USE OF A NEW ORE SHRINKAGE SYSTEM
WITH FLEXIBLE ROOFING AT THE KANSK MINE

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The Kansk polymetallic deposit has very weak country rocks, represented by crushed fissured, talcose serpentinites. These tend to swell and peel off, even when only partly exposed. The mineralization is very irregular and takes the form of veinlets, pockets, and disseminations. The contacts between the ore and serpentinites are indistinct.

The ore shrinkage system involved leaving a protective ore crust, 1-1.5 m thick, at the hanging wall. However, some of the crust peeled off during breaking and passing out, so that the serpentinites were not completely covered by ore. Ore losses when working bodies 6 and 6a have amounted to 30.7% over recent years (18.2% was accounted for by the protective crust and incomplete extraction), and dilution comprises 30.4% (6-8% during winning).

To reduce losses and dilution of the ore, new versions of the ore shrinkage system with a flexible dividing roof (lateral and horizontal) were developed. In the lateral system, after the block has been prepared and entered, while the slices are being taken out a flexible metal covering is erected in the room at the hanging wall and secured to the rock by shallow bolts; in the horizontal covering system, the metal mesh is laid on the ore after the room has been worked. The purpose of this covering is to isolate the room ore from the caving rock.

The equipment was tried out in 1965-1966. Blocks 23, 24-25, and 26 were worked with ore-shrinkage and a flexible covering at the hanging wall, while block 22 was mined using a horizontal cover. Operations proceeded in ore body districts 4, 5, 6a, and 10 under difficult geological conditions. This is a lenticular ore body, in which the bed positions in district 10 are relatively persistent, whereas those in districts 4, 5, and 6a are extremely erratic both along the strike and to the dip. The lengths of the rooms are 20-45 m, and room height over the entry horizon ranges from 12.5 to 28 m. This is a fairly strong ore, hardness 10-12, weakly fissured and prone to cake when moist. The rocks in the hanging wall are clay shales and serpentinites, fissured and weak (hardness 2-4). The relatively firm foot wall consists of limestone-shale breccia.

Figure 1 shows how block 23 was worked out using shrinkage and a lateral covering. Operations in the room took in slices of 1.5 m from the bottom upwards, without leaving any protective crust. The ore was mined from cross cuts run through to the center of the room by a rise-stope system with horizontal holes of 1.5-1.8 m, at intervals of 1.0-1.2 m. As the ore was mined out, the hanging wall in the room was lagged in metal mesh. Mesh strip width is 1.5 m, aperture 25 x 25 mm, and wire diameter 2.5 mm. At 6 m from the entry horizon level, the covering was fixed to the hanging-wall rock using reinforced concrete bolts 2 m long to consolidate the weak rock and prevent these from caving; further up, bolts and metal pins 0.4-0.7 m long were employed.

To install these reinforced concrete bolts, the holes were filled with a grout using an air injector (grout prepared in the room). The bolts were installed simultaneously over the entire slice in the room in a network 1.5 x 1.3 m (at intervals of 1.5 m over the height of the room, corresponding to the width of the mesh and the height of the slice being taken out, and every 1.3 m along the room so as to pack the dividing covering tightly against the uneven surface of the hanging wall and thus protect the covering from damage when the overlying ore slice is being mined out).

The mesh covering was hung on the bolts by means of nuts and washers. To protect the newly erected covering strip when mining out the upper ore slice, drilling and blasting were carefully calculated to ensure that the minimum amount of ore fragments flew out towards the covering.

Work involved in erecting the flexible covering at the hanging wall showed that the process was simple (low costs in terms of man power and material; materials costs were 80 kopeks/m² of covering).
The most difficult operation in erection was the installation of the reinforced concrete bolts. To reduce the difficulties involved here, in the upper part of the room the isolating covering was secured by means of metal pins made of round steel 16 mm in diameter and 0.4 m in length. A hook was made at one end to suspend the metal mesh. When erecting the covering, wooden plugs were placed in the shot holes, the pins were driven into these; the net hung on the pins and finally was tied there by wire. This method of securing the flexible covering is more effective than using the reinforced concrete bolts, both in terms of manpower and materials. However, when working in weak fissured rock, the use of reinforced concrete bolts is sometimes essential. In the bottom part of the room, the rock must be consolidated so that it will not cave before all the ore has been passed out.

On the basis of these investigations, we determined the cost of a lateral covering per ton of ore for deposits of varying thickness (Fig. 2). The covering at the hanging wall cut short any falls of weak rock and made mining safer in the rooms.

During mining, surplus ore was passed out through the bottom onto the haulage level and loaded into cars. When mining was finished, to prevent the caved room roof rock from mixing with the ore a metal mesh was placed on the mined ore right up to the foot wall and connected to the covering which had been erected at the hanging wall.

The ore was drawn out of the room according to a schedule which provided for regular discharge of a fixed amount of ore from each incline. During extraction of the ore, the rock in the hanging wall in the top part of the room caved together with the covering on to the mined ore; after this, the covering moved along behind the ore separating this from the rock. When extraction was completed, the covering descended to the level of the entry above all the discharge tunnels. In the bottom part of the room, the rock in the hanging wall was securely held by the reinforced concrete bolts and the metal mesh until all the ore had been removed. This was also the pattern of work in rooms 24, 25, and 26.

For mining ore body 10 (block 22), the system adopted was ore shrinkage with the horizontal dividing cover (Fig. 3). The ore body was wedged in between the main levels; the roof rock was composed of serpentinites and clay shales with a hardness of 2-4. The surrounding rock was comparatively stable limestone-shale breccia, hardness 7-8.

The block was prepared and entered in the normal way, the ore passed out on to the floor level of the entries and loaded into cars by PML-5 equipment. The ore chutes were driven in two series, spaced 6 m apart along the...