Chemical Contamination

Current State of the Abandoned Mine Wastes: Environmental Risks, Prospects for Extraction and Reclamation

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ABSTRACT

Mining activity entails accumulation of hundreds thousands tons of sulfide–bearing mill wastes with high concentrations of ore elements (Fe, Cu, Zn, Cd) and impurities (As, Hg, Be, and Tl). Oxidation of the sulfide minerals results in the formation of acidic solutions with high concentrations of SO_4^{2-}, Cu, Zn, Fe, As, Sb and other soluble species. These elements may migrate out of tailing dumps within drainage streams and get discharged into the rivers or seeped into groundwater, or they may end up in the atmosphere with air flows for tens of kilometers (Yurkevich et al., 2017; Bortnikova et al., 2019).

The relevance of solving the problem of industrial pollution is determined by the social significance of the natural environment protecting. Also the abandoned mine wastes can be considered as "man-made deposits" due tohigh content of valuable components and their volumes.And while Japan, the USA, China, the EU countries are actively using technology to re-engage valuable components from the "tailings" into production, in Russia, interest in deep processing technologies is so far only associated with the desire of mining processing companies to reduce their costs.Despite the fact that "Reproduction and use of natural resources" and "Environmental Protection" are long-term programs, adopted by the Russian Ministry of Natural Resources. In fact, the handling of abandoned waste in the Russian Federation is not currently regulated, the question remains open: there is no established methodology for estimating stockpiles and handling of waste stored in old, unaccounted for storages. Meanwhile, according to some estimates, the volumes of hazardous sulfide-containing mining waste in non-equipped storage facilities according to modern standards reach several billion tons in our country (data from www.gks.ru, 2017). They are stored in the open air, as a rule do not have anti-filter screens, are exposed to atmospheric precipitation. Active oxidation of finely ground material leads to chemical pollution of water and soil cover within a radius of several kilometers.

The recent investigation aims to detect mechanisms of chemical elements migration from the abandoned mine wastes and the ways of their immobilization. The main idea of the study is to assess the environmental damage and search for optimal methods to extractthevaluable components, reburythe toxic residues and reclaimthe contaminated areas. Study objects include abandoned wastesafter the processing of sulfide-containing polymetallic ores located in the immediate vicinity of the living area in the Kemerovo Region (Komsomolsk, Ursk, Belovo, Salair) and the Trans-Baikal Territory (Vershyno-Shakhtama and Vershyno-Darasuntowns, Fig.1).

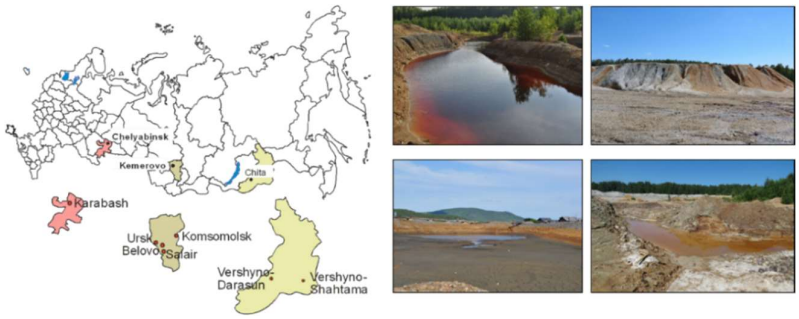

Figure 1. The layout and photos of thestudy objects

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The main results of the investigation include the scientifically based recommendations for waste treatment, reburial of toxic residues (As and Hg containing material) and the restoration of disturbed areas based on an integrated environmental and economic approach:

1. Assessment of the abandonedmine tailings volumes and composition, using the developed integrated methodology, combining classical geochemical testing and geophysical survey (Electrical Resistivity Tomography (ERT), electromagnetic scanning, aerial photography, Fig. 2).
2. Determination of existing geochemical anomalies in natural waters and soil cover in the vicinity of the mine tailings, comparison of actual monitoring data with the results of geophysical investigation.
3. Prognostic hazard assessment of waste according to the author's method, taking into account the acid-producing and neutralizing potentials of the substance.
4. Economic calculation of environmental damage from pollution of water and land resources at these facilities.
5. Search for the optimal method to extract metals (Cu, Zn, Au, Ag) from the studied wastes, and developthe anti-filter screen using natural and artificial materials with the economic calculation of the appropriateness of the proposed measures.

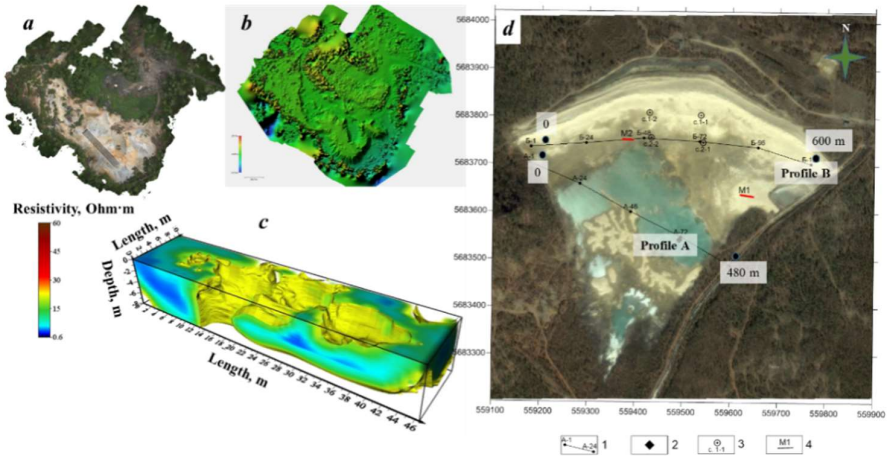

Figure 2. Drone high resolution photo (a), digital relief model (b), 3D – geoelectrical model of the Belokluch tailings, Kemerovo region(c), the investigation scheme on the Shahtama tailings (d): 1 – profiles of ERT, 2 – drainage pit, 3 – wells, 4 – profiles of micro-ERT.

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