

Evaluation of a new trend in the geotechnology for steeply dipping vein deposits in Kyrgyzstan

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Abstract. The authors evaluate advancement in the geotechnology for steeply dipping vein deposits. It is proposed to use large-diameter drilling with drilling assembly BGA-2V-02. As a result, the efficiency of mining is enhanced.

Lodes or vein deposits are important sources of minerals in the world. In the USSR in the 1970–80s, underground mining at such deposits yielded round the fourth of the total production of nonferrous, rare and precious metals in the country. Almost 70 mines performed development of such deposits under different ground conditions [1]. Regarding the world, such deposits are widely spread, e.g. in the North America.

Vein deposits are developed in the world using open stoping, systems with caving and systems with artificial support of mined-out voids. In accordance with [1], steeply dipping ore body development with vein mining method makes 55–60%, cut-and-fill stoping—20–25% and sublevel stoping—8–10%.

Performance of such mines greatly depends on the thickness and inclination of veins. Cut-and-fill methods show higher figures, while vein mining and sublevel stoping have lower performance.

Vein deposits attract increasingly much interest in the Kyrgyz Republic in the latest years. These are such ore bodies as Ishtamberdy, Zhamgyr, Tereksai and Terekkan. The other vein deposits—Kurandzhailyau, Altynzhylga, Komator, Savoyardy, Togolok, Pervenets, Trudovoe—are planned to be put into operation in the short term.

A feature of these veins is their steep dipping and low strength. The dip angles of these veins range from 52 to 85 deg and thickness varies from 0.3 to 1.5 m.

Steeply dipping veins are mined in Kyrgyzstan using systems with ore shrinkage (Zhamgyr, Terekkan, Trudovoe), with systems with support and selective extraction (Kurandzhailyau) and with sublevel stoping (Ishtamberdy). The loss of ore varies from 6.5% (Terekkan) to 14.8% (Ishtamberdy) while dilution reaches 30.7% (Ishtamberdy).

The analyses of ore loss and dilution at some vein ore bodies (Russia, Kazakhstan, Uzbekistan) show wide scatter of figures, depending on ore body occurrence and mining technology. In Kyrgyzstan, conventional mining of veins is connected with high dilution (to 31.0%) and loss (to 13%), which entails high operating cost.

For this reason, the Institute of Geomechanics and Mineral Mining, National Academy of Sciences of the Kyrgyz Republic jointly with the Institute of Mining and Mining Technologies carry out research aimed to justify a new trend of geotechnology for vein deposits. As a result of the research,



an underground geotechnology has been substantiated for low-strength ore veins and includes large-diameter drilling. This geotechnology is based on rotary drilling employed in coal mines. Rotary drilling of coal was widely used in the world [3] and in thin coalbed mining in the USSR [4–7].

Recent models of rotary drilling machines in USA were of high technical excellence and ensured sufficient technical-and-economic indices of face operation and, first of all, labor production output.

On the other hand, the high performance was reached in mining of thick beds of weak coal. Later on, rotary drilling machines were less and less employed as they failed to ensure high mining rates as compared with the continuous heading machines. In the USSR rotary drilling was applied mainly to extraction of thin (0.5–0.9m) beds. Rotary drilling machines and plants were designed and manufactured for those ground conditions. Russia preserves the same approach to rotary drilling machines, it is noteworthy that coal mining in Russia, to be profitable, presumes low cost of final product at comparatively low mine capacity—in small mines with thin personnel operating with high production output. In such conditions, rotary drilling machines are the best choice for their operation involves [7]:

- minimum number of personnel (3–4 miners per shift);
- much lower cost of equipment as compared with the conventional technologies;
- drop in operating cost of mining (2–3 times) owing to reduced consumption of materials (explosives, emulsion, spare parts, etc.);
- enhanced safety and comfort of operation.

The idea of using rotary drilling method in vein mining in Kyrgyzstan was first trialed at Ishtamberdy deposit. The equipment was drilling rig BGA-2V-02 adjusted for the local conditions.

Drilling rig BGA 2V is meant for hole drilling and expansion with cutter bits in rocks with a strength up to 50 MPa and with rotary bits in rocks with a strength up to 80 MPa. Drilling is performed in underground excavations with a cross section not less than 4 m². The minimum thickness of a vein is to be 0.3 m. Drilling rig BGA 2V is equipped with a rotary drill.

The rig (Figure 1) is composed of a drilling assembly 1 and an oil station 2 with a radiator 3. The oil station is mounted with screws on the frame of the drilling assembly. The rig performs all drilling operations.

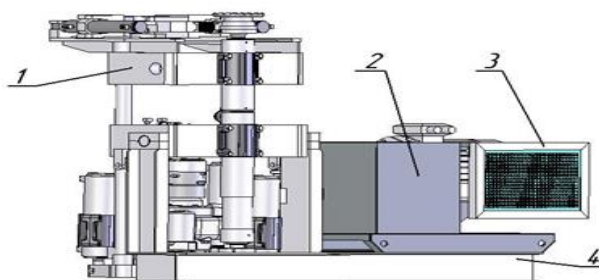


Figure 1. Drilling rig BGA 2V: 1—drilling assembly; 2—oil station; 3—radiator; 4—frame.

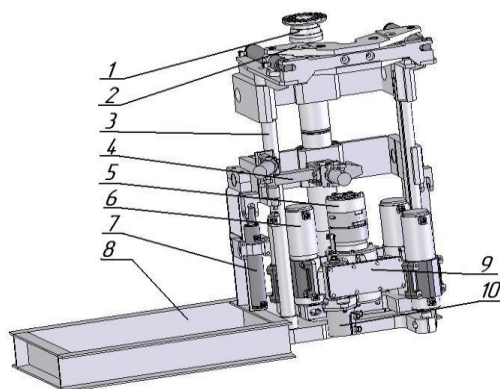


Figure 2. Drilling assembly: 1—leg; 2—crown runner; 3—rotating frame; 4—manipulator mechanism; 5—tool-joint; 6—rotation cylinder; 7—rotation cylinder; 8—frame; 9—reducing gear; 10—fluid-power motor.

The drilling assembly (Figure 2) contains reducing gear 9, cylinder 6 and 7, joint 5, crown runner 2, rotating frame 3, frame 2 and manipulator mechanism 4. The rod of the cylinder 7 is connected with the rotating frame 3, and the body of the cylinder is mounted on the frame 8. The crown runner is screwed to the rotating frame. The bodies of the cylinders are mounted on the reducing gear, and their rods are hinged with a yoke. The manipulator mechanism has a plug valve to reduce pressure and block the feed.

Rotation is executed by fluid-power motors connected with gear shafts by gear wheels. The gear shaft transmits rotation via gear wheels to a shaft where the tool-joint is set.

The oil station converts electric power from the power grid into hydraulic energy. The electric motor, via a tooth clutch, transmits rotation to a two-section gear-type pump. The larger section of the pump is for rotation of the fluid-power motors and for maneuvering feed. The smaller section of the pump is for setting the rig at a certain angle, to feed the hydraulic leg, control the crown runner and manipulator mechanism and for regular feed. The oil station is composed of a tank, pump drive and radiator. The radiator is equipped with a fan rotated by the fluid-power motor sequentially connected with a drain line.

The drilling assembly has a dust suppression system with water feed from a mine water line. The assembly is run by 2 operators.

The proof tests of the drilling assembly BGA-2A were carried out on 7–11 July, 2014 on level 2216 in drift no. 2 on the west of the northern ore vein. Total length of drilling was 30 running meters of holes drilled from level 2216 to level 2244.6; 26.5 running meters of holes were drilled with $D = 300$ m, $d = 500$ m, and 3.5 running meters of holes were drilled at $d = 150$ m and at an angle of 62 deg. Based on the test results, an expert committee decided on continuing the tests of a retreat reamer from level 2244.6 and proved applicability of the drilling assembly BGA2V in low-strength thin ore veins.

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