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Composition and constitution of pyrrhotite concentrate pellets after partial oxidative roasting

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Abstract

Using the methods of X-ray powder diffraction, electron microscopy and energy dispersive spectral microanalysis, the material composition of the pyrrhotite concentrate pellets subjected to partial oxidative roasting was studied. The structure and elemental composition of the obtained products are estimated, the features of the interphase distribution of elements are revealed. Heat treatment (800 °C) of the concentrate in an oxidizing atmosphere leads to a partial change in the forms of the basic elements. The proposed sequence of high-temperature reactions of solid phases and oxygen is established. The effect of oxidation on the formation of the zoning of the granules was confirmed. The zoning is associated with various desulfurization levels, which decreasing from 81% in the surface layer to 46% in the core.

With deepening, the aleuritic structure of the material acquires the characteristics of an aleuropsammitic structure, the microtexture retains a random porous character, and the pore size is reduced from 38 to 10 μm. The clastic component, represented by grains (size up to 145 μm) of a comminuted, angular, and semi-rounded shape, corresponding in composition to the $Fe_{1-x}S$–FeO_m and FeS_2–FeO_m systems, as well as $CaSO_4$, spinelids and silicates, is supplemented by $CuSO_4$ and $(Fe,Ni)_9S_8$ crystals. Basal cement (size up to 25 μm), similar in mineral composition to debris, passes into the pore cement (15 μm), marked by the predominance of complex aluminosilicates, calcium sulfates and sulfides, its volume fraction is reduced from 88 to 45%. Nickel in all layers of granules is associated with iron oxides and sulfides, which are part of the clastic and cement components, its highest contents (6.1-7.6 % wt.) are confined to Fe_2O_3 and $(Fe,Ni)_9S_8$. In detrital grains of $CuSO_4$, up to 4.9 % wt. Cu was found. The close contact of higher iron oxides and sulfides contributes to the fact that the enrichment of oxide phases with nickel occurs during the oxidation period. The porous nature of the microtexture of the granules weakens the intra-diffusion difficulties of the oxidation process and contributes to the completeness of the transformation of sulfides into oxides.

Subsequent smelting of a partially oxidized compacted concentrate with a flux (silicate nickeliferous ore) will make it possible to gain a matte with a regulated non-ferrous metal content.

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