

Preparation of ore blocks for mine leaching by reagent explosion injection

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Abstract. The current drilling-and-blasting operations fail to prepare intact ore body underlying a production horizon for subsequent mining and leaching. It is found that the required preparation quality is possible by means of advanced implementation of ore body discontinuity and filling of the resultant system of joints with active leaching solutions.

Conventional work processes, e.g. drilling and blasting, are oriented in line of advance of the current production face and are therefore inefficient in preparation of underlying intact ore mass for extraction and leaching.

With a view to enhancing mine efficiency by means of reduction in energy input of a technology cycle and owing to an increase in extraction of valuable components, it is proposed to carry out explosion injection as an advanced preparation of an underlying ore block during drilling-and-blasting on a production level [1]. This article presents details of this synergetic approach. After muck has been removed from the face area on the current production level, the underlying block is pre-split by blasting for saturation of the created cracks with leaching solutions. With this end in view, a system of blast holes is made in the underlying block by ring drilling, and a package charge composed of an explosive and capsules with leaching solutions are placed there and initiated, which allows injection of leaching reagents in the pre-cracked zone and makes the period of rock mass relaxation go longer.

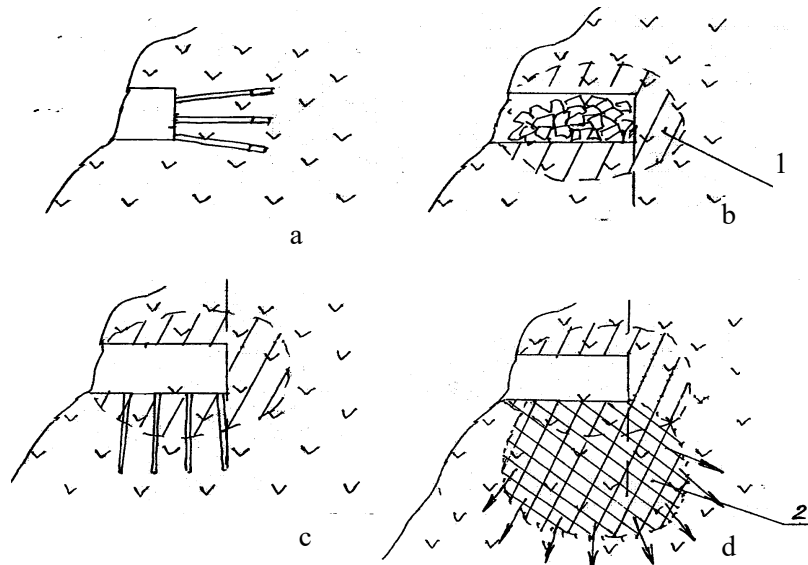
Then, drilling-and-blasting is continued at the current production face. Pressure created by the next blasting cycle to advance the production face facilitates deeper penetration of leaching reagents in the preliminary created zone of jointing in the underlying block and prevents cracks and other defects from closure. Such activation of underlying ore mass with leaching reagents weakens bonding between ore and rock particles. As a result, propagation of jointing and penetration of leaching agents proceed both along the current production level advance and towards the underlying ore block (see the figure below).

Saturation of underlying ore by injection during heading operations on the overlying level allows using explosives of lower energy later on. Furthermore, shattered and pre-split ore mass activated with leaching reagents is easier to be processed in the latter cycles of pre-treatment, separation, concentration and leaching.

The application of the proposed technology is described below in terms of Talatui gold-bearing ore deposit within Darasun ore field. The deposit is composed of rebellious high-sulfide ore (pyrite, arsenopyrite, sulfosalt). Gold occurs as visible particles in quartz veins or as dispersed fines in matrix minerals, mostly, quartz and tourmaline. In view of gold dispersion, it is efficient to extract it from



mineral matrixes by leaching. It is advisable to prepare rebellious ore for further processing both on the current level and on the lower lying level.



Work cycle: (a) drilling and charging of blast holes at the current production face; (b) face area on horizontal level after drilling-and-blasting (1—pre-splitting zone in the ore block to be activated later on); (c) muck removal and drilling of vertical or inclined blast holes toward the underlying ore block, and installation of charges of explosives and reagent solutions; (d) initiation of the explosive charges and formation of cracks 2. Arrows show direction of permeation of leaching reagents.

When muck is removed from the current production face after pervious cycle blasting, ring and fan drilling is conducted to make blast holes 250 mm in diameter and to charge them with an explosive (ammonite ZhV no. 6, 400 kg per blast hole) added with two capsules. For gold extraction, one capsule contains sodium hypochlorite and the other capsule contains chlorohydric acid. Initiation of the explosive charge breaks the capsules, and the reagents intermingle and exothermally interact (heat emission). Concurrently, blasting disintegrates ore, a damage zone is formed as induced jointing, and the mix of the leaching agents is injected in the joints under action of gases after explosion. Reaction between the reagents generates hypochloric acid that is a key oxidizer for sulfide minerals–matrixes containing gold. In this case, after blasting, leaching process is oriented in the line of the current horizontal production face advance. After blasting, muck is removed from the production face area and is sent for further processing by pre-treatment, radiometric separation, etc. In the clean floor at the production face, vertical holes or, if required depending on the initial jointing of the rock mass, inclined holes with the diameter of 50 mm and 5 m long are drilled with the pattern 1×1 m. In these holes, charges of ammonite ZhV no. 6 (powder factor 1 kg/m³) are installed with the capsules of sodium hypochlorite and chlorohydric acid, i.e. the same reagents as in the main blasting cycle on the production level. The powder factor of the explosive charge ensures generation of the induced jointing zone with joints oriented vertically or at an angle downward as the blast holes.

In this case, initiation of the explosive charges induces the same events as in the previous cycle on the production level. As a result, concentration zones of induced jointing are formed in the underlying ore block, and leaching reagents penetrate these joints, weaken the ore mass and simultaneously liberate gold from mineral matrixes.

After that, the next drilling and blasting cycle is carried out for further advance of the production face horizontally. This process creates pressure that affects the induced jointing zone in the underlying ore block and contributes to penetration of leaching reagents to deeper levels. As a result, propagation of jointing and penetration of leaching reagents proceed both along the advance of the current production face and downward, toward the underlying ore block meant for mining later on.

Thus, as the production face is advanced, a damage zone of induced jointing is created under it, and free surfaces in these joints are pre-activated with leaching reagents. Owing to this, when mining is transferred to the lower lying level, rock mass there is weakened and less resistant to blasting, which allows using lower energy explosive charges and reduces period of subsequent leaching of valuable components from ore. Also, energy and finance expenditures per mining cycle are cut down. Moreover, it is expected that dynamic hazards (e.g. spalling under high stress) will abate when the lower level face catches up with the upper lying face.

Thus, injection of reagent solutions in ore during blasting allows preventing closure of micro-crack generated by previous blasting, and, consequently, betters further saturation of shattered block with leaching solutions.

References

- [1] Shevchenko YuS and Sekisov AG 2015 *Method of Ore Extraction and Preparation for Leaching* Favorable Decision of Application No 2015118529/03(028767)