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BURNED COAL-BEARING WASTE HEAPS FROM THE CHELYABINSK COAL BASIN, RUSSIA

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Intense human industrial activity results in the formation of technogenic lanscapes over a large area. Extraction and storage of a large body of rock on the earth's surface is a dramatic impact on the geological environment. The creation of dumps in the surroundings of coal mining enterprises presents an additional severe problem. The detailed mineralogical and geochemical investigation of waste mass composition must be a necessary procedure, preceding the decision on the waste heap destruction. Burned heaps in the Chelyabinsk coal basin are favourable objects for study on environmental mineralogy and investigation of ecological problems.

In the considered region there are about 50 heaps. The majority of these are 40–70 m in height, their volume reaches 1 000 000 m^3. The original waste material supplied contains mudstones, siderite concretions and coal-bearing material. Spontaneous oxidation of coal material in the heaps, with associated flame combustion, took place between 1960 and 1980. Coal combustion has been completed by now, and the heaps are composed of variably altered rocks. The emission of hot gases (T = 200–400 °C) can be observed. The essential factors that are responsible for the mineralogical variety of technogenic combustion metamorphic rocks are temperature (up to 1000–1200 °C), chemical heterogenity of initial wastes; aggressive gaseous medium (O_2 – from the atmosphere; S, F, Cl – from coals and waste rocks); high porosity of the heap rocks and active gas circulation.

The predominant process observed in silicate rocks during annealing is the decomposition of clay materials. The initial quartz–hydromica association in the mudstones is replaced by a quartz–mullite–hercynite association, and further gives way to refractory clinker: trydimite–mullite–cordierite (± hematite). This material constitutes the major part of the heaps. In the process of oxidative annealing of waste mass there is no active fractionation of Si, Al, Mg, Ti, Mn. Nevertheless the redistribution of Fe, Ca, F, and removal of Na, K, S, C outside the heaps are apparently to take place.

Some parts of the waste sedimentary rocks, the so-called "black blocks", were subjected to annealing under very reducing conditions and high temperature, dry refining of coal as well as carbonate dissociation were realized here. In these zones we identified monosulfides and carbides of iron, a wide variety of high temperature oxides and silicates, and abundant minerals of fluorine. One of the general mineral forming processes is precipitation from gaseous phase, either directly, similarly to the way ice crystallizes from vapour, or through interactions between different volatile cation and anion complexes ("reactions of gas–transport synthesis"). Where combustion has already terminated, "black blocks" remain the sustained source of nitrogen, chlorine and sulfur compounds.

At least three types of rocks, differing in hazardous effect on the environment, can be distinguished in the burned heaps: a) clinker, which is the chemically most tolerant part of the burned heaps; b) "black blocks", the source of toxic gases, containing S, F, Cl, N; c) asphalt-like crusts and the products of fumarole activity, the potential sources of sulfate contamination of soils and ground waters.