INFLUENCE OF UPPER SILESIAN COAL BASIN TECTONICS ON SEISMIC HAZARD ASSESSMENT

Agnieszka BRACŁAWSKA[1]

[1] *University of Silesia in Katowice, Faculty of Earth Sciences, Department of Applied Geology, ul. Będzińska 60, 41-200, Sosnowiec, abraclawska@us.edu.pl*

Introduction

The Upper Silesian Coal Basin (USCB) in Poland is known as one of the most seismically active mining areas in the world.

As is well known the tectonics of the USCB were formed in the Variscan orogenesis in the Asturian phase. The blocky structure of the basement (Gabzdyl, Gorol, 2008), which is built of consolidated crystalline rocks, had a significant influence on the style of tectonics. Geophysical investigations have shown that the basement is divided into several blocks, which, under the influence of horizontal pressure, moved in relation to each other. The dislocations caused local uplift and lowering of younger rocks and secondary sliding movements (Goszcz, 1999). The horizontal pressure shaped the characteristic features of USCB tectonics with numerous overlaps and folded structures along the western and north-eastern border of the area, as well as faults in the central part.

Also former research of seismicity in the USCB showed that it has a bimodal character (Kijko 1986). Events can be divided into low-energy events caused directly by the underground exploitation and regional ones (high-energetic) whose cause is not yet fully explained (Pilecka & Stec 2006). The strongest tremors are probably induced by the combination of two factors: the mining and tectonic one. The explanation of its genesis is the subject of the research.

Research on the formation of strong shocks and their relationship with tectonic processes that may lead to their generation were presented by Idziak, Teper and Zuberek (1999). They showed that the distribution of strong shocks is non-random, which is manifested by the fact that clusters of strong shocks are separated from each other by aseismic areas. In addition, the distribution of epicentries in the areas of strong phenomena shows latitudinal extension, mainly in the main saddle (in the central of USCB), which cannot be explained by the assumption about only operational origin of shocks.

The general purpose of the research is to check if there are relationships between the tectonics and seismic activity of the Upper Silesian Coal Basin. Former research of the seismotectonics of the USCB suggest that generating the strongest events had strictly connections with tectonics.

Samples and methods

For the needs of the research, data on tremors occurring between 1987-2017 in the considered area had to be collected. In the USCB tremors are recorded by the Upper Silesian Regional Seismic Network conducted by the Central Mining Institute. The database includes shocks with $M_L \geq 2.0$ (energy $\geq 6 \cdot 10^6$ J). In the considered period 18 076 shocks were recorded.

To check seismic activity in the Upper Silesian Coal Basin the graph of quarterly seismic activity of the studied area was created between 1987 – 2017.

Special attention had to be paid to the strict connections between the seismicity of the consider area and its tectonics. The analyzed region is characterized by inhomogeneous distribution of earthquakes. In the USCB tremor epicentres do not occur uniformly throughout the whole basin but grouped in several regions belonging to different structural units and are separated by regions where strong shocks are not observed.

Results

The analysis of quarterly seismic activity of the USCB area shows that it is variable regardless of mining activity. In addition, an increase in activity is noticeable despite the decline in extraction (Patyńska, Stec, 2017). This may indicate the effect of the tectonics of this area. The change of seismic activity of events

depends both on the intensity of exploitation and on the variability of the lithological and tectonic structure, as well as on the accumulation of stresses occurring in the rock mass.
The research confirmed the strong impact of USCB tectonics on generating strong seismic events. Due to the very complicated tectonic structure of the USCB area and the fact that high energy shocks do not occur uniformly throughout the studied area, despite exploitation, it is assumed that the impact of tectonics plays an important role in generating strong seismic events throughout USCB.

Conclusions

The results indicate that the seismic activity in the Upper Silesian Coal Basin is strongly associated with its tectonics. The cause of seismic events in the USCB is undoubtedly the violation of the rock mass balance by mining activity. However, mining is not the sole cause of the occurrence of shocks, research conducted by Teper (1998) confirms the simultaneous impact of tectonics and mining activity. In addition, it is not possible to exclude the involvement of the network of carboniferous cutting faults in the processes of triggering energy in this area.
It should also be noted that it is still difficult to clearly determine the exact genesis of the strongest shocks. The explanation of the genesis of strong seismic events in USCB is still matter of discussion.
In conclusion it needs for further research on this problem to be able to clearly determine what is the reason for the occurrence of the strongest shocks in Upper Silesian Coal Basin. Currently, the author has been working on checking whether the strongest shocks are related to the seismic activity of areas without the USCB, especially in the southern – in the area of the Carpathians arc. The resolution of this problem requires further study going beyond the USCB and statements whether the tectonic activity and the geodynamics of areas located south of the USCB affects the strongest shocks.

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