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ENERGY-DRIVEN PHASE CHANGES OF BAUXITES

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Bauxites from the Vezhayu-Vorykvinskoe deposit (Middle Timan, Russia) are characterized by a considerable iron content, which negatively affect the ore processing. Using modern instrument base for mineralogical studies the author conducted test experiments proving the changes of phase composition and magnetic properties of bauxites after thermal and radiation-thermal processing. The results will allow reconsidering technologies of bauxite processing.

Keywords: high-ferriferous bauxites, thermal processing, accelerated electron processing, magnetic properties.

ФАЗОВЫЕ ИЗМЕНЕНИЯ МИНЕРАЛОВ БОКСИТОВ ПРИ ЭНЕРГЕТИЧЕСКИХ ВОЗДЕЙСТВИЯХ

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Бокситы Вежаю-Ворыквинского месторождения (Средний Тиман, Россия) характеризуются значительной ожезненностью, что негативно влияет на обогатимость руд. Используя современную приборную базу для минералогических исследований, автор провел ряд пробных экспериментов, в результате которых удалось показать, что при термической и радиационно-термической обработках происходит изменение фазового состава и магнитных свойств бокситов. Результаты позволят пересмотреть технологии переработки бокситов.

Ключевые слова: высокожелезистые бокситы, термическая обработка, обработка ускоренными электронами, магнитные свойства.

Introduction

Russia does not have sufficient reserves for domestic consumption of bauxites, generally their quality is poor. A quarter of bauxite reserves are concentrated in the Timan bauxite province, including the Vezhayu-Vorykvinskoe deposit.

To achieve the competitiveness of alumina production it is necessary to achieve lower costs of bauxite processing within the existing technological cycles of modern production. The high content of non-magnetic ferrous oxides — goethite-hydrogoethite and hematite-hydrohematite is one of the main problems of preliminary processing of bauxites [4]. Transformation of non-magnetic iron minerals in magnetic ones could promote the separation of aluminum and ferriferous phases, thereby increasing the quality of ore. In [5] the authors studied the influence of physical and chemical factors on iron minerals for the purpose of their transformation and increasing magnetic phase. A number of papers [1—3, 6] demonstrated the possibility of changes of the magnetic properties of minerals through its processing by high-energy electrons, therefore the main aim of our test experiments was to compare the influence of various energy impacts, for example, temperature and irradiation with accelerated electrons on the magnetic properties of bauxites for the development of effective processing technologies.

Objects and methods of study

The objects of our study were ferriferous bauxites from the Vezhayu-Vorykvinskoe deposit (Middle Timan, Russia). The initial sample was grinded to condition < 0.1 mm.

The chemical analysis was performed with the help of X-ray fluorescence spectrometer ARL.OPTIM'X. The radiation-thermal processing of the bauxite samples was carried

out by a beam of accelerated electrons with energy of 2.4 MeV in the industrial accelerator ILU-6. The thermal processing was carried out in a muffle furnace. The heating rate was 25 °C.

For the separation of bauxite into magnetic and non-magnetic phases we used the separator 138 SBE. The separator worked in the modes with the following values of magnetic field strength: 1.55, 3.22, 4.77, 6.37, 7.96×10^5 A/m. To evaluate the magnetic properties we applied a magnetic susceptibility measuring device (IMV).

Results and discussion

Table shows a high ferriferous content, silica module (SM) — 11, 92. We mark SM increase and iron decrease with decreasing particle size.

The results of experiments on the effect of thermal radiation and thermal processing of the bauxites on their phase composition and magnetic properties are shown in Figure.

Figure shows that the magnetic susceptibility of bauxites changes at these methods. If the thermal processing in a muffle furnace results in decrease, the radiation-thermal processing results in increase of magnetic susceptibility. Heating rate of the bauxites in the accelerator ILU-6 was at 25 °C/min. After heating to 600 °C and subsequent cooling to initial condition the volumetric magnetic susceptibility of the bauxites was $197.81 \cdot 10^{-5}$ SI units, i.e. increased by almost 6 times.

The samples after the radiation-thermal processing were exposed to the dry magnetic separation. The largest share of the magnetic phase is obtained by pre-heating of the samples to 600 °C. The share of the magnetic phase is 80.17 %. In the samples without thermal processing — 17.78 %. At the same time, according to the chemical analysis the shares of aluminum and iron oxides in the magnetic and non-magnetic phases are

Chemical composition of the studied bauxites by particle size

Химический состав исследуемых бокситов по гранулометрическим фракциям

Fraction, mm	Yield, %	Composition, wt. %				SM	Output, %			
		Al ₂ O ₃	SiO ₂	Fe ₂ O ₃	Cr ₂ O ₃		Al ₂ O ₃	SiO ₂	Fe ₂ O ₃	Cr ₂ O ₃
+0.071	2.86	50.87	6.56	34.89	0.02	7.75	2.50	3.80	3.70	2.59
−0.071 +0.045	7.14	51.34	5.82	35.86	0.02	8.82	6.30	8.50	9.40	7.16
−0.045 +0.032	8.40	57.34	5.41	29.87	0.02	10.60	8.30	9.30	9.20	9.43
−0.032 +0.020	5.10	51.14	6.30	33.87	0.02	8.12	4.50	6.60	5.40	6.08
−0.020	76.50	59.67	4.58	25.35	0.02	13.03	78.40	71.80	71.30	74.74
Total	100	58.19	4.88	27.18	0.02	11.92	100	100	100	100

Thermal dependence of volumetric magnetic susceptibility revealed in different experiments: 1 — heating without irradiation, 2 — heating with irradiation, 3 — magnetic susceptibility values in the irradiation experiments after 20 min exposure at 200 and 300 °C

Температурная зависимость объемной магнитной восприимчивости, выявленная в разных экспериментах: 1 — нагревание без облучения, 2 — нагревание с облучением, 3 — значения магнитной восприимчивости в экспериментах с облучением после 20 мин. выдержки при 200 и 300 °C

practically the same: Al₂O₃ 64.15—64.19 %, Fe₂O₃ 26.46—26.80 %.

According to the preliminary experimental data, the radiation-thermal modification of ferri-ferrous bauxites from the Vezhayu-Vorykvinskoe deposit (Middle Timan) can change their mineral composition and properties, including magnetic ones. It is necessary to continue physical and chemical and mineralogical studies to evaluate the influence of radiation and thermal processing on the phase composition and magnetic properties of highly ferri-ferrous bauxites and application of this approach in their processing technologies.

Conclusion

We conducted preliminary experiments on the thermal and radiation-thermal influence on Middle Timan bauxites to modify their technological properties. We showed the thermal and thermal-radiation processing resulted in the change of their phase composition and magnetic properties.

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