $Q_{III}$ has been preserved, since the time for their erosion is significantly less and the creation of the Syr Darya complex is still far from completed. Modern forms of relief and depth of cutting the valleys, mainly, were formed in the stages of development of Quarternary time and tectonic dislocations allocated by the study of qurternary sediments and structural-morphometric analysis are inherited by block movements of the previous times. Based on the foregoing, the concept of the time limits of the latest movements is mainly considered as a Quarternary time.

## CONCLUSION

1. The pecularity of the Chatkal-Kurama region are above mentioned arch uplifts separated in the relief, which were emphasized by the development of the peneplanation plane and rift-like faults associated with the arch structures, the fracturing zones.
2. As a result of a morphometric analysis of RES materials, a map of the latest tectonics was built, which is the main and secondary neofaults. The direction of stresses is established by a comparative analysis of radar images and the tectonic displacement density map.

3. In the arch uplift parts, lineaments and neofaults are developed. In the most plain parts of the Angren, Chirchik, North Fergana depressesions, the brachyanticlines and the brachysynclines are developed.
4. The displacement of the Neogene depression to the north is accompanied by crumpling and thrusting the bending area in Jurassic period with the simultaneous displacement into the depression and the front of sedimentation and deformation.

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