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The enrichment of stale tailings of Bom-Gorhon tungsten ore deposits

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Abstract

The results of mineralogical studies of technogenic tungsten raw material (stale tailings of Bom-Gorhon deposit) are represented. Its particle size distribution as well as tungsten and accompanying element distribution among the fractions were determined. The necessity of grinding the heaps down to 0.2-0.25 mm in size was established. It allows increasing the recovery rate of two or more times in comparison with the traditional pattern of tailing processing.

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Keywords: Tungsten; ore; technogenic deposit; enrichment; particle size distribution; physical and mechanical characteristics; X-ray analysis

1. Introduction

Despite the significant mineral reserves and reducing of resource consumption in recent years, depletion of mineral resources is one of the major problems in Russia. No widespread use of resource-saving technologies contributes to the large losses of minerals during mining and an enrichment process of raw materials[1]. An important part of the overall strategy of ore industry, including tungsten one, is the growing use of ore-enrichment waste as additional sources of minerals. In addition, the repository of ore-enrichment waste have high environmental hazards due to their negative impact on air, groundwater and surface water, soil cover of vast areas[2-4].

Currently there are five tungsten-mining enterprises in Russia. Only three of them are working – JSC "Lermontov Mining Company", JSC "Primorsky GOK" and JCS "Tyrnyauz GOK". From 1990 to 1998 the production of

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tungsten concentrates has fallen by 4.2 times. In comparison with 1998 in 1999 the concentrate production increased by 16.2%, mainly due to the JSC “Tyrnauz GOK” (growth of 86.2%)[3]. It should be noted that in Russia there are no significant reserve deposits, which explored reserves would correspond to the quality of foreign counterparts[6, 7].

Some enrichment plants are currently involved in the processing of "stale" tailings, since the content of valuable elements is comparable with the contents of these elements in processed ore [2, 8, 9]. Usually it is several times cheaper to make products from technogenic deposits than from specially mined raw materials, and this is characterized by rapid return on investment. However, the complex mineralogical, chemical and granulometric composition of tailings makes it difficult to calculate the total economic effect from their processing and determine an individual approach to evaluate of each tailing [10-12]. Therefore, concerning the use of ore-enrichment waste the most important one is the detailed mineralogical and technological research of each specific, individual technogenic deposits, the results of which will help to develop an effective and environmentally safe technology of industrial development of an additional ore mineral source.

2. Results and discussion

The objects of the study were the tailings of Bom-Gorhon tungsten ore deposits located in the Petrovsky-Trans-Baikal area of Chita region on the watershed of Bom-Gorkhon, Myshetaya and Zun-Tignya rivers. The Vein deposit contains tungsten mainly in the form of hubnerite (74-95%), the rest is scheelite. From the explored reserves 13.4 thousand tons have relatively high quality (content of WO_3 is 0.917%). The reserves of C1 + C2 category are 2120 thousand tons (revised estimation in 2006).

At enrichment of Bom-Gorkhon ore by a gravity method hundred thousand tons of the tailings with WO_3 content from 0.1 to 0.35% were accumulated. Thus, these tailings correspond to poor tungsten-containing ores of loose type.

This technogenic deposit is located on the surface and it is in loose form. It does not require the extraction and expenses on coarse and secondary crushing. Thus, the economic feasibility of additional tungsten extraction even at such low content can be seen.

According to mineralogical studies tailings contain two varieties of ore: quartz and greisen. The first one is represented by white quartz with hubnerite, pyrite, sphalerite, kassetiritom, kozalitom, gray drain quartz with gyubgneritom and other ore minerals, the second one is mainly quartz, feldspar and mica, there are pyrite, hubnerite, sphalerite, limonite, scheelite in smaller amounts. Besides the main element (tungsten), there are associated components – bismuth and tin.

On the location of technogenic deposit the traditional scheme for tungsten ores has been implemented: preliminary gravity enrichment with separation of bulk concentrate, its drying and two-stage magnetic separation. Firstly, the magnetic fraction is separated, then it is divided into weakly magnetic fraction that contains hubnerite and strongly magnetic fraction that including magnetite with pyrite. However, the proposed scheme provides less than 30% tungsten extraction from its chemically determined amount in the tailings.

This work is aimed at understanding the reason of such low yield at additional tungsten recovery and suggesting the ways to increase it. Complex mineralogical, chemical and granulometric composition of stale tailings containing a set of useful and rock-forming minerals requires additional research of physico-mechanical and technological properties of raw materials.

To perform the research a representative sample of stale tungsten-containing ore tailings was used. Sample preparation of the test material was carried out in accordance with GOST 14180-80.

Physico-mechanical characteristics of the tailings were determined according to GOST 25732-88. Humidity of the test material was 0.82%, bulk density – 1410 kg/m^3, the specific surface area – 711 cm^2/g. Ore particle size distribution carried out by sieve analysis is presented in fig. 1. Tungsten distribution among the factions is shown in tables 1 and 2.

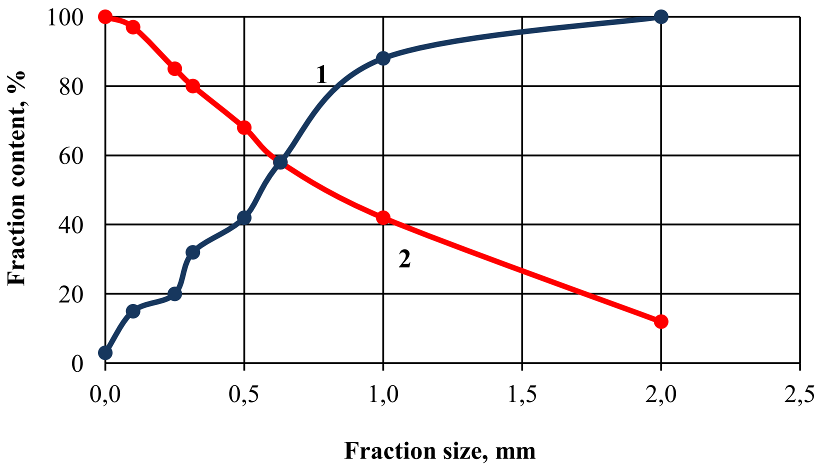

Fig. 1. Cumulative particle size distribution of passage (1) and sieve residue (2)

Table 1. Tungsten distribution among the factions

Fraction, mm	Yield, %	Total yield, %	Bulk density, kg/m^3	Tungsten content, mg/kg	Absolute tungsten distribution, mg/kg	Relative tungsten distribution, %
>2	12	12	1494	1239.0	148.68	13.83
-2+1	30	42	1500	524.7	157.41	14.63
-1+0.63	16	58	1346	706.4	113.02	10.51
-0.63+0.5	10	68	1350	736.7	73.67	6.85
-0.5+0.315	12	80	1339	1110.0	133.20	12.39
-0.315+0.25	5	85	1335	1084.0	54.20	5.04
-0.25+0.1	12	97	1430	1891.0	226.92	21.10
<0.1	3	100	1325	5607.5	168.23	15.65
Total	100				1075.33	100

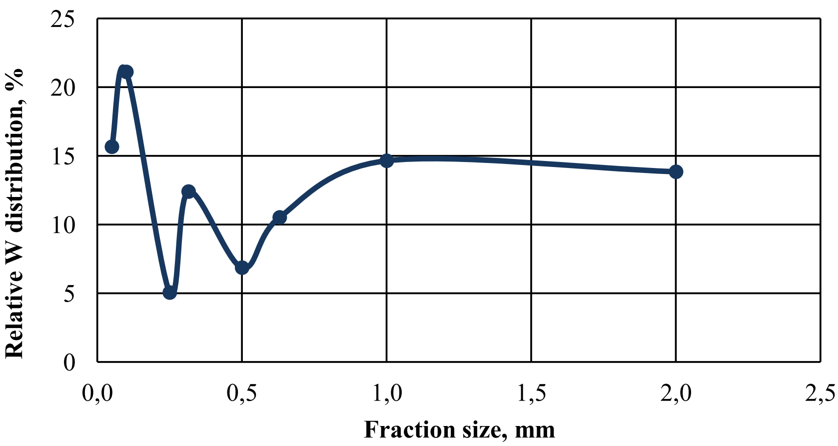

Fig. 2. Relative tungsten distribution among fractions

The obtained data demonstrate that the investigated material is polydispersed. The maximum tungsten content is contained in the fractions < 0.1 mm, -0.25+0.1 mm and > 2 mm, the minimum content is in the fraction -0.63+0.25 mm. Steady decline of the tungsten content with the fraction size decrease indicates a permanent opening of tungsten impregnations at extraction and their output into the fine fraction that is confirmed by the analysis.

Explanation and comparison of XRD patterns of different factions reveal that the predominant component of the host rock is quartz (fig. 3).

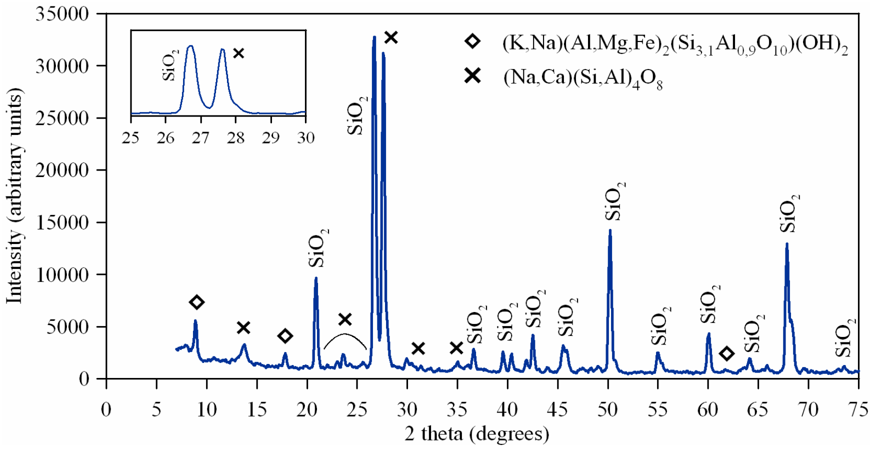

Fig. 3. XRD pattern of the fraction > 2 mm

Besides quartz, in all fractions the presence of sodium calcium aluminosilicate $(Na, Ca)(Si, Al)_4O_8$ and the potassium sodium aluminosilicate with the ions of aluminum, magnesium and iron $(K, Na)(Al, Mg, Fe)_2(Si_{3.1}Al_{0.9}O_{10})(OH)_2$ is confirmed. However, the content of the first compound is large in fractions of –0.315 0.25; –0.5 0.315; > 2.0, whereas the second compound is included in significant amount into composition of the fractions of 1.0+0.63 and –2.0+1.0.

a b c

Fig. 4. Microphotographs of tailings of tungsten ore enrichment of fractions > 2 mm (a), −0.5+0.315 mm (b), <0.25 mm (in)

Fig. 4 shows microphotographs of tailings. They indicate the simultaneous presence of transparent and translucent quartz crystals and crystals with yellow and pink tints. There are also thin impregnations from dark blue to black color with sizes of 0.01-0.1 mm. The part of the colored grains has low-magnetic properties.

3. Conclusion

Analysis of the present situation in Russia with mineral resources of ore industry, in particular tungsten one is made. It is shown that the processing of the stale tailings of ore enrichment is actual. It has technological, economic and ecological importance. Mineralogical, granulometric composition and technological properties of the basic tungsten-containing technogenic material of the Bom-Gorhon deposit is determed. Tungsten at the main useful component is predominantly the part of hubnerite that defines the technological properties of technogenic materials. The distribution of tungsten among the fractions is not uniform. The highest tungsten content in the smallest and largest fractions indicates that the tungsten grain size is predominantly less than 0.25 mm. Therefore, it is recommended to regrind the tailings to the fraction less than 0.25 mm. This will allow opening up the rock and carrying out more complete extraction of tungsten-containing minerals.

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