SELECTION OF ACCESSING AND DEVELOPMENT SCHEMES
FOR EXTRACTING RESERVES OF ORE BODY 2 IN IRTYSH DEPOSIT

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ABSTRACT

Purpose. Justification and selection of a rational scheme for accessing the second ore body of the Irtysh deposit based on a technical and economic comparison of its adopted competitive options.

Methods. The main mining, geological and engineering requirements for selecting the scheme for accessing the Irtysh field are considered to achieve the goal. Three competitive accessing options are proposed on the basis of project regulatory documents and geotechnological features of the ore body. The optimal scheme of accessing was suggested taking into account the volumes of mining and preparatory works and averaging of the metal content in the ore by the method of technical and economic comparison.

Findings. Analysis of the accessing schemes was performed for deposits similar in the geological conditions and represented by fragmented ore bodies. The advantages and disadvantages of 3 competitive access options are reviewed in detail. The technological and economic feasibility of excavation of ore body 2 reserves has been substantiated, i.e. of accessing them by fringedrifts between the Irtysh and Vspomogatel'naya mines on the upper horizons of the deposit. It is established that the difference in the volume of capital works (CW) and preparatory works (PW) is 45640 m³ in favor of accessing ore body 2 by fringedrifts between the Irtysh and Vspomogatel'naya mines. At the same time, the volumes of CW and PW at the initial and final stages of development are much lower than in the case of accessing by a transport ramp from the surface. The change in the average content of copper, lead and zinc with the simultaneous development of the Osnovnaya Deposit and the South-Eastern Deposit in the lower horizons of the field has been calculated.

Originality. For the conditions of ore body 2 of the Irtysh deposit, planned for development in accordance with the proposed access, it was found that despite the decrease in the copper content in the saleable ore, the lead content in the saleable ore will increase to 0.49% and zinc content, respectively, to 3.83%.

Practical implications. Mining of ore body 2 according to the recommended accessing scheme with a minimum amount of mining will allow to raise the productivity of the Irtysh mine to 600 thousand tons per year during the period 2018 – 2026, as well as to increase the extraction of lead and zinc.

Keywords: deposit, ore body, accessing scheme, mining volume, mineral content

1. INTRODUCTION

High efficiency of developing mineral deposits, represented by fragmented ore bodies, under the condition of their partial operation, should be achieved due to small capital investments, short payback period, as well as the use of simple accessing schemes and refining technology. The main deterrent to the intensive development of deposits from fragmented ore bodies is the weak methodological support for the selection of rational accessing schemes that take into account mining and geological features of these deposits and the improvement of the extracted mineral quality.

The main ore bodies of the Irtysh polymetallic deposit are the Osnovnaya and South-Eastern deposits, which successively replace one another along strike. Reserves of the Osnovnaya deposit are primarily developed, with ore remaining in inter-chamber and safety pillars and in small quantities in the edge reservoir area. Ore reserves in the upper part of South-Eastern deposit are mainly...
developed. Currently, there is a need to access and mine dispersed ore bodies in the upper horizons of the deposit to maintain the mine’s production capacity of 600 thousand tons of ore per year.

The ore reserves are exhausted, and the level of mining operations in the Osnovnaya and South-Eastern deposits of the Irtysh deposit is reduced. It is necessary to put into operation ore bodies 2, 3 and 4 that have not been processed yet at the upper horizons of the deposit in order to maintain the production capacity of the Irtysh mine at 600 thousand tons of ore per year.

Accessing of this site is scheduled in the development program of the Irtysh mine, which will increase the production capacity of the mining enterprise. Studies aimed at scientific and methodological substantiation of technological solutions for accessing and further development of fragmented ore bodies are considered relevant because ore bodies 2, 3 and 4 and Novaya deposit are not yet accessed.

2. ANALYSIS OF ACCESSING PATTERNS APPLIED TO THE DEVELOPMENT OF CONTIGUOUS ORE BODIES

There is a history of experience in accessing similar deposits represented by contiguous ore deposits in eastern Kazakhstan. Thus, at the Sekisovskoe gold deposit, accessing of fragmented ore bodies No. 2, 5 – 8, 10 and 11 is carried out by a transport ramp, going from the bottom (+310 m elevation) of the Main pit to the level –25 m developed by air-feeding, air-exhausting and lift raises. A distinctive feature of the deposit is contiguous ore bodies 1.5 – 2.5 m thick with areas of enclosing rocks 3 – 8 m and more (Nurseitova, Ilyasov, & Shaposhnik, 2014). The share of low-grade ore bodies on horizons ranges from 30 to 50% of ore reserves. The dip of ore bodies is 70 – 90°. Often most the host rocks have medium rather than strong resistance. Ore strength by Prod’yanov scale is f = 8 – 10. The ores are valuable, because they contain 5.23 g/t of gold and 6.90 g/t of silver. The rated annual output of the underground mine is 500 thousand tons of ore (Krupnik, Bitimbaev, Shaposhnik, Shaposhnik, & Demin, 2015).

Mining and geological conditions of the Sekisovskoe deposit allowed laying a transport ramp in the center of the field. This made it possible to significantly reduce the volume of mining works for accessing and preparation of isolated ore bodies located on the flanks of the deposit to maintain the mine’s production capacity of 600 thousand tons of ore per year.

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Another example of accessing contiguous ore deposits is the Suzdal gold ore deposit. It is represented by ore zones 1 – 3, 2 and 4. Ore zone 4 is separated from ore zones 1 – 3 by the distance of 900 m, which necessitated their separate accessing (Petrov, Zhumadilov, & Shaposhnik, 2014).

Accessing of the Suzdal field is determined by taking into account the geological and engineering conditions (Krupnik, Shaposhnik, & Shaposhnik, 2011):
- relatively shallow depth of ore bodies (ore zones 1 – 3, 2 at the depth of 550 – 600 m, ore zone 4 – at 350 m);
- spatial location of the ore bodies constituting the ore zones dispersed along the strike and dip;
- short deadlines for commissioning the lower horizons of ore zones 1 – 3, 4 and construction of facilities and structures for commissioning of the ore zone 4;
- terrain and the presence of the waste pits;
- application of self-propelled loading and transport equipment in the preparation, excavation and transportation of the rock mass in blocks and horizons;
- existing capital openings.

Thus, accessing of the separated ore bodies of the ore zones 1 – 3 and 2 was carried out by two road ramps, two elevator and ventilation raises.

Primary ores in the ore zone 1 – 3, represented by five ore bodies, and in the ore zone 2, represented by five ore bodies, are accessed together, which also allows to significantly reduce capital investments and operational costs for the extraction of ore reserves.

With mine design capacity at 550 thousand tons of ore per year and the average metal content in the saleable ore from the ore zone 1 – 3 – 9.94 g/t, ore zone 2 – 7.14 g/t, the deterioration of the mined ore quality is predictable: by the end of the ore zone 1 – 3 mining (2019) – at 3.4%; by the end of the ore zone 2 mining (2021) – at 25.7%.

While accessing ore deposits at greater depths, it is advisable to study and assess changes in the stress-strain state of the rock massif, depending on the variation of ore deposits excavation sequence. So, the geomechanical substantiation of the parameters characterizing excavation of Oktiabr’skyi northern deposits of the Glubokaya mine was carried out on the basis of 3-D parametric model developed in accordance with the geological surveying documentation presented in the form of vertical sections and plans (Neverov, Neverov, Shaposhnik, & Konurin, 2018). The developed forecast maps of stress distribution in the rock massif depending on the order of excavation development allowed to establish the practically absent (at the scale level) or minimal influence of mined deposits on each other, which, in general, makes it possible to implement different variants of the development sequence. A geomechanical assessment of mining situation was also conducted at the Irtysh field (Zhirkov, Shaposhnik, Nikolaev, & Neverov, 2018).

The analysis of foreign and domestic experience has shown significant technological and organizational advantages and high efficiency of the improved field accessing schemes by road ramps compared to the use of vertical elevator shafts. An essential role is played by the
method of accessing by motor transport ramps when stopping thin ore bodies separated along strike and dip in difficult mining and geological conditions with low confidence of ore deposits’ preliminary exploration. (Sadvakasov, Zhumasov, Egorochkin, Akashev, 2007).

Auto-transport ramps, like ventilation workings and emergency mechanized exits with transportation of rock mass and people by road, are provided at the Suzdal mine of Alel JSC, Sekisovskoe mine, Maleevskiy mine of Kazzine, Obruchevskiy and Dolin mines of Kazzine, Talap and Vesnemne-Aralchinskoe deposits (Erőfeev, Nikiforov, Cherkasov, & Fabrichnov, 1989; Beisebayev, Bitimbaev, & Daukeev, 1997; Barilyuk, Ananin, & Ort, 2003; Kaplanov, Kalmykov, & Rylnikova, 2003; Ryabov et al., 2005) and others. Thus, at the moment, the issues of accessing ore body 2 of the Irtysh deposit or fields with similar geotechnological conditions are insufficiently covered in literature, which is of scholarly interest for the mining science (design) of this region.

### 3. GEOTECHNOLOGICAL CONDITIONS FOR THE DEVELOPMENT OF THE IRTYSH FIELD

The Irtysh deposit is located in the foothill part of the Rudny Altai within the smoothed bald mountain passing into the plain. Absolute elevations are from 360 to 490 m. The main ore-bearing structure is the zone of increased shale of effusive-sedimentary rocks converted during the hydrothermal alteration into microquartzites – sericite-quartz, chlorite-sericite-quartz formations. Microquartzites are developed mainly in the hanging side of the deposit, which has a shale texture. Sericite-quartz schists are most common in the lying side of the deposit in the immediate vicinity of ore bodies. The rocks of the hanging side are represented by chlorite-sericite-quartz schists, whose strength is \( f = 15 \) on Protod’yakonov scale. Stability is average, sustainability category is III. The rocks are split and fractured in different degrees. The maximum schistosity of rocks is noted near ore bodies (Zhaksylykov, Frolov, & Kozlov, 1981; Feasibility study of industrial…, 2013).

The deposit was accessed by the shafts of mines Vspomogatel’naya, Skipovaya and Irtysh up to horizon 15, mine RESH – up to horizon 14 (Industrial development project…, 2010). The distance between the Skipovaya and Vspomogatel’naya shafts on the one side and the Irtysh mine, located on the southeastern flank, on the other side, is 3.2 – 3.3 km. Further accessing and preparation is carried out by stopping the field haulage drifts to the entire length of the Osnovnaya and South-Eastern deposits (up to 4.5 km) with crossovers (transport races), accessing the ore bodies at full power in 100 m along the strike, at each of the operational horizons located each 50 meters vertically. Transportation of the mined ore from the horizons is carried out by rail transport, i.e. mine overhead wire locomotives KR 10 carrying VG 2.2 trolleys to the central ore disposal at the Skipovaya shaft. All extracted ore goes along the concentration horizon 13 to the crushing and dosing complex of the Skipovaya shaft and then – to the receiving hopper on the surface by skips. The rock is transported in trolleys UVB 1.6 (with lateral unloading) to the central rock formation, along horizon 13 to the Skipovaya shaft and is further delivered to the rock dump on the surface.

The deposit is completely covered by a layer of Cenozoic clays and loams from the surface. In addition to the Osnovnaya deposit, ore bodies 2 and 3 have a partial outlet to the erosion section (under the sediment). Thickness of the Cenozoic deposits over ore body 2 is from 10 to 40 m, and over body 3 – from 3 to 10 m. The ore is partially oxidized in the near-surface part, while there are no actually oxidized ores, there is a mixed type of ores. The boundary between mixed and sulphide ores for ore body 2 goes at a depth of 70 – 120 m in the southeastern and central parts, gradually sinking in the northwest direction to depths of 160 – 220 m. As a result, near-surface ores of the central part, as well as the entire northwestern part of the belt of ore body 2, (700 m along the strike), are represented by a mixed type of ore. Single non-productive intersections (mineralization zone) that have no practical interest in terms of estimating mixed ore reserves are available only for the near-surface zone of ore body 3 partial oxidation.

The ore body 2 is represented by three imbricate lenses of sulphide ores. The length of ore bodies is: along the strike – 2300 m, along the dip – from 30 to 200 m (average 120 m); the maximum thickness of ore bodies is 5.3 m (average 1.3 m), the depth – from 70 to 300 m. Ore bodies are steeply dipping (80 – 90°). Ores and enclosing rocks are of medium resistance to the unstable ones, ores are of medium-strength (\( f = 12 \)), enclosing rocks are of medium (\( f = 7 – 9 \)) and below medium strength (\( f = 4 – 6 \)), straddled and jointed. Information on the parameters of ore deposits and bodies is presented in Table 1.

#### Table 1. Linear parameters of the main ore bodies of the Irtysh deposit

<table>
<thead>
<tr>
<th>Ore bodies</th>
<th>Along the strike</th>
<th>Thickness, m</th>
<th>Depth, m</th>
<th>Angles of fall, deg.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Length of ore bodies, m</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>from to average</td>
<td>maximum</td>
<td>average</td>
<td>from to</td>
</tr>
<tr>
<td>Main deposit</td>
<td>2700</td>
<td>70 – 100</td>
<td>600</td>
<td>390</td>
</tr>
<tr>
<td>Ore body 1</td>
<td>780</td>
<td>40</td>
<td>60</td>
<td>50</td>
</tr>
<tr>
<td>Parallel deposit</td>
<td>750</td>
<td>50</td>
<td>80</td>
<td>70</td>
</tr>
<tr>
<td>South-East deposit</td>
<td>3300</td>
<td>60 – 100</td>
<td>500</td>
<td>310</td>
</tr>
<tr>
<td>Ore body 2</td>
<td>2300</td>
<td>30</td>
<td>200</td>
<td>120</td>
</tr>
<tr>
<td>Ore body 3</td>
<td>700</td>
<td>40</td>
<td>80</td>
<td>70</td>
</tr>
<tr>
<td>Ore body 4</td>
<td>480</td>
<td>40</td>
<td>80</td>
<td>110</td>
</tr>
<tr>
<td>New deposit</td>
<td>1500</td>
<td>80</td>
<td>170</td>
<td>140</td>
</tr>
<tr>
<td>Ore lens 202</td>
<td>580</td>
<td>40</td>
<td>80</td>
<td>70</td>
</tr>
</tbody>
</table>

\* – without Cenozoic deposits; ** – without oxidized and mixed ores
4. METHODOLOGICAL ASPECTS OF CHOOSING COMPETITIVE ACCESSING SCHEMES

Option for accessing ore body 2 should be selected taking into account the following geological and engineering conditions:
- relatively small depth of ore bodies’ occurrence (300 m under the surface);
- spatial arrangement along the strike and dip of ore body 2;
- short deadlines for commissioning of working horizons and construction of the facilities for starting development of the ore zone;
- topography;
- application of self-propelled drilling, handling and transport equipment in the preparation, cleaning and transportation of rock in blocks and horizons;
- actual location of the existing surface facilities of the enterprise.

In accordance with the current rules (Norms of technological design..., 1986; Rules for ensuring industrial..., 2014), scheme No. 1 (Fig. 1) is proposed for accessing ore body 2 with an inclined transport ramp from the surface, which includes drilling of the following excavations:
- main opening – transport ramp from the surface (mark +489.17 m) to the mark of +171 m on the southeast flank of the field in the Irtysh mine shaft area;
- ramps from the transport gradient at elevations of +321, +271, +221, +171 m;
- fringedrifts every 50 m vertically at elevations of +321, +271, +221, +171 m.

Two separate exits for people from each horizon directly from the mark of +171 m to the surface are provided by stopping the elevator raise with the section of 10.0 m² (2.8×3.57 m) and the length of 320 m. Ventilation raise, having access to the day surface, is developed for ventilation of mining operations horizons. The use of the lift ALIMAK SE 700 FC or PSL-1000 is possible for evacuation of people in emergency situations taking into account section of the raise and the performed calculations.

Elevator raise can be developed by drilling (by a drilling machine Rhino-2000 C, diameter of the raise D = 3687 mm, pilot well with a diameter 349 mm, drill bit – Pilot Bits – 349 SCMH), sweep head 3687 mm (expander CRH 10 E). Eastern Kazakhstan companies have already accumulated certain experience in drilling ventilation shafts 250 m deep of 3.13 m dia by the tool Rhino 1298 DC (Sandvik) at Maleevskiy mine of Zyranyovskiy ore-dressing and processing enterprise (ODaPE) and by Rhino 1200 and 400 at Tishinskii mine of Ridder ODaPE, JSC Kazzinc. Drilling of three shafts 3.1 m dia by the Rhino tool is planned for accessing the Dolinnoe and Obruchevskoe deposits of Ridder ODaPE (the speed of stopping a pilot well is 300 m per month, for the extension – 160 m per month).

Scheme No. 1 allows to solve problems of accessing and preparation of the upper horizons reserves in the deposit (ore body 2) and further ore body 3. The projected main openings are located beyond the boundaries of the possible zone of rock mass displacement.


Figure 1. Schemes No. 1 and 2 of ore body 2 accessing in the Irtysh deposit

Scheme No. 2 of accessing ore body 2 by an inclined transport ramp from the surface of the mark +454.16 m to the northwest of the Irtysh mine (Fig. 1) allows to reduce the volume of mining and CW. However, in this case, the volumes of stopping the transport ramp along sediments increase. The ventilation scheme is assumed to be forced. Fresh air is supplied by ventilation and elevator raises. The exhaust air is delivered to the surface along the transport ramp.

Scheme No. 3 presupposes stopping by fringedrifts between the Irtysh and Vspomogatel’naya mines on the upper horizons:
- designing pit-bottom of the Irtysh mine shaft at levels +321, +271, +221, +171 m;
- stopping crosscuts of the Irtysh mine shaft at levels of +321, +271, +221, +171 m;
- stopping fringedrifts at 50-m interval vertically at +321, +271, +221, +171 m.

5. TECHNICAL AND ECONOMIC COMPARISON OF THE ACCESS OPTIONS

Scheme No. 3 allows to solve questions of accessing and preparation of the deposit upper horizons reserves (ore body 2) and further – ore bodies 3 and 4. The projected main openings are located beyond the boundaries of the possible zone of rock mass displacement. The difference in the volume of CW and PW is 45640 m³ in favor of the option of accessing ore body 2 by fringedrifts between the Irtysh and Vspomogatel’naya mines (Fig. 2).
The main opening from the surface by sediment; coming along the trunk of the Irtysh trunk; main air handling unit on the surface (use of fresh air accessing the ore by a transport ramp from the surface. Stages of development are much lower than in the case of ing existing openings, is envisaged to maintain annual emergence mechanized exits to the surface, considering transportation of rock mass, ventilation and arrangement of ore veins with the formation of a single scheme for (Norms of technological design…, 1986). Joint mining of ore body reserves to be 200 thousand tons of ore per year (Fig. 3).

6. CONCLUSIONS

Analysis of merits and demerits of the considered ore body 2 access schemes, taking into account the possible risks associated with carrying out and strengthening the transport ramp from the surface along the sediments, has shown that a more attractive and economically expedient option is accessing by fringedrifts between the Irtysh and Vspomogatel’naya mines.

In developing the design documentation for mining ore body 2, it is advisable to consider the issue of additional exploration of reserves from ore bodies 3 and 4 and, on its basis, to carry out the necessary geological
survey. It is also possible to consider the expediency of using the existing horizon 6 as a concentration horizon for the passage of ore and rock from marks 321, 271, 221, 171 m, followed by the issuance of ore and rock along the Irtysh mine shaft, which eventually will allow to average ores of lower horizons and ore body 2 in terms of their quality.

The extraction of ore along ore body 2 is planned to begin in 2018 with a volume of 9180 tons. In 2019–2021, the ore body 2 will achieve maximum ore output of 200 thousand tons. Mining of ore body 2 will end in 2022 at 58419 tons per year.

Mining of ore body 2 will allow to reach the productivity of the Irtysh mine at 600 thousand tons per year in the period 2018–2026. The main development system in the relevant mining and geological conditions for the Irtysh deposit (with medium stability of ore and enclosing rocks) is a system with ore storage with the following indicators: specific volume of preparatory works – 70.3 m³/1000 t; specific volume of first workings – 14.4 m³/1000 t; losses – 8.9%.

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ОБГРУНТУВАННЯ І ВИБІР СХЕМІ РОЗКРИТТЯ ДЛЯ ВИЇМКИ ЗАПАСІВ ДРУГОГО РУДНОГО ТІЛА ІРТИШСЬКОГО РОДОВИЩА

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Мета. Обґрунтування та вибір раціональної схеми розкриття другого рудного тіла Іртишського родовища на підставі техніко-економічного порівняння її прийнятих конкурентних варіантів.

Методика. Для досягнення поставленої мети використани основні гірнично-геологічні та інженерно-технічні вимоги для вибору схеми розкриття Іртишського родовища. На підставі положень проектних нормативних документів і геотехнологічних особливостей рудного тіла запропоновано 3 конкурентних варіантів розкриття. Методом техніко-економічного порівняння приймалася оптимальна схема розкриття з урахуванням об’ємів гірничо-капіталних і підготовчих робіт та усереднення вмісту металу в руді.

Результати. Виконано аналіз схем розкриття, аналогічних за гірнично-геологічними умовами родовищ, представлених збіжніми рудними покладами. Детально розглянуті переваги й недоліки з конкурентних варіантів розкриття. Обґрунтована технологічна та економічна доцільність виїмки запасів рудного тіла 2, а саме розкриття польовими штреками між шахтами “Іртишська” і “Допоміжна” на верхніх горизонтах родовища. Встановлено, що різниця в об’ємах гірничо-капіталних (ГКР) і підготовчих робіт (ГПР) становить 45640 м³ на користь
варіанті розкриття рудного тіла 2 полювими штреками між шахтами "Іртинська" і "Допоміжна", при цьому об’єм ГКР і ГПР на початковій і кінцевій стадіях відпрацювання значно нижче, ніж при варіанті розкриття транспортним ухилом з поверхні. Підрахована зміна середнього вмісту міді, свинцю і цинку з одночасним відпрацюванням Основного і Підлінного покладів на нижніх горизонтах родовища.

Наукова новизна. Для умов рудного тіла 2 Іртинського родовища, яке планується розробляти, відповідно до запропонованого варіанту розкриття, встановлено, що, незалежно від зниження вмісту міді у товарній руді, в цілому по родовищу підвищується вміст свинцю в товарній руді до 0.49%, а цинку – до 3.83% відповідно.

Практична значимість. Введення в відпрацювання рудного тіла 2, відповідно до рекомендованої схеми розкриття з мінімальним об’ємом гірничих робіт, дозволить досягти продуктивності Іртинського родовища до 600 тис. т на рік у період 2018 – 2026 рр., а також додатково підвищити витяг свинцю і цинку.

Ключові слова: роздивоче, рудне тіло, схема розкриття, об’єм гірничих робіт, вміст корисного компонента

ОБОСНОВАННЯ І ВБИОР СХЕМ ВСКРЫТИЯ ДЛЯ ВЫЕМКИ ЗАПАСОВ ВТОРОГО РУДНОГО ТЕЛА ІРТЫШСКОГО МЕСТОРОЖДЕНИЯ

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Цель. Обоснование и выбор рациональной схемы вскрытия второго рудного тела Иртышского месторождения на основании технико-экономического сравнения ее принятых конкурентных вариантов.

Методика. Для достижения поставленной цели выделены основные горно-геологические и инженерно-технические требования для выбора схем вскрытия Иртышского месторождения. На основании положений проектных нормативных документов и геотехнологических особенностей рудного тела предложены 3 конкурентных варианта вскрытия. Методом технико-экономического сравнения принималась оптимальная схема вскрытия с учётом объемов горно-капитальных и подготовительных работ и усреднения содержания металла в руде.

Результаты. Выполнен анализ схем вскрытия, аналогичных по горно-геологическим условиям месторождения, представленных сближенными рудными залежками. Детально рассмотрены достоинства и недостатки 3 конкурентных вариантов вскрытия. Обоснована технологическая и экономическая целесообразность выемки запасов рудного тела 2, а именно вскрытие полевыми штреками между шахтами “Іртинська” и “Вспомогательная” на верхних горизонтах месторождения. Установлено, что разница в объемах горно-капитальных (ГКР) и подготовительных работ (ГПР) составляет 45640 м³ в пользу варианта вскрытия рудного тела 2 полевыми штреками между шахтами “Йиртинская” и “Вспомогательная”, при этом объемы ГКР и ГПР на начальной и конечной стадиях отработки значительно ниже, чем при варианте вскрытия транспортным уклоном с поверхности. Подсчитано изменение среднего содержания меди, свинца и цинка с одновременной отработкой Основной и Юго-Восточной залежей на нижних горизонтах месторождения.

Научная новизна. Для условий рудного тела 2 Иртинского месторождения, планируемого к разработке, согласно принятому варианту вскрытия, установлено, что, несмотря на снижение содержание меди в товарной руде, в целом по руднику повысится содержание свинца в товарной руде до 0.49%, а цинка – до 3.83% соответственно.

Практическая значимость. Ввод в отработку рудного тела 2, согласно рекомендованной схеме вскрытия с минимальным объемом горных работ, позволит достичь производительности Иртинского родовища до 600 тыс. т в год в период 2018 – 2026 гг., а также дополнительно повысить извлечение свинца и цинка.

Ключевые слова: месторождение, рудное тело, схема вскрытия, объем горных работ, содержание полезного компонента

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