Abstract

One of the effects of mining exploitation are deformations on the surface, which affects the safety of mining and post-mining areas. Therefore, mining plants to monitor surface movements in order to identify the deformations, their range and their decay time after the end of mining exploitation. Currently, monitring of deformations is doing with using classical surveying methods.

In recent years, the methods of satellite radar interferometry (InSAR) are gaining in popularity, which are also successfully used to observe movements of the earth's surface caused by mining exploitation. All measurement techniques have limitations. InSAR methods also have limitations, such as the ability to detect displacements with a gradient less than half of the electromagnetic wave used in the radar. The consequence of this limitation is the fact that the displacements of the surface determined by InSAR methods are in many places underestimated.

The aim of the work was to adapt the InSAR methods to detect large surface subsidence, which were defined in the work as those that exceed 1000 mm, and which will reveal on the surface within 12 months, in the conditions of the Upper Silesian Coal Basin (USCB) and to identify their range in mining areas and their decay time in post-mining areas. The research was carried out in the area of the USCB in eight selected locations. Seven research areas were located in the mining areas of active hard coal mines and one in the post-mining area of the protective pillar of the city center of Bytom. SAR images from the European constellation of Sentinel-1A/1B radar satellites were used in the research. The movements of the surface were determined using the SBAS and PSInSAR time series methods. Surface subsidence measured with classical surveying methods were used to verify the obtained results.

In the context of the possibility of detecting large deformations with the InSAR methods, it was shown that the underestimation of the results obtained from the processing of SAR images with the InSAR methods is directly proportional to the velociy of the surface subsidence. Based on the demonstrated relationship, an innovative method for identifying large subsidence using the SBAS method was developed. The method was called the method of linear relationships. Based on classical surveying measurements, the method was validated. The validation proved in a quantitative and qualitative way its suitability for detecting large subsidence of the land surface using InSAR methods.

The research of the range of mining deformations led to the development of a method for its determination using satellite radar interferometry. Based on the developed method, the average range of mining deformations in the USCB was determined to be $1.16H \pm 0.22H$, where

H is the average depth of the seam. In the context of the deformations decay time after the end of mining exploitation, a method for determining the time coefficient *c* in the Knothe function using InSAR was developed. It has been proven that the use of InSAR methods allows for a more accurate determination of the time coefficient. Therefore also for a more accurate determination of the time from the end of mining exploitation in which surface deformations will still be revealed. In addition, the long-term analysis showed the occurrence of residual deformations.

The research carried out allowed to achieve the set goals and prove the thesis of the work. The results of the work can be used in the protection of the surface of mining and post-mining areas.