

Hello,

Our apologies for the delay.

Let's get started-

In the first case (Pecos)-- we observed a method where the waste and tailings are blocked by iron or cement walls (can be cracked), covered with a layer of soil and plants. The streams of water are directed along the lined passages (with a specific liner), which prevents water from getting into waste settlements

In the second case (Questa Mine) – there is pumping of water from adit and treatment of water in a specially constructed water treatment plant. There is an isolation and cover of wasted material by soil and plants.

In the third case (Spanish Mine) cleanup of seeping water from the adit (free flowing) by construction of raised settling pond (the smallest system of water cleanup that we saw).

In the fourth case (Empire Mine) pumping of water from the audit and cleanup of water in a series of three settling ponds.

I am not going to assess the effectiveness and cost of each of these systems; I believe, that there are specialists who do just that.

Here is my opinion on the possibility of adopting these systems for conditions in Zakamensk.

1. Factors, which complicate the implementation of methods to liquidate (reduce) the impact of waste conditions, which need to be considered.
  - Permafrost
  - High number of sources of contaminated water (5 adits); they are spread out
  - Large amount of settled material under technogenic (Barun-Narin); this is relevant when we discuss the method of building isolation blocks.
2. Suggestions for technical implementation.

#### 2.1. Contaminated water.

There are two sources of contaminated water – this is adit water (4 sources) that come to the surface) and drainage water, which comes from technogenic deposit Barun-Narin.

a) Water, which goes into the stream Modonkul - to be directed into one contained stream and cleaned by putting it through a series of settling ponds, which are filled with limestone (Victoria's research); to consider sequential treatment ponds, as at Empire Mine.

Contaminated underground water from Barun-Narin—it is necessary to bore holes to reach water and treat water afterwards; direct water to the settling ponds for treatment. This territory already has several hydrolic holes (Plusnin's research); the analysis of composition of underground water; it is necessary to create a map of underground water and determine its place and volume that needs to be pumped.

b) Water, that goes into the stream Mirgensheno (stream Evanovka and stream Gudzhirka); also direct it along the lined stream into one settling pond filled with limestone.

c) As an alternative plan, to build separate settling ponds next to each source of contaminated water.

## 2.2 On isolation of technogenic sand at Barun-Narin

- a) To cover with soil and plant vegetation in order to prevent sand spreading by wind. In my opinion, it is necessary to cover tailing piles with (geo)material to protect it from atmospheric precipitation and then cover it with soil. It will be necessary to flatten the surface; as of right now there is a mountain of tailings after their transportation. If this project is carried out in conjunction with the next suggestion (2.2 b), it is possible to prevent contamination of ground water from Barun-Narin waste pile (new tailings) and pumping of water through holes (2.1) will not be necessary.
- b) Isolation of water streams by building additional diverting streams, which will prevent mountain water and water from Barun-Narin flow through the sand. Building of dams will practically be unrealistic because of the large amount of settling material under Barun-Narin (up to 100 meters).

During winter streams freeze and water will flow on top of treatment facilities. We will have to accept it or reject this idea altogether (it's not realistic to heat several kilometers of stream). Then, as an option we can consider constructing a treatment plant and collection (by pumping) of contaminated water from various sources into one (we'll have to heat the pipes.)

Naturally, we'll have to further study and calculate various options.

Sincerely, Andrei Rogalev

Additional suggestions (comments) of Olga Smirnova – in continuation of the necessary scientific research in support of technical solutions of liquidation of negative impact of waste material of mining on the environment in Zakamensk.

A) Matt's research (University of New Mexico) – impact of inhaled fractions of dust from the territory of Zakamensk and waste tailings on live organisms (mice) has shown toxicity of dust. He offered to continue this line of research (to conduct various types of analysis that he is able to do). I believe, that we need to support this line of research because the data will be required to prove the necessity of projects of isolation of the dust surface of the tailings. It is necessary to publish the results in the unrestricted publication (so the data can be cited).

B) To continue research in order to find technical solutions for safe storage of tailings from the enrichment plant by selecting effective geochemical barriers (Plusnin, Smirnova, Dabaeva).

C) To continue research of forms of migration of potentially toxic chemical elements in geotechnogenic landscapes (Smirnova) in order to determine factors and conditions of prevention of the possible formation of their migrating forms.

D) To continue the search of ways of secondary use of waste of mining industry (study ways of how to use tailing as possible fertilizers) – laboratory hydro-geology and geology of Geological Institute (Doroshkevich Svetlana)

Taking into consideration Mehdi's proposal for collaboration in the analysis of elements, his interest in our research and in Matt's research, I suggest that it is necessary to finish formatting of our Agreement of Scientific Collaboration of our organizations (SRIC, UNM, GIN SB RAS).

I am absolutely against the idea of transporting tailing of sulfate ore to the basin of Dzhida. I also do not favor the idea of closing Western adit, since such attempts have been made already with failed results (but I can be wrong, because I do not fully understand this method of solving the problem).