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GIS-MODELLING OF THE CRYSTALLINE BASEMENT OF THE TERRITORY OF BELARUS IN DIFFERENT GEOLOGICAL AGES

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As part of this work, GIS modeling of the crystalline basement of the territory of Belarus for various geological epochs, including data on the fault network, was performed using ESRI ArcGIS software. As an example, a comparison of surfaces in the modern era and in the late Devonian is given. A map of the difference in basement marks between the specified epochs is constructed. This work is important for understanding modern geodynamics of fractal zones in Belarus.

The crystalline basement of the earth's crust is a complex natural structure. The main interrelated factors determining the structure of the crystalline basement specific areas include: the capacity of the asthenosphere, the topography (the folded deformations), the pattern of the fractures (disjunctive breaks), age and composition of rocks composing the basement, neotectonic activity of its structures.

The territory of Belarus has a heterogeneous structure of the crystalline basement. The power of the asthenosphere varies from 30 to 130 km. The surface of the crystalline basement is within the range of 0 to 6.5 km below the ground surface. According to the structural zoning, there are three granulite complexes in the crystalline basement of Belarus: the Belarusian-Baltic, Vitebsk, and Braginsky zones; the Osnitsk-Mikashevichi volcano-plutonic belt, as well as the Central Belarusian, Inchukalna zones, and the Central Pripyat block.

The formation of the crystalline basement took place during the archean – early proterozoic and is divided into proto-oceanic, transitional and continental stages. During the proto-oceanic stage (early archaea), the entire territory of modern Belarus was covered by the ocean. At this time, all three granulite complexes were formed, as well as the Minsk block. During the transition stage (late archaea – early Proterozoic), a Central Belarusian deflection was formed. Last, during the continental stage (the second half of the early Proterozoic), the Osnitsk-Mikashevichi volcanoplutonic belt was formed.

In accordance with the surface topography of the basement, the territory of Belarus is divided into positive, negative and transitional institutions: the Belarusian anteclise, the Latvian saddle, Orsha depression, Zhlobin saddle, Pripyat trough, the Podlaska-Brest depression, the Polesye saddle and little structures coming into the country is only marginal. Within each of them, tectonic structures of a smaller order are distinguished: protrusions, steps, horsts, grabens, domes, mulds, structural bays, etc.

All tectonic structures are intersected by a network of fractures. Fractures play a crucial role in the formation of the basement. They define the boundaries of structural complexes and tectonic structures of the highest order , as well as form structures of the lowest order - horsts, grabens, protrusions, steps. Modern movements of the earth's crust and a number of other geophysical processes are manifested along the fractures [1].

All the fractures of the crystalline basement of Belarus are divided into structure that emerged in the early Archean (mostly meridional and submeridional stretch) – early Proterozoic and postconsolidation (early Proterozoic – Riphean, latitudinal and sublatitudinal).

About half of the ancient basement fractures are active in the current geological epoch, which is confirmed by a number of studies [2,3,5].

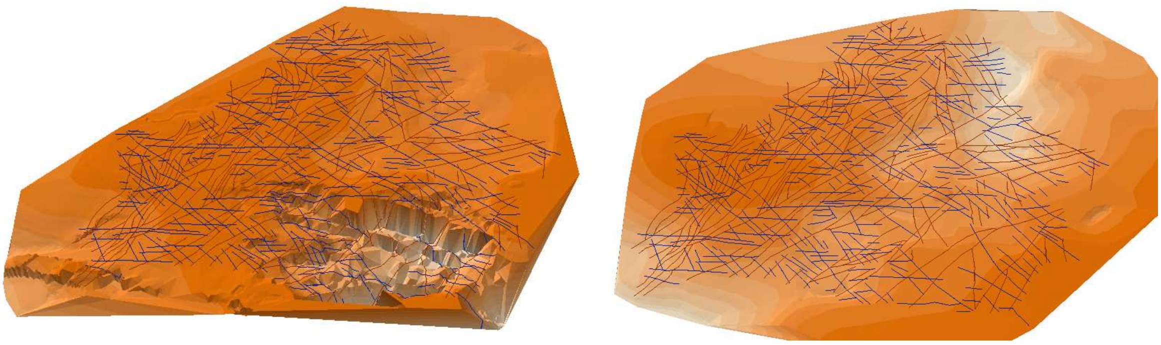
Modeling the formation of the crystalline basement will allow us to better understand the processes of modern endogenous geodynamics, and to correlate the location and dynamics of deep fractures with tectonic structures of all orders.

Modelling of the crystalline basement of Belarus was carried out according to the monograph by A.Makhnach (А. Махнач, 2001). The monograph presents maps of tectonic structures of Belarus in high detail, as well as paleotectonic maps of the Eastern European platform for different periods of geological history: the late

Baikal, Caledonian, Hercynian folds, the beginning of the Devonian period, and pre-Carboniferous time. The book also provides maps of discontinuous violations. The geographical reference of raster maps in the GIS package was performed to the geometry of the contour of the administrative borders of Belarus, plotted according to Openstreetmap data. Vector layers such as "structure-forming Fractures", "postconsolidation Fractures", and "(paleo)isohypses" (showing the absolute level of the Basement surface) were created for each of the maps. For the Pripyat trough, dot marks are also applied.

Using the 3D Analyst module of ESRI ArcGIS software, TIN models of the Basement for different epochs are constructed based on the layer height attribute "(paleo-)isohypses" and the layer height attribute of dot markers, using fractures as barriers.

For example, let's compare the surface of the crystalline basement in the modern era and in the late Frasnian time of the Devonian, on the eve of the separation of the Pripyat trough.



a b

a – recent time, b – late Frasnian time of the Devonian

Figure 1. – Model of crystalline basement of Belarus with the designation of the fractal network

Using the Surface Difference tool of the 3D Analyst module, we will find the difference between the basement surface in Devonian time and in the modern era. (fig. 2).

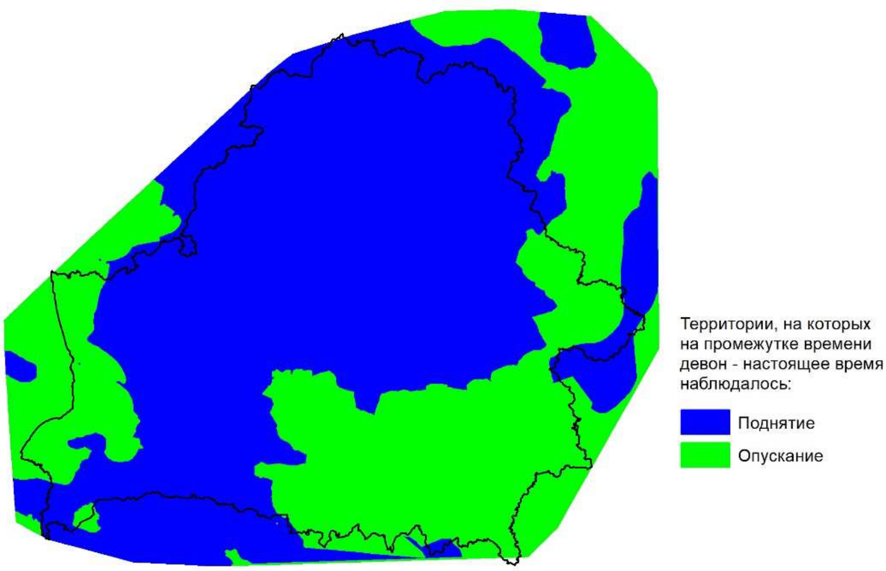


Figure 2. – Map of the difference in the height of the surface of the crystalline basement of the territory of Belarus between the late Devonian era and the recent time

According to the obtained map, it can be concluded that in addition to the Pripyat deflection, the regions in the Podlasko-Brest and Orsha depressions experienced lowering, while the rest of the country experienced a slight rise. Possible errors may be related to different details and different authorship of the source data. The research will continue with the involvement of new sources and new instruments of analysis.

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