ESTIMATION OF THE ACID-BASE POTENTIAL OF ROCKS AS A FIRST STEP OF THE ENVIRONMENTAL PREDICTION

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During mining of sulfide-containing ores, storage of waste rocks and mill tailings, the development of the process usually named as *acid mine drainage,* is defined mainly by composition and ratio of sulfides and wall-rock minerals interacted with "water" in various geochemical situations. This research was focused on quantification of potential of waste rocks of the Veduga gold deposit (the Yenisei range), planned to intensive exploitation, to neutralize acid drains. Veduga is characterized by insignificant quantity of sulphidic minerals (pyrite, arsenopyrite, pyrrhotite), usually not exceeding 5-7 %. Ore bodies are metasomatic rocks, compositionally adequate to sericitolite, in which quartz and carbonate-quartz veins, lenses and the fragment sulfide mineralization are located.

Total neutralizing potential (ΣNP) was determined from the reaction of rock samples with standard HCl solution (0.1 or 0.5 N) with the subsequent back-titration up to pH 7 by the NaOH of similar normality. The NP value expressed as tons of the $CaCO_3$-equivalent per one thousand of tons of waste rock (parts per thousand, i.e. ppt = 0.1 wt. %) was calculated by method [1]. Analytical CO_2-content of the same samples, determined by titrimetric method, has been re-calculated to calcite concentration (wt.%) to estimate acid-neutralization potential of carbonates only (NP_{carb}).

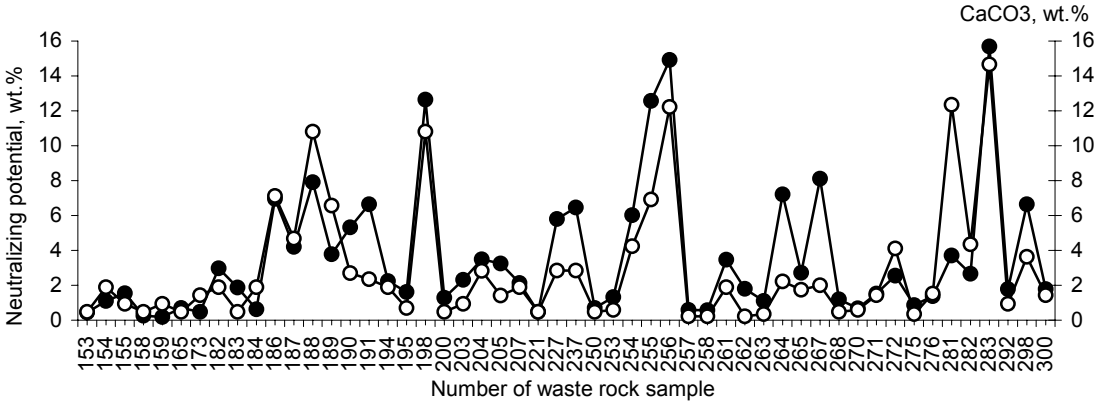


Fig.1. Dependence of total neutralizing potential (solid circles, a scale at the left) of Veduga waste rocks versus their $CaCO_{3(S)}$ concentration (open circles, a scale on the right).

As a whole, waste rocks of the Veduga deposit have low ΣNP; from 95 analyzed samples, only 19 have ΣNP > 50 ppt. The data resulted in Fig. 1, quantitatively prove, that the total potential of rock samples is higher than what would be provided only by carbonates ($NP_{carb} = CaCO_3$, wt. %) though their interrelation is obvious. It is most pronounced in the rock samples with high neutralizing potential (e.g. 188, 198, 255, 256, 283), allowing their use as geochemical barriers (e.g. around the future tailings impoundments).

Acid-producing potential (AP) of 85 waste rocks was calculated according to [2] from the concentration of sulfide S (wt.%) measured by a weight method and calculated as a difference of total sulfur and sulphatic sulfur. The calculations of AP are based on the following assumed stoichiometry:

$$FeS_2 + 2CaCO_{3(s)} + 15/4O_2 + 7/2H_2O = Fe(OH)_{3(s)} + 2SO_4^{2-} + 2Ca^{2+} + 2H_2CO_{3(aq)} \quad (1)$$

For each mole of pyrite that is oxidized, two moles of calcite are required for acid neutralization. On a mass ratio basis, for each gram of sulfur present, 3.125 grams of calcite are required. When expressed in parts per thousand of waste rocks, for 10 ppt of sulfur (equal to 1 wt.%) present, 31.25 ppt of calcite is required for acid neutralization: $AP = S_{sulfide}$ (wt.%) · 31.25. Actually, in the first case we calculated the quantity of the $CaCO_3$-equivalents in the sample, in the second – the quantity required for neutralization of an acid. As a whole, waste rocks of Veduga have low AP < 50 ppt as well (Fig. 2). Nevertheless, those located below the line of equal values of potentials could give a rise to the solutions with low pH during interaction with water. Tool measurement of pH of water extracts (solid/liquid = 1:4) was carried out to check this conclusion.

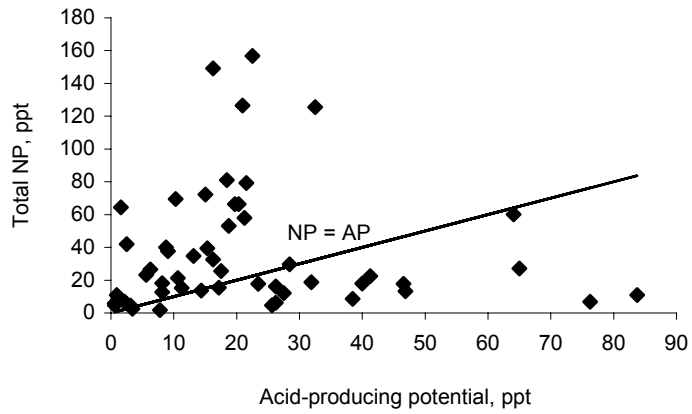
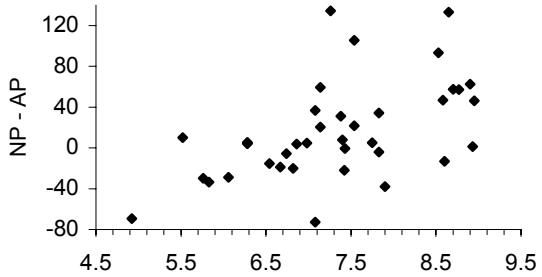


Fig.2. Calculated values of total NP and Acid-producing Potential. Solid line corresponds to their equal values (NP=AP).



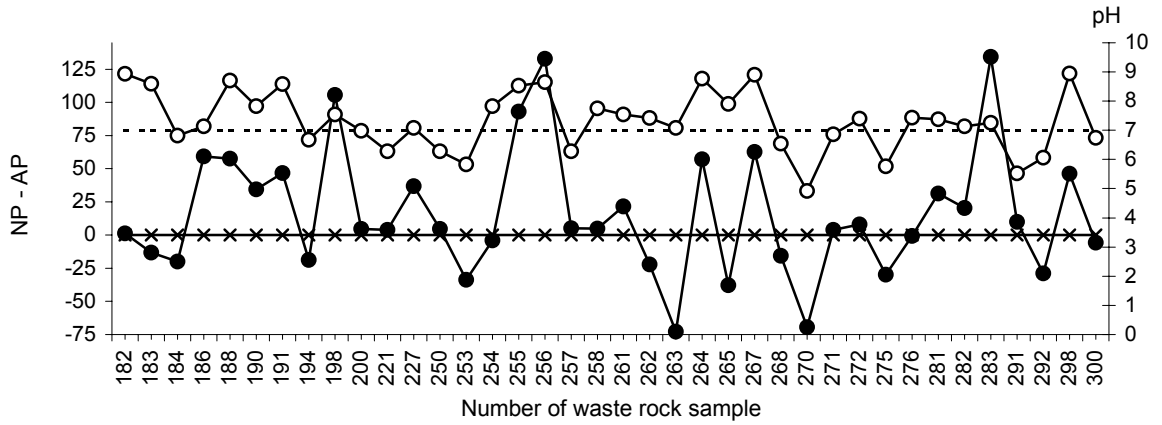


Fig.3. Values of the resulting potential of waste-rock samples equal to difference NP - AP (solid circles, a scale at the left) and pH of water extracts (open circles, a scale on the right). A line with crosses - equal values of ΣNP and AP, a dashed line - neutral values of pH under normal conditions.

Really, a good agreement of negative values of the resulting potential of waste rock samples (NP - AP) with low pH (<7) of the prepared water extracts is observed. Samples 253, 270, 275, 292 confirm to this concept, whereas, pH of water extract in the sample 263 with one of the lowest (ΣNP – AP) is 7.1. In addition, the cut of Fig. 3 shows the dependence of all (ΣNP - AP) versus solutions pH. The above-mentioned 4 waste rock samples with high acid potential were exposed to laboratory leaching tests by water within 20 weeks in flow-through reactors (Bortnikova et al., present bulletin). In this paper we will not go into the problems of behaviour of heavy metals and anions, we'll only specify, that the pH has gone down significantly with time: 253 (5.83 / 3.70), 270 (4.92 / 3.48), 275 (5.76 / 4.12), 292 (6.06 / 4.24) where numerator indicateds pH of water extracts, and denominator - pH of leachates.

In general, the developed set of experimental definitions allow us to recommend the elaborated techniques to be used in the research of other similar objects, and the methodological approach - as a basis of grading of sulfide-containing wall-rocks, waste rocks and mill tailings of different geochemical types.

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