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CRITICAL PLACES AT LOCALITY ČISTÁ, MINE JERONÝM AND THEIR POSSIBLE DEVELOPMENT

Summary. Protection of technical cultural monument hasn't in the Czech Republic deep roots. And now it is still rare phenomenon, in many respects unpopular, because the monument care and protection is something that is necessarily linked to endowment titles, increased costs and many other measures. Therefore we have to activities, which are in last years and at present proceed at Mine Jeronym with regard to availability of funds, mark to the Czech ratios for quite extraordinary. However, it should be noted that the monumental care has virtually no influence on spatio - temporal changes in this mine. The aim of the contribution is the definition and description of the critical places of the mine, because owing to many factors is rock mass eroded and it acts of mining working with the presence of several places with potentially reduced stability. Critical places can be seen both in the underground, but also on the surface of surface units after the completion of mining activities at this mine.

MIEJSCA KRYTYCZNE W OKOLICY CISTA, KOPALNIA JERONYM I MOŻLIWOŚCI ICH REKULTYWACJI

Streszczenie. Ochrona zabytków przemysłowych w Republice Czeskiej nie jest głęboko zakorzenioną praktyką. Można powiedzieć, że jest zjawiskiem rzadkim, w wielu aspektach niepopularnym, ponieważ dbałość o zabytki przemysłowe i ich ochrona nieuchronnie pociągają za sobą problemy finansowe, zwiększone koszty oraz inne środki naprawcze. Dlatego też działalność prowadzona w kopalni Jeronym w ciągu ostatnich lat jest w Czechach czymś wyjątkowym, zwłaszcza zważywszy na słabą dostępności do funduszy i dotacji. Ponadto, należy podkreślić, iż dbałość o zabytek przemysłowy w żaden sposób nie wpływa na zmiany przestrzenne i warunki operacyjne kopalni. Celem niniejszej pracy jest identyfikacja oraz opis miejsc krytycznych w zabytkowej kopalni.

Z uwagi na wiele czynników krytycznych, górotwór występujący w kopalni uległ erozji, co w wielu miejscach doprowadziło do zmniejszonej jego stabilności. Miejsca krytyczne są widoczne zarówno pod ziemią, jak i w obiektach powierzchniowych kopalni, w których zakończono już eksploatację górniczą.

1. Introduction

Immovable cultural technical monument Jeroným Mine is located about 8 km west of the Horní Slavkov, Sokolov district. This is a complex of old and abandoned mine workings: galleries and stopes of different direction and inclination, vertical and oblique mining workings, shaft Jeroným and Jeroným drainage adit. All of these mining workings arose in connection with the mining of tin ore, and their origins may date to 15^{th} century.

The complex of mining workings is divided into two separate parts [13]:
The old mine workings (OMW) in the northwestern area around the complex, forming a separate part of mining works. This is probably the oldest part of the monuments, which appeared in 1982 by Mr. František Baroch from Prameny. This monument is administered by the Ministry of the Environment Czech Republic.
Abandoned mine workings (AMW) spatially represent the largest part of monuments. These include Jeroným pit, a complex of mining areas, mainly in the form of dredging chambers and Jeroným drainage adit with a length of 396 m. This monument is in the administration of state-owned company DIAMO Stráž pod Ralskem, Management of uranium deposits Příbram. AMW area is now due to comprehensive geomechanical monitoring explored and better documented than in 2001 [14, 16]. Currently, each locality area at locality Čistá has his owner and works, on both technical areas of cultural monuments, the current run without greater coordination, although in principle, lead to the same goal [2, 5, 15].
The article describes several types of critical points, indicating examples, which are:

- Residual pillar
- Caves
- Mine water
- Surface formations.

2. Critical places in underground

The object of Figure No 1 is a simplified spatial disposition at Jeroným Mine, part of AMW, enriched about the list under mentioned critical and relatively critical places. For the purposes of this contribution we introduce the concept of a relatively critical position, i.e. it is a place where are changes in the behavior of the solid rock mass in a short time period (years) hardly noticeable. It's only the expression of ideas and formulation of possible consequences near a significant failure of mining workings stability. The other critical point we understand the place where are in the short term notable changes in the mass behavior.

As can be seen from the beginning of this contribution, both types of critical places to the exemption in the form of surface phenomenon occur only in the underground, however, may have an impact on the surface. Spatial extent of this mining working compared to similar mining workings is considerable, but we can say that the critical places in the underground, leave out problems of mine waters [3, 4], are exclusively located at the upper floor of the chambers K1, K4 and chamber K3, but spreads even at adit floor.

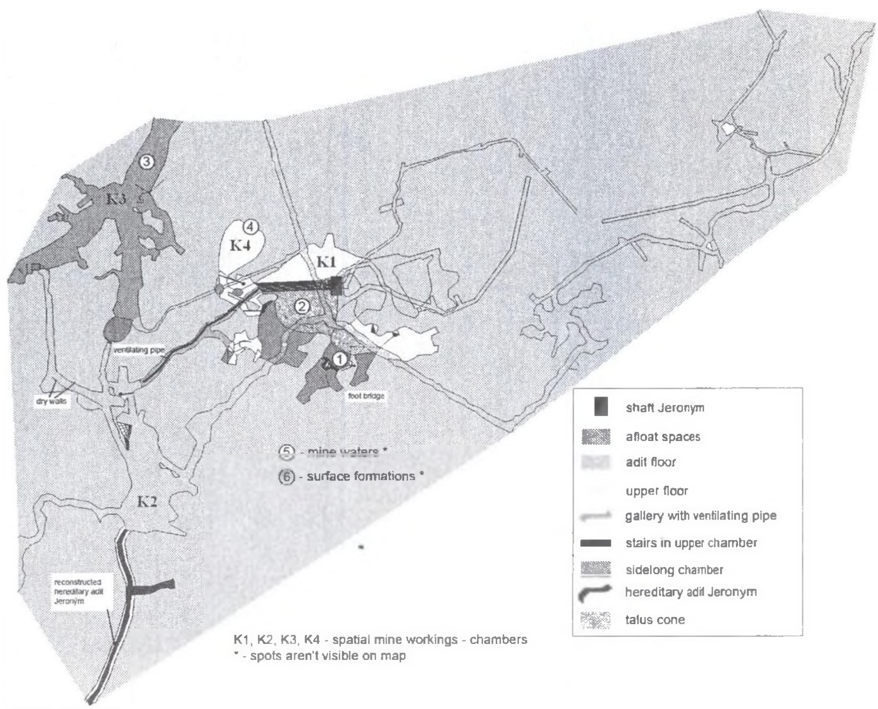

Fig. 1. Spatial disposition of Mine Jeroným inc. critical places
Rys. 1. Układ przestrzenny kopalni Jeronym z zaznaczonymi miejscami krytycznymi

As a critical place it is possible label place so - called foot bridge - spot 1 and cavings in the chambers K3, K4 - spot 3 and 4. Other places may be marked as "relatively" critical. These places include places designated by spots 2 and further spots 5 and 6 applies to all mining waters, respectively to surface shapes over Jeroným Mine.

2.1. The residual pillars of the chamber K1

By cranny tectonics reflected on the residual pillars of the chambers K 1, was at first reconnaissance in situ pronounced presumption, that acts about recent tectonics, evoked probably by anthropogenic influences and fluctuation in mine waters level, has a major impact on the chamber K 1 stability [1,8,9]. These tensile fractures replicate roughly some guidelines of natural tectonic. In contrast to her there're however mainly indirect, non-continuous as far as pinnated with markedly higher count (3 - 5/m), some considerably splay (15 mm) and fresh, without clay coating. This is the most evident on the residual pillar with a diameter of about 1 m situated at the foot of loose waste rock in small chamber east of K1, so - called foot bridge. There is splayed (up to 5 mm) tensile fractures system in the pillars also at floor around the pillars, see Figure No 2.

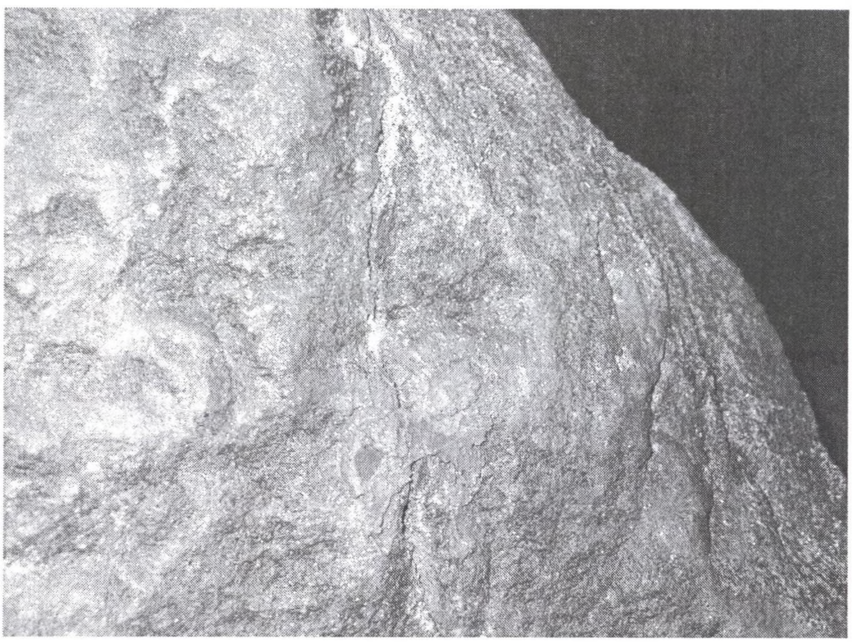

Fig. 2. An example of crack in the surroundings of pillar
Rys. 2. Przykład pęknięć w otoczeniu filaru ochronnego

Tension joint behinds a "foot bridge" is now permanently inaccessible [7], because the site is located under the residual roof pillar, which is strongly disturbed, see. Figure 3.

A major factor negatively affecting the stability of the pillars in the chamber K1 is also the fluctuations in water level, which is best reflected in the above-mentioned foot bridge. In this place it is possible to expect a roof total destruction and subsequently also the pillars with an adjacent surroundings. To the category of relatively critical points is necessary to include talus cone in the chamber K1 - spot 2, which contributes to the development of tectonic. Performed measurements showed that the dynamic development of disjunctive tectonic occurs primarily in the chamber K1 residual pillars [5]. It can be assumed that these displays are subjected to sheared load of anthropogenic dump material, which was strewn in the chamber K1 in 70's of the 20^{th} century [11].

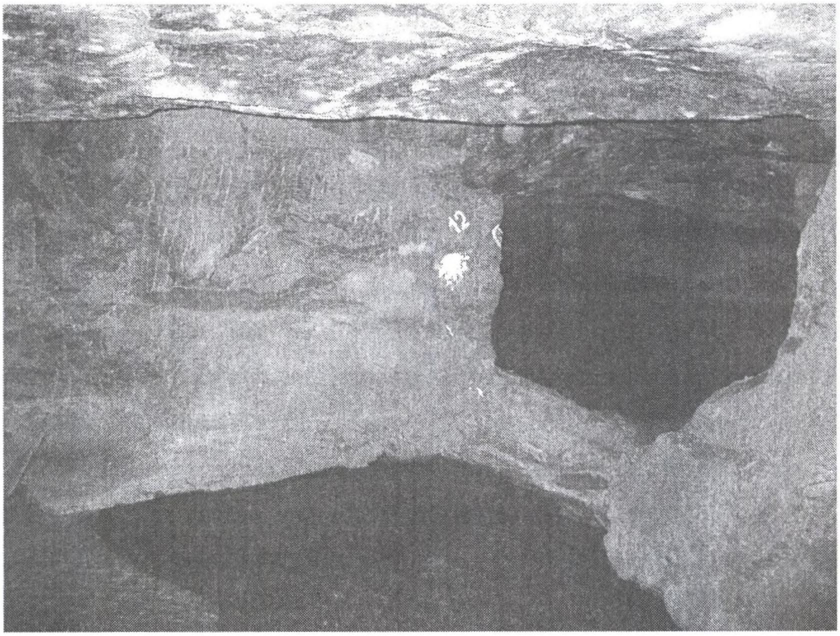

Fig. 3. Defective pillar - the foot bridge
Rys. 3. Uszkodzony filar- most dla pieszych

2.2. Caves

Chambers K3 and K4 problems consist in cavings when in the orifice of a caving K3 and K4 in the orifice of two caves containing gneissic material. It is an unmistakable signal of breaking the ceilings in these chambers, eventually material from above situated mining workings. It is possible suppose, that acts about caving, which could reach up to the surface.

At chambers K3 orifice there're evident local roof falls and sides. In single K3 there're already visible marks of roof falls in large scale. Biggest roof falls along tectonics K3 trench to measuring profiles levels of surface mine waters V3 and V4 [10]. Chamber K3 is a chamber with a large cave-in space and exactly allocating and documentation of these cavings is complicated. Despite these facts it is known approximate continuance and direction of this chamber. If we take cavings into consideration, chamber K3 is upward spatial mining working, and there is a hypothesis that the highest point on the chamber K3 may be located very close to the surface. Similarly, as well as in the chamber K4.

Setting plan close to settlement with cavings won't be, out of doubt, simple matter. It is very difficult to determine what percentage ratio is currently cave-in and open spaces. On the basis of comparison with the map background it is possible pronounce an opinion that the ratio numbers 75% open spaces and 25% cave-in or still inaccessible spaces. Most of the inaccessible areas will most likely represent inclined continuation of the current accessible spaces. Especial geomechanical steady status at present out of doubt will chase, when they accede to cavings and backfill haulage. In this perspective, it is clear that the issue of the relatively large cavings above and below the mine accessible parts can not be underestimated.

2.3. Mine waters

Unknown fact in mine water problem is as well innocence state of rock mass between regions AMW and OMW. Map data that are available, don‘t record in this space any mine workings, but their existence, though in form partial or total cavings, it is impossible exclude. If there are, they constitute (except tectonic breaks) preferential channel for infiltration of underground waters. These preferential routes may in rheological conception have change according to consolidation of material, his choking and jointing fine-grained washing, internal erosion etc.

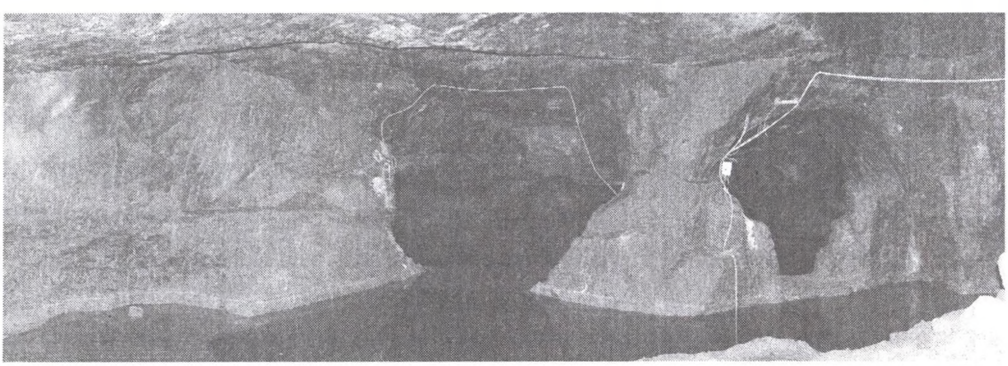

Fig. 4. Activity of water - afloat foot bridge
Rys. 4. Działanie wody- zalany most dla pieszych

Water activity illustrated e.g. Hereditary adit Jeroným, which in its historical form was entirely transit in 70's of 20^{th} century. Presently adit is fully reconstructed, i.e. newly impacted (passing of caving) in open curved profile with steel support. The reason of inaccessible adit was deep a ceiling sink of original adit in longitude c. 120 m (ends of cavings) [12]. The character of caving in adit witnessed about it, that to cave didn‘t occur only thanks suspense and deformation status of massif, but also thanks fluxional pressure gravitational moisture and internal erosion silty and clay components of rock mass environment in contact zone of deposit (weakening of the rock skeleton).

In the evaluation of unknown facts, there is a need to draw attention to the risks resulting from the possible negative effects of static and fluxional (hydrodynamic) pressure on underground waters on geomechanical stability spacial complex mining workings at mine Jeroným [6]. The negative impact of mine waters on geomechanical stability of mining workings can be seen in the following factors [17]:

- Static pressure of mine waters in drainless spaces above the adit floor level. While these spaces are still known as drainless, it is impossible for a certainty exclude infiltration mine waters at the level Jeroným drainage adit. Gravity water movement nevertheless exists. In this case, the negative impact of mining water may occur as a result of the further mentioned factors.
- Fluxional pressure of gravitational moisture. Its consequence is internal erosion of fine rocks parts and the weakening of the rock skeleton.
- Erasing effect of water on tectonic areas. The presence of water on tectonic areas reduces friction on these surfaces, which in consequence leads to shear strenght reduction of fissure and cracks.
- Feldspars chemical weathering in water environment.

The assessment of these factors is very difficult. In all of those factors it acts about long-term effects. As weighted against can be designated the fluxional water pressure and related internal erosion.

3. Critical places on the surface - inbreak

Pinka in a Czech word used for describing of relief shapes in the country arising mainly as a result of mining activities. In this contribution the term surface depression will be used, although it is not the exact equivalent to the Czech term.

The shapes may have either a regular circular plan (often arise over the crossroads of mining galleries), or elliptic (the connection of two surface depressions of circular plan) or irregular (resulting from rapid dismounting, infall or collapse of subsurface mining workings). The difference between surface depression and decreasing depression is only quantitative. Surface depressions are usually areal small and generally shorter than 25 m (usually 6 to 12 meters), depth ranges between 3 and 5 meters, the walls have a greater slope. In immediate surroundings of Jeroným Mine, in spite of resolution on parts OMW and AMW, we register till now 41 these surface formations. If we simplify for objective the shape of all surface depressions to the circular shape, the minimum surface depression size, i.e. its diameter is less than 1 meter, the maximum average is 15.5 meters. The depth of these formations is also very variable, ranging from 0.5 to 15 meters.

The issues of critical points are crucial surface depressions, when their surface localization approximately corresponds with the spatial situation in the underground spaces. Based on this fact, it can be assumed that spatio-temporal development of these places may in the future result in direct communication to mining workings. As stated in the contribution, close to the surface are the chamber K3 and K4. Exactly localization of surface formations of Mine Jeroným is the subject of the activities carried out this year, but in this activity must take into account the morphology of the terrain in reason of mining Sn-W ores in this locality by opencast mining.

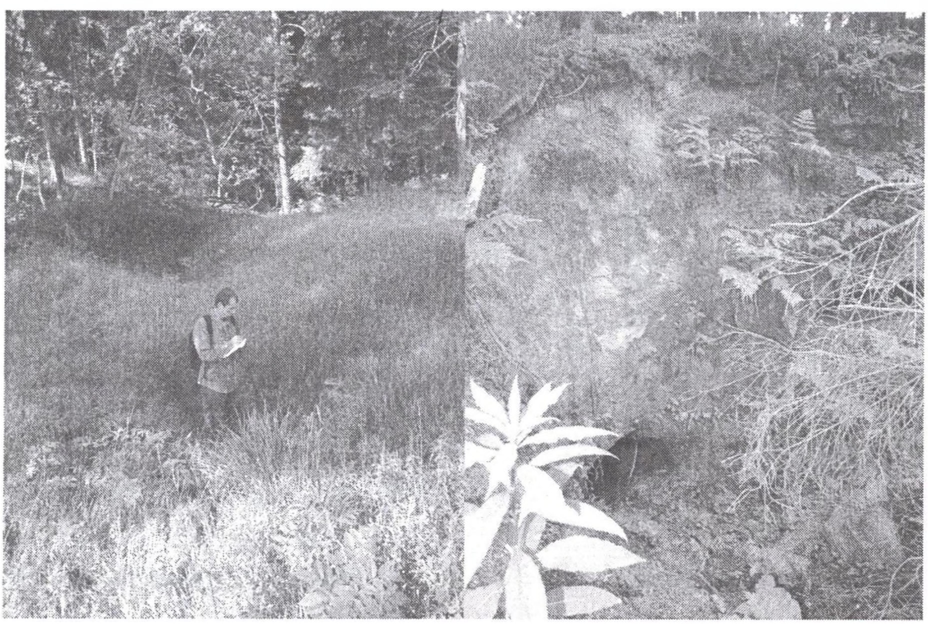

Fig. 5. Pinka line, open pinka
Rys. 5. Zapadlisko liniowe, zapadlisko otwarte

4. Conclusion

Restoring of Jeroným Mine runs more than 10 years. During this period we did not find significant negative effects, notably affecting the stability of mining workings. Critical points are not mentioned in the contribution in the context of historical workings to ensure nothing unusual. It is possible to say, that it is the typical accompanying characteristics of the movement after the former mining activities. As noted, a critical point of the whole mine is the residual pillar in the chamber K1, so-called foot bridge, where is a risk of destruction with time high. If it proceeds about the mine water, it's still a very open question. In AMW there exist afloat mining workings alongside mining workings that demonstrably affect far below the level of flooded mine workings and aren't flooded. There are mining workings with high water tributaries, in addition to workings in which is a minimum of water. The communication system of waters of the AMW is not sufficiently verified yet [3]. So far, is not also shown clear links between OMW and AMW. Retained mine water in the area of mining accessible parts may affect the progress of work in the retrieval of mining workings in the deeper parts of the deposit.

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