

PREDICTIVE MODEL OF DRAINAGE – WASTE HEAP NTERACTION: PREVENTIVE ESTIMATION OF POTENTIAL RISK

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Acid drainage in mining regions is one of the most actual problems of modern geochemistry. Nowadays, while mining planning the reliable estimation of possible acid drainage effluents with high amounts of toxic components becomes of a paramount importance. This work is an expert evaluation of potential waste environmental hazard at one of gold deposits Veduga at the Yenisei Range.

The deposit belongs to impregnated ore type with complex mineral composition and located in ter-rigenous series. Main ore minerals are sulfides - pyrrhotite, pyrite and arsenopyrite (2-5% in total) and minor minerals are sulfides and sulfosalts of Cu, Ni, Co, Fe, Pb [1] Metasomatic aureoles are enriched in Sn, W, Mo, Li, Be [2]. In order to obtain geochemical evaluation of drainage effluent: 1) full analysis of waste rocks both in macro- and microcomposition, totally for 40 elements, was made; 2) mobile (water-soluble and exchangeable) species of elements in rocks were determined; 3) minerals that concentrate toxic elements were defined; 4) the antacid capacity of wastes was studied.

Waste rocks are considerably enriched in water-soluble species and even more in exchangeable species (i.e. species soluble in acid drainage). Species content is listed in Table.

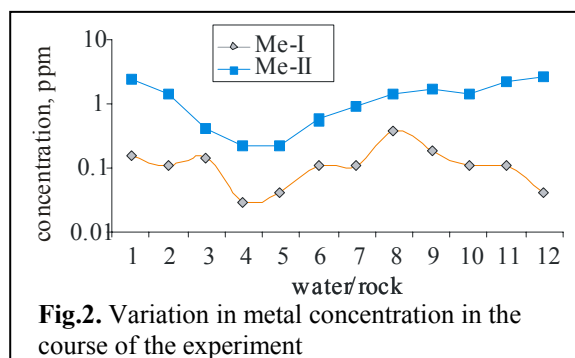
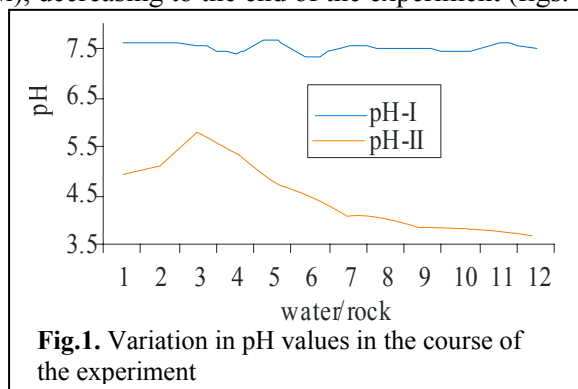
Table. Contents of water-soluble (numerator) and exchangeable (denominator) species of elements in waste rocks of the Veduga deposit (ppm)

n = 50	As	Sb	Zn	Pb	Cu	Co	Ni	Be
mean	0.2/1.7	0.4/2.2	1/2.9	0.04/5.2	0.17/1.2	0.12/1.9	0.28/3.2	0.004/0.046
maximum	4/16	2.7/18	9.5/13	0.53/63	1/9.5	1.3/6	3.6/11	0.024/0.12

Note: n – number of analyses

The full picture of waste rock composition allowed us to choose necessary rock samples for kinetic modeling of rapid oxidizing leaching of elements by seasonal streams.

Water-rock ratio was equal 0.6 at the first phase of experiment and 12 at the last phase, with 20 weeks of total duration of experiment. The experiment have shown that due to interaction of waste rocks with seasonal streams, dissolved species of metals (Fe, Al, Mn, Zn, Cu, Co, Ni), metalloids (As, Sb, Mo) and extremely toxic elements such as Be and Hg will release into environment. All rocks were divided in two groups according to pH of water achieved during interaction. The first group consists of rocks which drainage was neutral to subalkaline with low concentration of metals (Fe, Zn, Cu, Co, Ni), decreasing to the end of the experiment (figs. 1, 2).



Such metals as Zn, Cu, Co, Ni, Cr, V had similar behavior in the course of the experiment (high intercorrelations), therefore plotted curves of their total content adequately display variances of each component. Samples from the 2nd group of rocks produced acid solutions with metal content one order higher than the 1st group. In the first group solutions, by the end of the experiment metal concentrations began to decrease in contrast to solutions of the second group where concentrations of elements steadily raised. This may be evidence of proceeding oxidation and dissolution of sulfides and sulfosalts. Rate of As and Sb release into solution depends on their forms of existence in rocks. High As contents were formed both in acid solutions (all mobile forms dissolved) and in subalkaline solutions

(water-soluble forms). Water-soluble As species were leached rather quickly that caused As concentrations to decrease at water-rock ratio equal twelve, however, a large amount of exchangeable As species (in rocks) led to long leaching process with increasing arsenic content along increasing water acidity. (fig. 3).

Mineralogical study had shown the presence of oxidized arsenopyrite grains in sample N 190. These grains were considerably replaced with secondary arsenic minerals which were the source of As in solutions of this column. In sample N 270 evident signs of As-minerals oxidation were not observed, instead, As-sulfosalts were determined. Obviously these As-minerals were gradually dissolved in acid solutions. Moreover, samples of waste rocks contain a large amount of Fe hydroxides, which surround and replace sulfides. These Fe hydroxides can sorb arsenic released from its primary minerals when they corroded. Later, Fe hydroxides with sorbed arsenic can serve as its source in acid drainage effluents.

Leaching of Sb (fig. 4) and Mo took place in neutral to subalkaline solutions that were caused by: 1) accumulation of mobile forms of these elements in rocks independently of their oxidation form, and 2) possible desorption of Sb and Mo exchangeable species in neutral streams.

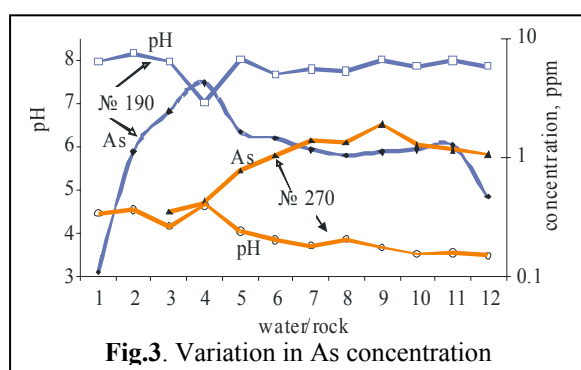


Fig.3. Variation in As concentration

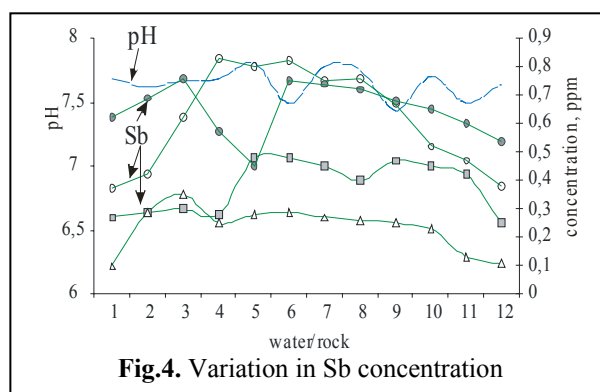


Fig.4. Variation in Sb concentration

Beryllium release in solutions begins with destruction of micas in the acid media, which witness by Al dissolved species occurrence, high positive correlation between these elements and significant negative correlation (between beryllium and aluminum content in solution) and pH values.

Thorough investigation of waste rocks with complex composition has shown features of hydrogeochemical anomalies formation during interaction of waste rocks with water streams. Sb, Mo and partly As will release in neutral to subalkaline solutions. With media acidification, such metals as Fe, Al, Zn, Cu, Co, Ni, Be will get significant mobility. After mixing these two types of solutions, resulted solution become neutral, consequently Fe-hydroxides precipitate and adsorb most toxic elements. Concentrations of metals, As, Sb fall to the safe level due to their sedimentation and dilution. However, beryllium content remains high, several times exceeding maximum permissible concentration.

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