COMPREHENSIVE STUDY OF DIAMONDS FROM DIFFICULT-TO-DRESS SOURCE MATERIAL

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The problem of diamond recover from difficult-to-dress raw (dressing tailings) by physico-chemical processes is obviously topical due to the wide introduction of the methods of final retreating of gravitational diamond-bearing concentrates, such as sticky separation and film and foam floatation. The degree of recovering of diamonds varies widely at different deposits and constitutes about 10 % of the -2+0.5 granulometric separation class yield in average. The analysis of scientific studies of domestic and foreign investigators showed that there is no a justified hypothesis that explains the mechanism of diamond surface hydrophilization (desensitization) or reveals the factors favouring hydrophilization. After A.G. Lopatin (1991) in real conditions there is a wide range of hydrophobic-hydrophilic properties of diamond surface that are mainly responsible for how much diamonds remain in dressing tailings. The diamond surface is defined by three different states of carbon atoms: the atoms of a diamond itself, reconstructed atoms, and oxidized atoms. Ethic, lactonic, and carbonyl groups are formed at the surface of oxidized diamonds. The replacement of gas molecules for water molecules and the growth of surface oxidation level result in hydrophilization.

In this paper the authors report the comparison of diamonds in terms of their mineralogical features. The diamonds from foam separation concentrate and foam separation tailings of the Yubileinaya and Sytykan kimberlite pipes were investigated. To characterize some typomorphic features more completely we used the data on the diamonds of comparable size from geoprospecting samples of the aforesaid bodies. The investigations were carried out using the methods of crystal morphological analysis (Bartoshinsky, 1983), photo-luminescence, X-ray luminescence, microprobe, electronic paramagnetic resonance (EPR), mass-spectrometry and UV-spectrometry.

The results of crystal morphological studies permitted to note the rather high content of Bartoshinsky's I, II, III, and VI crystal varieties among the unrecovered diamonds. These morphological groups are chiefly represented by octahedrons with trigon and ditrigon growth sculptures, polycentric crystals with (111)+(110)+(100) combination forms, smoothed-angular combined crystals (111)+(110), and rounded sculptural to smooth-face crystals. The set of morphological individuals among the recovered diamonds is similar. Nevertheless, the number of coloured crystals with strongly sculptured surface and the portion of twins, intergrowths, and damaged crystals are somewhat higher in tailings. The individual sets of diamond morphological types in each kimberlite body determine the individual morphological crystal sets in dressing tailings of the Yubileinaya and Sytykan pipes. Thus, the coloured deformed crystals with etching grooves dominate in the Yubileinaya pipe.

Study of physical features of both recovered and unrecovered diamonds, their volatile inclusions, and elementary composition of crystal surface helped to obtain the following results:

1. According to photo-luminescence results no considerable differences in the set of impurity defects were recorded for the diamonds from concentrate and dressing tailings. According to X-ray

luminescence the contrast is more clear - the spectral peaks of recovered diamonds are several times higher.

2. Application of electronic paramagnetic resonance method (EPR) allowed to record the impurities and diamond crystalline lattice distortion. We studied the clusters of centres N3V (carbon vacancy surrounded by three nitrogen atoms) and R (broken C-C bond). The main difference between recovered and unrecovered diamonds concerns the concentration of paramagnetic centres in crystals which is higher in the diamonds from dressing tailings.

3. Compositional study of 100-200 mkm and 15-20 mkm thick near-surface layers of unrecovered diamond crystals was carried out using EMMA electronic microscope and electronic microprobe CamScan, respectively. Microprobe analysis provided the determination of the content of eight elements: Mg, Al, Si, Ca, Ti, Cr, Mn, and Fe. The elevated contents of Si, Mg, Al, Ca, and Fe were estimated. The occurrence of these elements in a near-surface layer is likely caused by minor mineral inclusions. Elementary composition of hydrophobic crystal surface seems to be more complicated compared to hydrophilic crystal surface. Chemical composition of the surface of larger diamonds (-2+1 mm) is more multi-element than that of fine diamonds (–1+0.5 mm).

4. Investigation of volatiles from diamond crystals was performed using the mass-spectrometer MCX–4. The content of H_2O, CO_2, and CO are adequate or nearly so. The content of N_2 is higher in the crystals of uncovered diamonds.

Our studies of crystal morphological features and physical properties of diamonds from dressing tailings of the Yubileinaya and Sytykan pipes allowed the conclusion, that to solve the problem of maximum useful component output from diamond-bearing concentrate the further investigations should be focused on the comprehensive study of diamond surface and near-surface layer of 1-2 mkm thick.