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Lineaments analysis of the Dniester area (between Bakota and Novodnistrovsk)

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SUMMARY

The study of lineaments has been conducted for over a century. Since then, various methods and approaches to their study have been developed. The results of the research of lineaments have applications in various branches of geology, including petroleum geology, hydrogeology, engineering geology, and minerals. In this post, we present the results of a study of lineaments in the middle reaches of the Dniester. We used both remote and traditional field research methods to study lineaments. As a result of the processing of Earth remote sensing data, geophysical studies, field observations, a number of maps and diagrams have been constructed. These included lineaments maps, lineaments density maps, rose charts of the lineaments and joints. Joint analysis and comparison of these data allowed to conclude about the peculiarities of the distribution of lineaments, their conditionality by geological structures, areas of high concentration. It is concluded that there is a need for detailed research in the area of Stara Ushytsya since the maximum density of lineaments is set here. The average value of the lineaments density is noted for the hydraulic structures of the area. Our studies have shown that the study of lineaments is an effective tool for research the effect of the geological substrate on the state of the terrain.

Introduction

The concept of lineaments and the term "lineaments itself was introduced into the geological circulation by Hobbs in 1904 (Hobbs, 1903). Although it is possible to find in the geological literature a large number of definitions of the term "lineament" (even such exotic ones as cloudlineaments, negative and positive lineaments, underground lineaments, geophysical lineaments, magnetic lineaments) the concept remains unchanged. Its essence is that linear objects reflect the geological structure and lineaments may be used to elucidate the internal structure inaccessible to direct observations. In contrast to the concept, methods and approaches to the collection, processing and presentation of lineaments over the last century have changed significantly and have undergone a dramatic development (Tiren, 2010; Florinsky 2016). First and foremost is the use of digital (Farahbakhsh et al., 2020) technologies and data from space (Muhammad & Awdal, 2012). Thanks to IT technologies the possibility of automatic extraction of lineaments has emerged.

For the study of lineaments, we chose the Dniester section between Bakota and Novodnistorvsk for several reasons. First, there is a geological map of 1: 200000 high quality scale for this territory issued in 2008 (Bratslavsky et al, 2007).

The presence of a high quality geological background is an important point in the study of lineaments because it is used to compare and interpret the results obtained. Secondly, in this part along the Dniester river and its tributaries there are many outcrops of rocks of the different ages, ranging from Archean to Quaternary, which may be used to collect geological and structural information for the subsequent interpretation of the lineaments.

The third reason is the presence of hydrotechnical structures (Novodnistrovska hydroelectric power station) and settlements within this area, for which it is important to elucidate the influence of the structural factor on their stability.

Data and research methods

From a tectonic point of view, the study area is located on the southwestern slope of the Ukrainian Shield. In the geological structure are involved rocks of Proterozoic, Paleozoic, Mesozoic and Cenozoic.

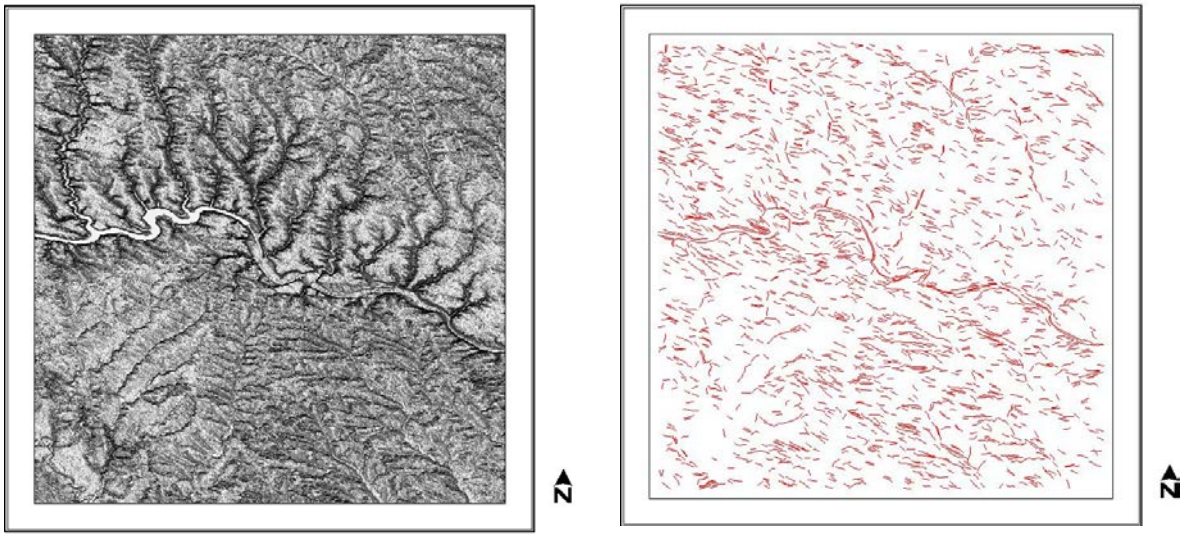
The basis for the study of the specified area is the following data: (1) SRTM with a resolution of 30 m, (2) geological map of scale 1: 200000, (3) own field observations, (4) gravimetric data. During field observations, joints were recorded using geological compass. Surveying of the surface with the use of a Phantom 3 quadcopter was performed for individual sites in order to obtain an orthophoto and a DTR (digital terrain model). All this data is stored in a single GIS project. The basis for the extraction of lineaments was the SRTM data. Lineaments were obtained automatically using the Geomatica program.

The automatic extraction of lineaments is an important point in their study because this eliminates the subjective factor. This factor is significant because by the manual, traditional drawing of lineaments, the researcher even subconsciously uses his previous knowledge and experience. The obtained lineaments in the form of polylines are subsequently used to construct the lineament density maps and charts.

The lineament density map was constructed using the standard procedure in ArcGis. The field measurements of the joints were used to construct the rose diagrams and contour diagrams. The map of gravimetric data for the study area in the automatic mode highlights linear elements for further comparison with the topolineaments

Research results

As a result of our research we have obtained the following results. (1) A map of the lineaments (segments of lineaments), (2) a map of the density of the lineaments, (3) Rose plot of the joints strike, (4) from the geological map the faults for the study area were obtained, (5) the gravitational lineaments were extracted from the gravitational map. Analysis of the lineaments maps and the lineaments density shows the following. The concentration of lineaments is in the northwest direction, less pronounced in the northeast. The highest concentration is observed in the area of Stara Ushytsia. Faults and joints have the same strike.



a b

Figure 1 *(a) Shaded relief model, (b) extracted lineaments.*

Similar strike of the density of lineaments, faults and joints testifies to their genetic association. It is difficult to speak about the time of formation of these structures on the basis of their equal orientation. These structures can occur both in the last stages of development of the territory (alpine stage), and may be inherited from previous stages. This issue requires specific study and specific methods and approaches.

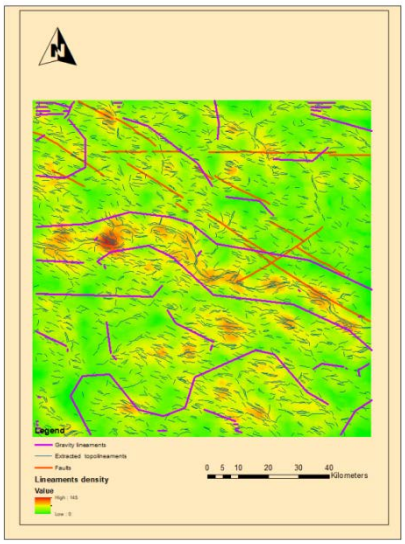


Figure 2 *Density map of topolineaments, gravitational lineaments and faults*

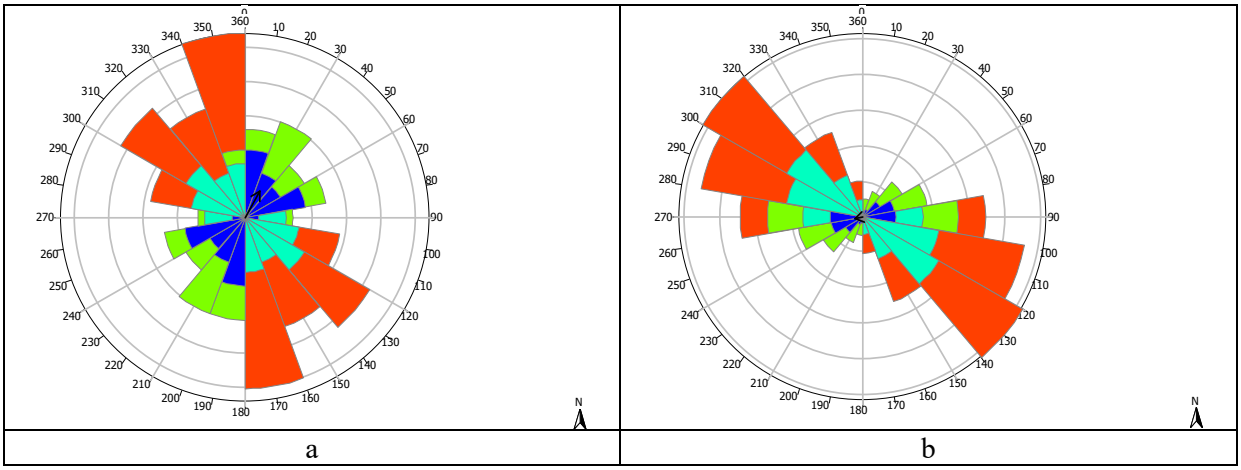


Figure 3 *Rose plot of (a) joints and (b) lineaments*

Conclusions

The study of lineaments showed their genetic connection to geological structures (faults, cracks). The lithological factor is not decisive.

Important hydrotechnical objects in the study area are in areas with average line density densities. The highest concentration of lineaments was found in the area of Stara Ushytsia. Special engineering-geological surveys should be conducted here.

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