Impact of Uranium Mining and Processing on the Environment of Mountainous areas of Kyrgyzstan

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Abstract. In this report the results of analysis of modern geo-ecological situation in areas of uranium mining and milling in the territory of Kyrgyzstan are presented. Major threats for the mountain environment and citizens which are connected to mining and processing of the uranium are due to the contamination of the hydrosphere by radio nuclides, and due to the stimulation of dangerous natural and technological processes (landslides, mudflows, destruction of the tailings and dumps) with unfavorable ecological consequences.

Introduction

During the last 100 years the territory of Kyrgyzstan served for the Czar Russia at the beginning and later the USSR as one of the major mineral and raw materials base (radium, uranium and rear earth elements). First findings of radioactive uranium–radium minerals in the mountains (Ferghan valley) occurred at the same time as in Kuri couple at the end of XIX century (Aleshin and others, 2000). Similar minerals were found in Teo – Moyunsky mine which is located 30 km on the South – West from Osh city (Fig.1)

From 1907 to 1913 820 000 kg of ores was mined from this uranium–radium deposit, 655 000 kg was brought to St. Petersberg. The Teo–Moyunsky mine was an underground mine, at the time of it's closing the depth was more than 220 m.

In the 40th of the 20 century with the practical implementation of atomic energy techniques mostly for military purposes a booming development of uranium industry happened. At that time 10 uranium deposits in Shekaftar, Kyzyl–Jar, Mayly Suu, Rishtan and other place (Fig.1) were started out in Kyrgyzstan in the Northern bench of Ferghana valley. Industrial exploitation of the large uranium deposit Mayly Suu started in 1945. The Lenynabad (Ferghansky) chemical plant was build in 1947 in a very short period of time; Mayly Suu and TeoMounsky mines were part of this complex, being the first soviet uranium production for military purposes. Enterprises at this site including the hydro steel plant in Mayly Suu were processing ores from Eastern Germany (Erzgebirge), Chekhoslovakia (Yakhimov), Bulgaria (Bukhovo) and Tadjikistan (Taboshar, Adrasman) utill the middle of 1950. About 75% of the uranium was brought from the former German Democratic Republic ("Wismut").

At the beginning of 1950 uranium mining started in Myn Kush and Kadjy-Say. In 1951 the Karabaltynsky rock plant in the north of Kyrgyzstan was the biggest plant of the USSR. In our days, uranium which is mined by in situ leaching in Kazakhstan is processed in the plant. Starting in the middle of 1950, Kyrgyzstan became one of the major uranium producers in the former USSR. It should be mentioned that in Kyrgyzstan uranium was mined by all known technologies including recovery from the lake Issyk–Kul.

As result of this activities there are 30 tailings with a total area of 6 500 000 m^2 and 50 000 000 m^3 of tailings in different areas of Kyrgzstan (Fig.1). As a result of mining 25 dumps with a total area of 230 000 m^2 and 4 000 000 $м^3$ of rocks and raw uranium were created. Analysis of modern geo-ecological situation in the uranium mining and processing areas in Kyrgyzstan show that negative impact of mines and wastes on the environment has 2 major forms:

- Stimulation of dangerous natural and geotechnical processes (landslides, mudflows, accidents on the waste storage) with unfavorable ecological consequences with regional and global character
- Contamination of the environment and especially hydrosphere by radionuclides and toxic components.

Dangerous geo-ecological processes in the area of storage of mine waste

The number of uranium mines, total amount of uranium waste and sizes of the tailings are relatively small in comparison to USA, Canada, and East Germany. But due to natural phenomena of mountainous landscape, character and scale of the impact of uranium industry products on the environment is much higher in Kyrgyzstan.

Among unfavorable factors connected to the mining specifics are the following: complex mountainous landscape (3-dimensional); high seismic and tectonic activity; instability of slopes; variety and intensity of destructive natural processes in the mountains (erosion, denudation, landslides, mudflows, extreme sediments and change of the climate); high destruction of mountainous regions by geotechnical factors, especially during mining activities (Torgoev & Aleshyn 2001).

Long time history of mining, milling and processing in Kyrgyzstan including uranium shows that combination of above mentioned factors and processes was often the reason of the accidents in regional and global scale. The high probability of such cascade catastrophes is connected to the fact that the majority of mines were built on unstable mountain slopes. And radioactive dumps were located adjacent to riverbeds due to lack of suitable places.

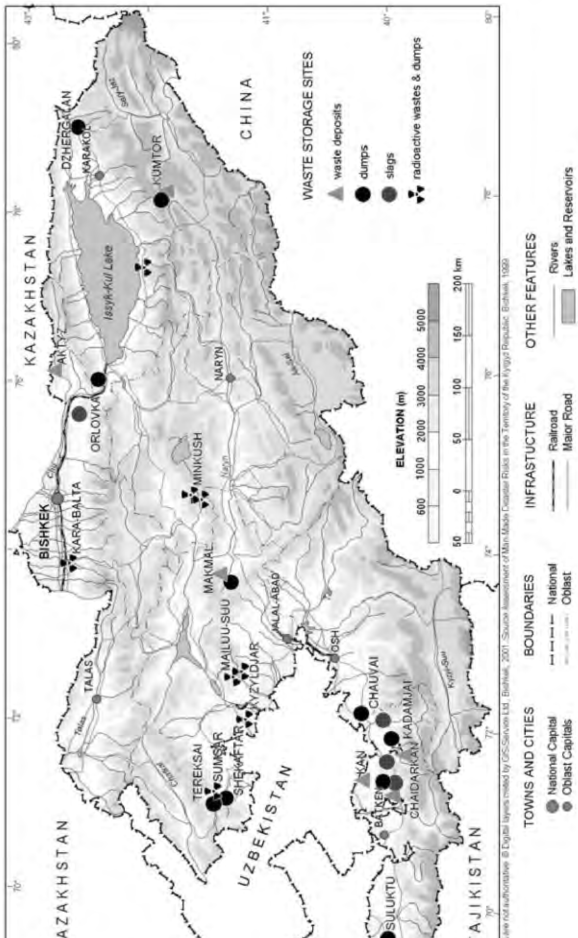

Fig. 1. Waste Storage Sites in Kyrgyzstan

In April, 1958 after an earthquake and heavy rains the weak dam of the tailing #7 in Mayly Suu was destroyed, being constructed only 30 m away from the river Mayly Suu(Fig.2). 600 000 m^3 of the tailings (about 50 % of the total volume) were spilled into the river. The radioactive mudflow destroyed a lot of houses in the town, people were killed and the tailings were spread over 40 km down by the river, contaminating flood plains. Cleaning up agricultural fields was going on for many years. Such accidents also took place on other tailings in Kyrgyzstan (Torgoev, Aleshyn 2001).

Impact on groundwater from radionuclide emission

Evaluation of geo-ecological and radiological risk in the areas of mining and ore processing of radioactive minerals is showing the high risk of destruction of radioactive waste storages during earthquakes, mudflows and abnormal precipitation in Myn Kush, Kadjy Say, Ak Tuz and especially when landslides in Mayly Suu (Fig.1) happened.

Landslide processes in Mayly Suu region started to develop in 1953 to 54, when underground works, building of mining constructions and infrastructure measures were intensified. Around mines most of the landslides were caused by underground voids with depth up to 30 - 40 m, and by dumps constructed on unstable mountain surfaces. More than 50 different active landslide events within the town's area. were reported (Torgoev, 2001).

In Mayly Suu landslides developed in loess-like soils of the red color sandstone clay deposits of the Massagetsky stage (oligocenic-miocen). The largest landslides with a volume of more than 1 million m^3 (Tectonic, Koy-Tash and others) happened on slopes that are related to sandstone-clay deposits of the Cretaceous-Paleogenic with anticlinale folds in the upper slopes and sinclinale in the lower part. Due to high level of ground waters (1.5 - 5.0m), the activation of landslide processes is happening every year in relation to heavy rainfall events.

The situation in Mayly Suu is even worse due to the fact that some large landslides are dangerous not only for living areas but also to tailings. Destruction of the tailings (3,5,7,8,9) with spills of radioactive waste to the river can cause ecological catastrophes in the far field with possible radioactive contamination of heavy populated territories in Kyrgyzstan and Uzbekistan.

Calculations show that destruction of tailings might deposit 1,2 million m^3 in to the river with total amount of radio nuclides 15 000 Ku. The overall contaminated area will be 300 km^2. In order to prevent such catastrophic scenarios a project for re-burial of waste was started in 1996. At the same time an automatic monitoring of the landslide processes started and is going on. It includes a sub-system of emergency alarm for landslides (Torgoev et. al. 20001).

Contamination of the hydrosphere

Besides the narrow location of the radioactive waste sites to lakes and rivers there is also the poor geotechnical constructions of the tailings, absence of hydro-isolation and degradation of protective constructions to mention. Especially old tailings from the time after the II World War tailings which were build at the early stages of uranium mining form 1946 to 55 are of special concern. This period of time is characterized by serious under estimation of ecological danger caused by uranium mining and processing. Today it is clear that serious mistakes were made (Torgoev and Aleshyn 2001).

The beginning stage of uranium producing in Mayly Suu can be considered as an example. In the valley of Maylyu Suu river, about 30 km from the border to Uzbekistan radioactive waste was stored in 23 tailings and 13 dumps (Fig.2). The total volume of radioactive waste is 2 million m^3 and the total activity is 50 000

Ku. Investigations show that some tailings (3,5,7,8,9,10,18) and dumps in the riverbed of Myly Suu are the reason of systematic radioactive contamination of the river due to poor dam construction, high water content of the tailings and not reliable hydro-isolation.

Uranium concentrations in the water shown higher value than background with $4,4*10^{-6}$ g/l above the tailing#3 and $1,7 *10^{-2}$ g/l below tailing#3, that means several thousands times above background concentration. 30 km from the tailing in the village of Madanyat, the uranium concentration in the river water is still 10 - 15 times higher than the background with $1,8*10^{-5}$ g/l (Aleshyn and others 2000). In many cases seepage water from the tailings infiltrates into the ground water.

This can be shown on the example of uranium tailing in Kara Balta. (Torgoev and Aleshyn 2001). In spite of a mighty aeration zone (up to 85 m) the ground water is contaminated with high level of sulfates, nitrates and heavy metals. Within contaminated areas the sulfate and nitrate concentrations are 5-8 fold the natural ones. An intensive contamination zone is spread on 15 km from the tailing and being 100 - 120 m in depth. A change of the intensive contamination zone was determined in 1999 based on samples from ground waters.

In the drill holes upstream the tailings the concentration of uranium in the ground waters was found to be 0.008 mg/l, in the drills downstream the town uranium concentrations reach up to 0.30 mg/l (Torgoev, Aleshyn 2001).

There are some major reasons of radioactive and toxic contamination of the soil and underground water in the area of Kara Balty tailing. One of them is a loss of the quality of the tailing's hydro-isolation. Leaching rates from the tailing were calculated by balance method for 1996 to 1998 to be 70 to 100 m^3 /year.

In the area around Kadjy Say in the period of 1948 to 1966 uranium bearing coal was mined for leaching of uranium oxide ($U_3 O_8$). During operation of the plant and after it's liquidation 400 000 m^3 of waste were buried in the tailing and an ash dump. The tailing is located 1.5 km far from the coast of the mountainous lake Issyk Kul. area. This is the Djety Oguz radon spa and beach by the village Jenish with radioactive monazite sand. Gamma radiation from cosmic rays is 0.466 mSv/a on the lake altitude (1608 m). Thus, in Issyk Kul province average amount of radiation from the natural sources is 1.726 mSv/a, which is much smaller than the background value 5 mSv/a (Mylius 1997).

Migration of seepage water from the tailing towards the lake is likely to occur. However, no monitoring wells are available. It should be mentioned that the natural elevated uranium concentration in the lake's water are affected by radioactivity and hydro chemical characteristics of the surface drainage water and subsurface radon springs. On average, Issyk Kul's lake water contains $3.0*10^{6}$ % of uranium which is one order of magnitude higher than Ocean water (10^{-7} %).

In 1997 specialists from the German Federal Institute for Geosciences from Hannover (BGR) jointly conducted measurements of radiation level in 680 places around lake Issyk Kul with specialists from Kyrgyzstan.

This measurements show that average earth gamma radiation is about 1.26 mSv/a, 66% of measured data is lower than that, 28% of measurements is 1.26 - 1.77 mSv/a. High numbers (6%) were measured in the Kadjy Say uranium mining district.

Impact on groundwater from radionuclide emission

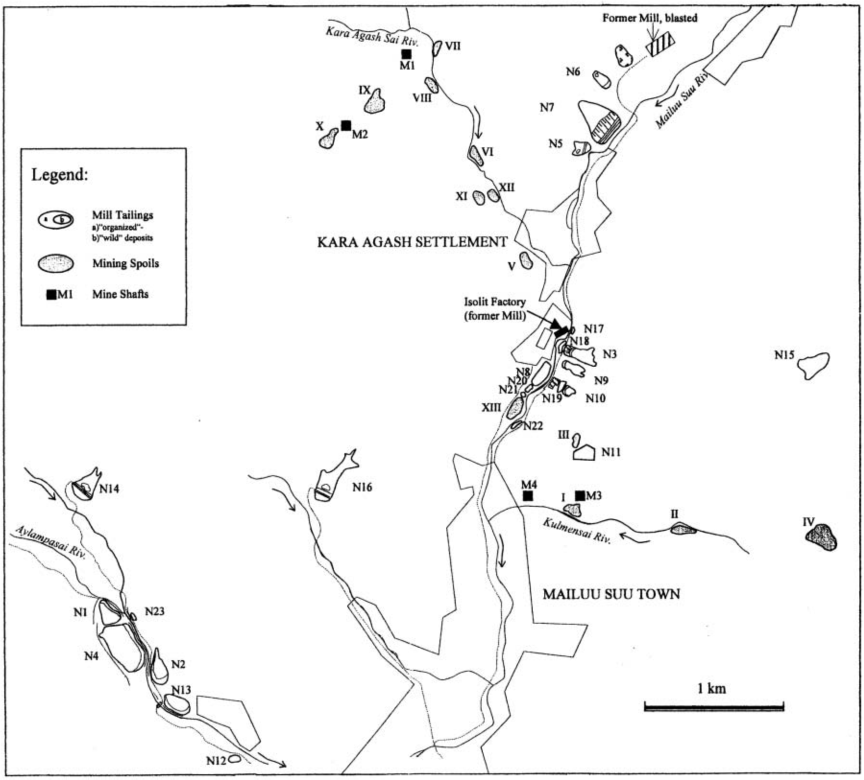

Fig. 2. Location of Mill Tailings and Waste Rock Dumps in the Mailuu Suu Area

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