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Geometry of surface deformations caused by induced shocks in the area of underground copper exploitation

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The level of intensity of induced seismic phenomena occurring in areas of mining activity is very diverse. Induced shocks may be directly related to the exploitation carried out or to mining and tectonic factors. In the case of impact on the surface, two types of mining tremors are distinguished: energetically weak shocks, not causing surface deformation, and shocks exceeding a certain energy level, which cause terrain deformations. Surface displacements are the most common form of the effects of underground mining operations, including induced seismicity. Geological research uses Sentinel-1 imagery to determine the geometry of surface displacements that were caused by induced shocks by satellite radar interferometry. In this research four induced shocks with magnitude M>4.0 was used, which occurred in the Legnica-Glogow Copper District in the Rudna mine. This area is one of the most seismically active places in Poland due to the underground exploitation of copper ore. For calculations, the differential satellite radar interferometry (DInSAR) method was used. The DInSAR technique allowed the determination of surface displacement towards the Line of Sight (LOS) between two images acquired at different times (before and after induced shock) with millimeter accuracy. In the presented research calculations were carried out separately for observations acquired in descending and ascending orbits. The Sentinel-1 satellites are a constellation of two radar satellites that observe the surface of lands and oceans at a time interval of 6 days. Therefore, 6 days, 12 days, 18 days and 24 days were assumed as the time intervals between the images. Vertical displacements were calculated based on the generated LOS displacement maps. In addition, charts of subsidence in the N-S and W-E directions were prepared, 3D models of subsidence were made, and deformation geometry was analyzed for individual shocks. As a result of the research, the spatial extent of deformation in the horizontal surface was determined: N-S and W-E, which in both directions was over 2 km. However, surface displacements caused by induced shocks reached values up to 10 cm.