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“Uranium Mine Aftermath and Yangiabad Expedition in Uzbekistan ”

Tsukatani, T., Toderich, K. and Goldstein, R.I.

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Uranium Mine Aftermath and Yangiabad Expedition in Uzbekistan

Tsukatani¹, T., Toderich², K. and Goldstein³, R.I.

Abstract

This article describes the first half of a history of uranium mines in the Fergana Valley of Central Asia, introduces the existing environment of the old mines, and analyzes a part of heavy metals of water resource in the surrounding. Fergana Valley itself has a long history of civilization, to which Chinese called Dayuan, going back to the conquest of Alexander the Great in 329 BCE or the description of a Chinese explorer Zhang Qian in 130 BCE. After the Second World War, however, Soviet Union polluted the area with heavy metal and radioactivity where a dense monoculture of cotton was developed. A great number of uranium works are located in the landslide zone and are currently exposed to destruction, thus causing radioactive pollution of the surface and underground water. The rehabilitation will cost a huge amount of cost and time.

Uzbek and Japanese team dispatched a joint expedition in October 1998 to Yangiabad, one of the former uranium mines, and sampled surface water and particles in the sediments. Japanese side has studied 58 points and Uzbek side has studied 13 random points located in the Yangiabad sites. ICP-MS analysis showed that the uranium concentration of the river water around Yangiabad was unbelievably high (10 to 1,000 ppb-U²³⁸).

Outline

For more than 40 years, Uzbekistan was one of the main uranium raw material bases for the former Soviet Union. It was resulted in a large number of uranium stockpiles and hydrometallurgical wastes accumulated on the territory. Some of the biggest uranium deposits (Maili-say, Shekaftar, and Kyzyl dzhar) are located in Kyrgyzstan. Water erosion of radioactive wastes of these deposits causes transborder contamination of the surface and soil water and soil structure of the Northern Namangan region since all water arteries, which are active bearers of radioactive materials, have their detrital cones on the territory of Uzbekistan. This is the place

¹ Professor Emeritus, Kyoto University : tsuka@kinet-tv.ne.jp (His position is from April 2008)

² Consultant, ICBA-Central Asia, Tashkent: ktoderich@cgiar.org. (She was in Uzbek Acad. Sciences)

³ Head, Complex Geocological Expedition Kyzyltepageologia at State Committee of Uzbekistan for Geology and Mineral Resources (He has left for Israel.)

where radioactive sedimentation occurs. Soil water uranium is concentrated in stagnant, swamped area of the central part of the valley forming, together with the associated strontium, selenium, vanadium, lead, zinc, molybdenum, and other elements.

This article describes the first half of the history of uranium development in Uzbekistan, introduces the current state of an old uranium mine from the aspect of environmental problems, and analyzes a part of the distribution of heavy metals of water resource in the surrounding. Central Asia was one of the large supply bases of uranium that was the nuclear weapon raw material in the Former Soviet Union in the cold war era, and large-scale mining was conducted in the Fergana Valley and Kyzylkum Desert. It reflected the abundant deposit of natural resources on this ground. Uzbekistan is a standing uranium exporting. However, the situation of disintegration of Soviet Union has left a big, negative inheritance on the uranium mine sites of Uzbekistan. In the Fergana Valley of an overpopulated zone where irrigation agriculture was especially developed, and where that has valuable historic culture and ruins of the human race, a lot of uranium sillage was left and remained in the foot of mountains. It exposes the increasing tendency in recent years to danger of flowing out of ore sillage by a certain flood and landslide into the irrigated areas. This is not only a problem of one Uzbekistan country but also is equal to the present world that obtained energy of nuclear power with the problem that should be thought. This article provides the basic intelligence.

Introduction

There is a history of in the uranium extraction of in Central Asia for 100 years⁴. The mining of the radioactive substance started at the end of the 19th century in the Fergana Valley⁵. At first, the ore was mined from uranium-radium deposit in 1899 at Tuyamuyun (40° 21' N, 72° 36' E) near the old town Osh in the southeast basin. Tuyamuyun sent off a large amount of ore containing uranium to Germany via St. Petersburg in the 1910's. Moreover, it is ascertained that Taboshar and Kyzyl dzhar, etc. at the west edge of the Fergana Valley produced the uranium ore before the Second World War.

After and in the war, the Soviet Union went forward on the nuclear weapons drive. The Fergana Valley became the main supply base of the uranium of secret backs in the 1950's and 1940's, and many deposits were developed. The main deposits were Taboshar (40° 35' N, 69° 38' E), Yangiabad (41° 08' N, 70° 06' E), Charkesar (41° 02' N, 70° 52' E), Uygursay (41° 02' N,

⁴ D. B. Shimkin: Uranium Deposits in the USSR, Science 21 January 1949, 109: 58-60.

⁵ Russia at that time did not know the radium extraction method, and however, it was extracted to the first radium from Russia in December 1921.

3

71° 12' E), Shekaftar (41° 18' N, 71° 19' E), Kyzyl dzhar (41° 26' 0N, 72° 01' 0E), and Maili-say (41° 18' N, 72° 27' E). Uranium processing up to yellow cake started at Chkalovsk near Leninabad (Khujand) in the late 1940s. Taboshar was the first mines to transfer the uranium to Chkalovsk.

In the late 1950s, uranium extraction shifted to underground leaching in Kyzylkum desert. Uranium production in Uzbekistan is limited to three in-situ leaching (ISL) sites: Uchkuduk, Zafarabad, and Nurabad. With underground leaching, no large infrastructure, transport facilities, and others are required; conditions for highly efficient development of poor but large deposits are thus provided, reducing investment 2-3 times and tripling the labor productivity as assessed in terms of the end-product. Basic sources of environment pollution on the uranium-ore of Kyzylkum are: the dumps of ores below industrial grade that were formed during the process of deposit development by open and underground ways; underground leaching mines; and tailing of the hydrometallurgical plant in Navoi that processes uranium ores and solutions of hydrochloric acid. Uranium ore's extraction on Kyzylkum territory has been conducted in restricted volumes. Basic volume was fulfilled on Uchkuduk. As a result of 30 years' deposit operation it was piled up 23 dumps of ores below industrial grade. Total surface of dumps is about 700 th. sq. meters; mountain mass volume in it exceeds 3 mln. tons. Since 1992, all uranium production is exported mainly to the United States.

The uranium ore site left in Fergana Valley was transfigured to the world's largest polluted area by the radioactive substance without informing the resident in the surrounding on its pollution. If a radioactive sullage of Charkesar, Uygursay, Shekaftar, Kyzyl dzhar and Maili-say, all of them are located in the northern part of mountainous region of Fergana Valley, does the collapse and outflow according to the global warming in recent years and other factors, the affected area would be 1,300 km² in Fergana only and the population is 1.1 million.

The uranium will elute from the Fergana Valley to the stream water in the situation to date and the future. If the amount of fissionable uranium 235 is calculated from the density of the eluted uranium and the river flow rate, it becomes 75 kg a year only in the Yangiabad deposit. The amount of the fissionable uranium from Yangiabad corresponds to seven Hiroshima atomic bombs a year if the uranium 235 of 10 kg was used for a Hiroshima type atomic bomb. It is possible to look for the importance of the uranium waste problem of Fergana from this figure.

Uzbekistan was one of the main uranium supply regions of the former Soviet Union for 40 years or more. Soviet Union left many uranium ore dregs and other heavy metal wastes in this country as a result. The uranium ore deposit is located in the landslide zone in the Fergana

Valley, and therefore, underground and surface water produces radioactive pollution of drinking water and irrigation water by underground water and surface water. Some deposits (Shekaftar, Kyzylzhar, and Maili-say) are in the Kyrgyzstan Republic, and the transfrontier pollution exists in the Uzbekistan Namangan area in the result that the sullage enters into the downstream. The sullage contains metals. Besides uranium, such metals as strontium, selenium, vanadium, lead, zinc, and molybdenum are contained in the sullage, thereby arises a metallic pollution in the hydrosphere and the soil.

In general, it is difficult to imagine the situation of the uranium's flowing out to the Fergana Valley of Uzbekistan, gathering in the Kairakkum Reservoir of Tadzhikistan through the irrigation canal like net meshes, entering Syrdarya main stream via the Khujand gate, and flowing into Aral Sea from the Chardara Reservoir through Kazakhstan. However, the water is given in the this process between the Fergana uranium ore deposit and Aral Sea, to the livestock drinking, to the rice and fruits though the soil, and to the living thing of the fishery. It is in such an environment and the size and the seriousness of the scale have the possibility of becoming the difficulty of measures. It may exceed our assumption far together when being thinking the generation's influence in the future.

Uranium ore deposit in the Fergana Valley

The outline of old uranium ore deposits that remain in the Fergana Valley is as follows. The position of the Fergana Valley is shown in Fig. 1. Figs. 2 and 3 show the location of deposits on the foot of a mountain. Each deposit surrounds the Fergana Valley, where peculiar distribution of the uranium mines is shown, and the danger of the sullage collapse by the flood and the landslide is shown.



Fig. 1 Topography and Hydrography of the Fergana Valley
 Novikov, V. and Rekacewicz, P: UNEP/GRID-ARENDAL, April 2005⁶.

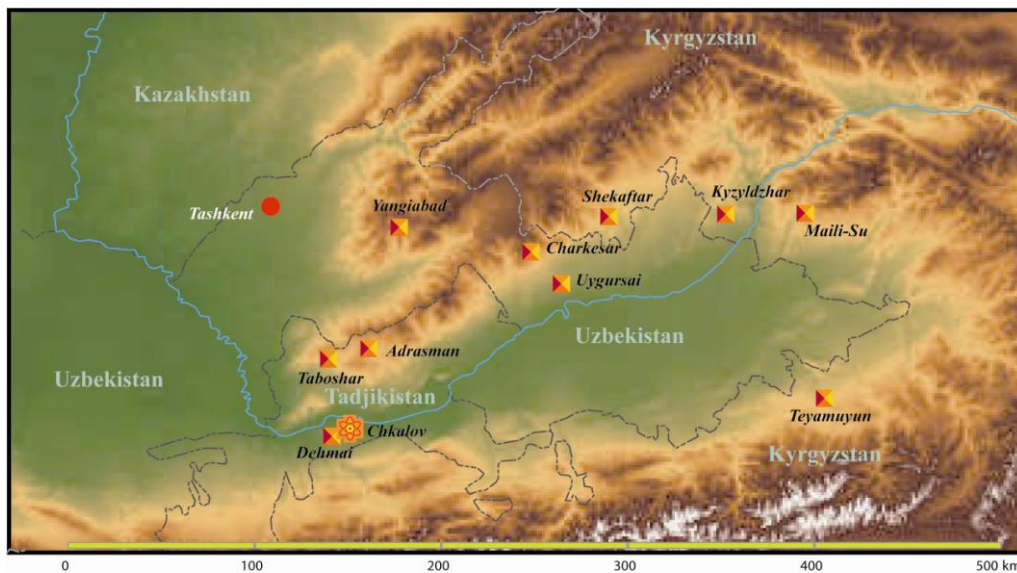


Fig. 2 Uranium Mines around Fergana Valley and Chkalovsk

⁶ http://maps.grida.no/go/graphic/topography_and_hydrography_of_the_fergana_valley

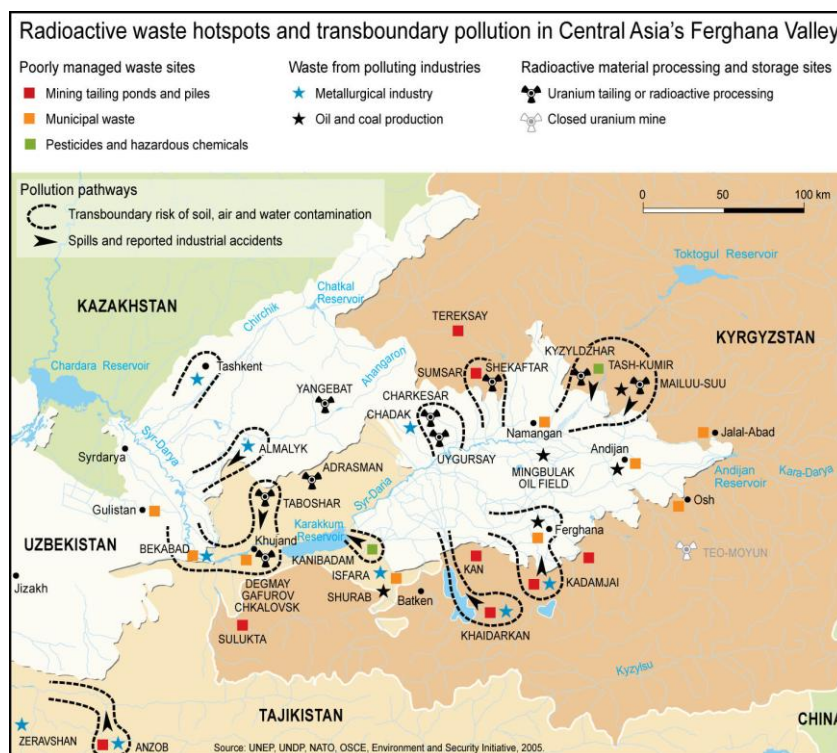


Fig. 3 Radioactive Waste Hotspots around Fergana Valley
Emmanuelle Bournay: UNEP/GRID-Arendal, 2006⁷.

1 *Taboshar*

Located on the southern slopes of the Kuramin Mountains, the Taboshar uranium mine is in Tajikistan, in 60 km of Uzbekistan. It is a roofless mine which, in the fifties, stretched over 400 hectares and used more than 10,000 miners. It had an extraction complex (former mine, processing plant and tailings) that was a huge assembly of facilities spread on over 400 hectares. It operated between 1949 and 1965. The site consists of open-pit, few underground mines, dismantled facilities, and a series of seven tailing sites covering 150 hectares. Since its closing in 1973, the mine is in the state of abandonment. There is a vast hole with a lake. Three huge radioactive tailing piles heap up 20 million tons of process residue tailings lies unprotected, vulnerable to the erosion by the wind and the rain. The site requires urgent rehabilitation as it poses.

⁷ http://maps.grida.no/go/graphic/radioactive_waste_hotspots_and_transboundary_pollution_in_central_asia_s_fergana_valley



Fig. 4 Uranium Mine Tailings at Taboshar,
Photo: P. Rickwood/IAEA

2 Charkesar deposit

The Charkesar deposit is adjacent to the district of the same name in Uzbekistan Namangan region Pap district⁸. In this Pap district there are radioactive wastes, remained after exhaustion of uranium deposits at Charkesar⁹. Radioactive materials are stored in dumps, covered with neutral ground. In some places the cover is destroyed by the precipitation. Gamma-ray intensity on the surface of the dumps is 300~450 $\mu\text{R}/\text{hour}$. Water flows from abandoned wells, and in regards to the microelement of water is close to the composition of underground leaching solution, containing a range of highly toxic elements (beryllium, manganese, iron, and aluminum). The same range of toxic substances has been found in bottom sediments of the brooklet, total alpha-activity of precipitation reaches 3.5~8.1 thousand Bq/kg.

Deposit was mined by underground mining and underground leaching that was 260 m mutually adjacent. The depth of the deposits was 140~280 m. The second mine lot had a depth of 150 m, and the mining site is connected with the fourth mine lot. The underground mine with 1 km expanded to the northwestward is the entire system.

⁸ It is a pity that the downstream town Pap is located. It is famous that Akhmadzhan Adylov, former general director of the Pap Agroindustrial Production Association in Namangan Province, is one of the central figures in the corruption case known as the Uzbekistan Cotton Mafia case in the era of Sharaf Rashidov (he was First Secretary of the Uzbek Communist Party from 1959 to 1983).

⁹ Sanitation2004-Uzbekistan, Division for Sustainable Development, UN Department of Economic and Social Affairs, 2004.

The entire tunnel is filled with the water current at a height of 1,293 m above sea level, and this water is supplied to the field irrigation and domestic drinking. In a preliminary survey, underwater trace element was close to the underground leaching solution in the tunnel. It contained sulfate, showed high mineralization (2.75 g/l), and showed pH 6.4. Metal concentration was beryllium 42 ppm, manganese 17 ppm, iron 38 ppm and aluminum 7 ppm. The uranium concentration was 4,000~6,100 ppm. There was such high density in the bottom sediment as uranium 18~1,750 g/l, arsenic 15~25 g/l, copper 150 g/l, zinc 400 g/l and beryllium 14 g/l. Gamma ray intensity of the rock left in brooklet is 150~200 $\mu\text{R}/\text{hour}$. The alpha ray of the sediment was 35,000-81,000 Bq/kg.

The building built in the Charkesar village uses the material moved from nearby sullage and Uygursay deposit. In preparatory investigations to the Charkesar resident (8,900 people), there was a radioactive gamma ray of 60~150 $\mu\text{R}/\text{hour}$ in 50 % of 250 household buildings, and the radon was 200~3,000 Bq/m³ that exceeded the permissible level. People contracted cancer, especially lung cancer, circulatory disease, respiratory disease, and urogenital disease.

3 Uygursay deposit

The Uygursay deposit operated from 1947 to 1954. Three mines were worked out and 300 km of boreholes were drilled. The processing plant was in the mine deposit area, and the radioactive material was disposed to the neighborhood of the mine. The depository site recently became clear that it is insufficient. A detailed environmental surveillance and conservation measures are necessary because it is karstic and is adjacent to Syrdarya up to 10km.

4 Sumsar-Shekaftar deposit

Sumsar has several prospects, including Shekaftar, which features carnotite (Potassium uranium vanadate) mineralization in widths of up to 2.5 meters with assays up to 0.1% across a

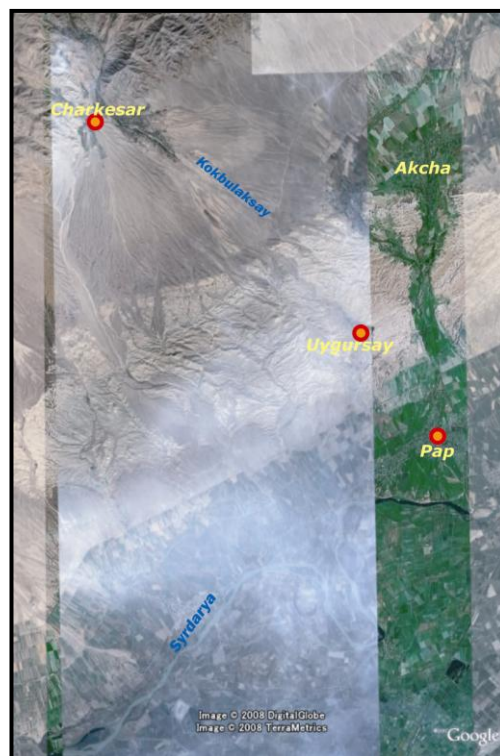


Fig. 5 Charkesar and Uygursay Deposits near Pap close to Syrdarya

Width is around 21 km. Google Earth, 2008.

series of lenses. Chonkal, which features hydrothermally altered porphyries up to 10 meters in width, with assays up to 0.09% U_3O_8 ; Tengi, which has mineralization associated with intrusive; and Yangak-Sa, where the mineralization is associated with granites¹⁰.

The Shekaftar deposit is in the Kyrgyzstan territory between Kasansai, Ala-Buka, Tengi, and Varzik villages in north Fergana. The Shekaftar deposit is limited to Paleocene carbonate. The ore containing uranium was developed from beginning of 1945 to 1958. 1,000 or more than 1,000 boreholes (141.3 m), 7.6 km underground site was developed and about 1/3 ore resources were mined at this time. The processing plant is located in the deposit district. There is a piling up sullage of the size of 100 m × 100 m × 10 m in the neighborhood. The gamma rays for the environmental radioactivity of 50~150 μR /hour was detected in a preparatory investigation. The uranium concentration showed 46~70 g/t and the selenium concentration showed 1.16 g/t. The deposit is supplied as materials for building construction without permission. The tunnel head has a heap of waste dump of 250 m × 150 m × 20 m piles in size, and the radioactivity is 80~250 μR /hour .



Fig. 6 Great Wall of Shekaftar

Николай Петров, 2007: <http://nikolay-petrov.mylivepage.ru/image/>

The mining tailings are concentrated in village Sumsar, Shekaftar and Terek-Sai of Chatkal rayon¹¹. In the 1960s, uranium mining went on in Maili-say. Around the Sumsar

¹⁰ Uraniumletter International, December 2006. www.monaromining.com.au.

settlement, there are two mine tailings (used for exploration of lead, copper, zinc, silver and cadmium heavy metal ores), which previously belonged to the Sumsar ore department until 1978. Three tailings ponds near the Sumsar River containing 4.5 million tons of radioactive uranium rock, lead and toxic heavy metal salts have been partially eroded allowing a constant inflow of heavy metal pollutants. In the territory of the Shekaftar settlement, eight dumps are located containing 700,000 m³ of substandard uranium ores; they have not been rehabilitated, and the radiation level is up to 90 µR/hour .

The waste dumps were located close to residential areas; one is located in a mountainous area. Currently, the sites have no owners; the tailings are not monitored and are washed away into the drinking water. The owner of the abandoned mining tailings has changed several times. The tailings are located on the banks of the Sumsar River.

During the rain seasons, the tailing dams erode and are washed away, the tailing slopes erode and deepen, and no rehabilitation and conservation works have been made over a long period of time. The Shekaftar settlement drinks water from the Sumsar River and is located down the stream from the mine tailings. Similar is the situation around Terek-Say mine complex.

5 *Kyzylzhar deposit*

The Kyzylzhar deposit in the Kyrgyzstan territory is 20 km north of Uchkurgan It belongs to the Paleogene carbonate rock. Underground mining was done in 1957~1960. Only the northwest part in the deposit was developed due to a difficulty and technical incompleteness of mining. The ore waste made when developing is not reproduced, a high density radioelement flows into the intermittent Aksai river through a temporary riverbed, and it pours into the Narin river at an international border with Uzbekistan.

6 *Maili-say deposit*

The Maili-say deposit in the Kyrgyzstan territory is located, along the same name river 30 km from Uzbekistan on the northeastern border of the Fergana Valley. The uranium ore is a carbonate rock layer of the Paleogene Alai and Turkestan range. The first discovery of the uranium ore in this region was in 1933. The mining started in 1946 and continued for 23 years until 1968. As for the uranium, whole quantity of uranium was mined by the underground mining method. The depth of the mining tunnel was more than 220 m at the time of its closing.

¹¹ Olga Pavlova: Presentations by Oblast Committee Representatives, Fourth Regional Meeting of Local Environmental Authorities from Kyrgyzstan, Tajikistan and Uzbekistan, Dushanbe, Tajikistan, 11-12 July 2006.

The fineness of ore is low-grade ore (0.03-0.1 %), and is fineness ordinary ore (0.1-0.2 %), quality item title ore (0.2-0.5 %), and a usual high-grade ore (0.5% or more). The main portion of ore was processed at a local hydrometallurgical plant of the Maili-say facilities to provide raw material of the Soviet nuclear weapon arsenal. These facilities also processed uranium ores, delivered from Tajikistan (Taboshar), East Germany and Czechoslovakia¹². Approximately 2.5 million cubic meters of radioactive waste remain in 23 tailings and 13 stockpiles of run-of-mine (ROM) ores down the valley of the river and its tributaries. The total volume is 2.7 million m³ and the total radioactivity is 1.1x10¹⁵ Bq. Tailings 3, 5 and 7 are considered potential hot spots due to the danger of landslides, and could easily release a large amount of waste material into the Maili-say river, which would flow to the Syrdarya, and the Fergana Valley in Uzbekistan.



Fig. 7 Tailing Dumps at Maili-say¹³

#3, 9, ... indicate the numbers of 23 tailings. Arrows show the landslide forces.
 Photo: Министерство чрезвычайных ситуаций Кыргызской Республики

The main source of pollution is the radioactive waste that piled up in the sillage and the slag heap¹⁴. They have abandoned partly according to the plan and the partly because of

¹² Torgoev I.A., Aleshin U.G : The history of discovering uranic deposits in Kyrgyzstan. Ecological Bulletin MUREK, No.4, August 2002.

¹³ Проблема отходов, Документы и иллюстрации, Экологическое состояние региона Ферганской долины: http://enrin.grida.no/htmls/ferghana_valley

spontaneous abandonment. The main source of pollution is the radioactive waste that piled up in the sillage and the slag heap. They have abandoned partly according to the plan and the partly because of spontaneous abandonment.

The amount of the rough estimate of radioactive waste that flowed out from the sillage is about ten % of the primary quantities. Gamma ray is intensified and reaches to 1,000 $\mu\text{R}/\text{hour}$ on the surface of the sillage or on the rain ditch. Concentrated decay of the radon reaches 30,000~40,000 Bq/m^3 or more according to the sillage condition. At present, there exists no protection of the environment against the majority of the sillage. There is neither protective fences for the sillage or marker that alarms the danger of the radiation. Cows pasture, children play, and people live in a cottage on and around the tailings.

The uranium, radium, and those decay products are related to the radioactive waste in the sillage. There is not quantitatively much uranium. An overwhelming amount of radioactive waste pours into Maili-say river water. The composition of this river is a carbonate type. The uranium often migrates under such a condition and forms the carbonate complex. Radium moves with the bottom sediment.

Radium in the bottom sediment of the Maili-say river decreases to almost one tenth or less, and the backing ground value (3×10^{-3} % uranium equivalent) is almost maintained in the distance of 30km from the 7th deposit to Izbaskan (frontier town belonging to Uzbekistan). The radium concentration of the stream water is about 1×10^{-12} g/l or less. The uranium concentration is about 1.5×10^{-5} g/l, and it is one digit higher than the background level. The chemical composition of radioactive waste reflects the initial composition of the uranium ore, where the content of calcium is intensified, while silicon, nickel, copper, chrome, and other elements decreases. Additionally, the density of manganese is high, and reaches 500~2,000 g/l in the lower layer of the waste. This is a vestige of the oxidation extraction processing.

Large-scale pollution (ore splinter) exists over 15 square km^2 of the Maili-say city. Everything was collected, and kept into one of the slag heaps. Radium (10^{-13} g/l) of the low concentration and reinforced uranium were seen in the sillage and the water in the city. This water is used in the irrigation region. The intensity of the radionuclide of the drinking water is not measured. The radionuclide of the farm products has not been surveyed. A radon concentration in the dwelling in the city and the adjacent village in the air has not been measured. The population densities are about 1,500 people per one square km. It is thought that

¹⁴ Gerhard Schmidt: Anlagenzustand und radiologische Bewertung der früheren Urangewinnungsanlagen am Standort Mailii Su (Kirgisstan), im Auftrag der Friedrich Ebert Stiftung, Büro Bischkek (Kirgisstan), December 1997.

the population living from the Maili-say valley to the Uzbekistan Izbaskan village in the Fergana Valley is the risk group. The adjoining land is a farming region now.

Various accidents occurred in the past 30 years. A part of the sullage was destroyed by the landslide in 1958, 1984, 1994, and 2002. When all of the sullage collapses, 1.15 million m³ of the sullage with the radionuclide of 10,600 Ci will be thrown to the Izbaskan village. The area polluted by it will be 300 km².

They are uranium tailings accumulated in mountain valleys close to the Uzbek border (Andijan and Fergana oblasts). Most of the tailing dams are unstable due to insufficient storage capacity, and are not equipped with a base lining to prevent seepage of hazardous substances into surface and groundwater. The potential risk of accidents due to geological hazards, like landslides, mudflows, or earthquakes, is high. In April, 1958 after an earthquake and heavy rains the weak dam of the tailing #7 in Maili-say was destroyed, being constructed only 30 m away from the Maili-say river. 600,000 m³ 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. Since 1958, when a breach in a tailing dam released 6,000 m³ of radioactive material along 25 km in the Maili-say river, these processes have been documented in the region. From 1992 to 1996, several landslides triggered by tectonic events led to the erosion and partial destruction of some tailings, releasing toxic materials into the environment. The population densities are about 1,500 /km². The people living from the Maili-say valley to the Uzbekistan Izbaskan village is the risk group.

7 Yangiabad deposit

The Yangiabad deposit is located in the Dukentsay river valley that flows from the north side into the town of Angren. Dukentsay river valley is located in the North-Eastern part of Chatkal mountain ridge of Tien Shan mountains. The river is formed by confluence of two small mountain streams - Alatanga and Chilten. When coming out from mountains the river is frill of rapids and then it joins bigger river - Akhangaran which in its turn feeds Tuyabuguz (alias Tashkent lake) reservoir before flowing into Syrdarya river. Hydrothermal and sedimentary deposit had been operating for 1950-1980 on this ground.

Radioactive wastes of exhaust deposits of Yangiabad mining field are located on the area of about 50 km² in the Akhangaran district of Tashkent region¹⁵. Radioactive waste from

¹⁵ Sanitation2004-Uzbekistan, Division for Sustainable Development, UN Department of Economic and Social Affairs, 2004.

the uranium mine (heap of mined ore below an industrial standard) piles up in the Yangiabad region. The gross volume of stored there contaminated material is about 500 thousand m³. The uranium of 250-300 tons is contained in the storing soil. Abnormally high radium intensity (2,500 Bq/m³) is found in an accommodation of Yangiabad and its site. Intensity of gamma-radiation within the limits of contaminated areas here is around 60~200 µR/hour, and seldom 1,500 µR/hour. Main radioactive material is referred to low radioactive waste. The basic data has been collected to execute inactivation and care work by Republican point for radioactive waste disposal (RPRWD).

Since 1970 RPRWD undertakes disposal of all radioactive waste, produced in all research institutions, medical institutions and sectors of economy. It has been determined in the result of survey, which outside the borders of sanitary protection zone RPRWD has no negative impact on the environment.

There is the Angren open-pit brown coal deposit that is the biggest in Uzbekistan in the Akhangaran river valley where the Dukentsay river flows in. This valley expands 100 km or more (10km in width). Part of the coal produced from this deposit contains uranium. Fly ash is generated if this coal is burnt in the thermal power plant combustion furnace, and the density of the radionuclide increases by a factor of several. A part of this coal fly ash is discharged from the chimney and does the diffusion and deposition in the surrounding. This problem of radioactive coal is serious for Uzbekistan.



Fig. 8 A View of Yangiabad

8 Chkalovsk Uranium Combine

Vostokredmet (Востокредмет: Eastern Plant of Rare Metals, or Khujand Uranium and Refining Association)¹⁶, known as the Leninabad Mining and Chemical Combine until 1992, was established at Chkalovsk in May 1945 by Lavrenti Beria, the Soviet secret police chief, to mine and process uranium from deposits in Tajikistan, Kyrgyzstan, and Uzbekistan. During the

¹⁶ Anya Loukianova: Tajikistan Profile, NTI Working for a Safer World, Updated November 2007

Cold War years, Vostokredmet produced yellowcake for the Soviet nuclear power and defense industries, processing up to 1,000,000 metric tons of uranium ore per year. The uranium produced at Chkalovsk exploded the first Soviet nuclear bomb at Semipalatinsk in August 1949.

Radioactive ore was processed at the western industrial complex of Vostokredmet that is in the vicinity of reservoir Kairakkum. The waste was piled up in the Dehmai village, located 10 km southwest of Chkalovsk and the Gafurov village. This has the major risk for the pollution of the Syrdarya river.

The most serious source of danger is a waste dump in the town of Dehmai. This site, which contains 36 million tons of waste, has not been guarded for more than 10 years. A vast amount of water accumulates in its pit during the winter period, which then dries up in summer. Thus, radioactive dust rises from the dump and settles in some parts of the city of Chkalovsk, not far from Khujand, the center of the province. According to experts, in some parts of Khujand (primarily residential areas) the background radiation reading is 80 $\mu\text{R}/\text{hour}$ and higher. But in certain parts of the Sogd area, background radiation can be as high as 1,000 $\mu\text{R}/\text{hour}$ (IWPR; nuclear.kz 04.04.05)¹⁷. The maximum permissible concentration in Tajikistan is 57 $\mu\text{R}/\text{hour}$.

Unaware of the terrible dangers posed by uranium waste, people continue to build houses and plant gardens next to the dumps.



Fig. 9 A View of Khujand

Uranium ore deposit in Kyzylkum Desert

The facilities are subordinate to the Navoi Mining and Metallurgy Combine (NMMC) in the Navoi City. In 1999, NMMC produced 2,130 metric tons (t) of uranium, or 6.8% of the world's total output. Output for 2006 is estimated at 2,270t per year from the Northern, Central and Southern mining districts¹⁸. The uranium deposits are in the central Kyzylkum area, a 125km wide belt extending 400km from Uchkuduk in the northwest to Nurabad in the southeast.

¹⁷ Daler Hamidov: Tajikistan's Atomic Dustbin, IWPR, Reporting Central Asia 394, 8 July 2005.

¹⁸ Uranium production figures, Information Papers, 1998-2006: World Nuclear Association, <http://www.world-nuclear.org/info/uprod.html>.

It has a uranium waste reservoir from 1961. The area is 23.4 ha and the amount of waste is 3 mln. tons. Waste is composed of sand and clay containing 120-200 g/t of uranium. NMMC monitors the state of waste.

Uranium extraction had shifted from conventional and underground operations to in-situ leaching (ISL) operations. Fig. 9 shows the location of the uranium deposit in Kyzylkum Desert.

When the uranium is developed by ISL method, local pollution appears in the ambient surrounding. The reason of this pollution is that the balance of injection and suction of the solvent collapses, and the solvent left in the deposit extends to the vein of underground water. The target of pollution is the atmosphere, soil, and underground water.

Underground ISL by the sulfuric acid injection worsens the ecology of the vein of underground water that includes the mineral in the surrounding, and the quality of underground water deteriorates. The contaminant is sulphuric acid ion, hydrogen ion, uranium, iron, aluminum, and manganese, other heavy metals contained in the solvent, and nitrate at the stage of processing. Sulfate rises 20 times or more, aluminum and uranium rise 100 times more, and the pollution level of iron and the beryllium rises to about 1,000 times.



Fig. 10 Location of Uranium Deposit in Kyzylkum Desert

When the carbonate is used with the oxidant by underground ISL, the underground water concentrates not much. Though the ecology of underground water that includes the mineral deteriorates, yet the degree is lower than it injects sulfuric acid. Other elements do not change though the carbonate use slightly increases carbonate, calcium, ammonia, chlorine, sulfate, uranium, and molybdenum.

Local environmental pollution extends only within the range of 100-150 m for underground leaching. However, there is considerable danger even when underground water is used as household water and drinking water. The polluted water table area has been extending little by little for 8-10 years according to the regular observation though the solvent component of the underground ISL district does not change much. This result doesn't expect a fast self-reproduction of underground water.

Underground uranium ore deposit is required to be reproduced for the regeneration of water quality. Especially, the vein of underground water must be reproduced under the freshwater environment. Almost all underground ISL districts of Uzbekistan are under the vein of salt water.

Besides the waste repository and the underground leaching district mentioned above, there is "The first Navoi Hydro–Metallurgical Plant (NHMP)" of NMMC located in the left bank of Zarafshan to the west of Navoi City. The area of the sillage storing dam is 630 ha. The height of the dam is 15m. The sillage renunciation began in 1964, and the piled up waste is 59.7 million tons. Waste is a fine schlich that remained after processing uranium mineral at Uchkuduk, Sugraly and Sabyrsay deposit. The radioactivity is 90 kBq/kg and the radionuclide gross intensity is 160,000 Ci. The storing dam water is seen to enter into the underground water vein. It increases the ions of the underground water salinity, the sulphuric acid, the chlorine, iron, the selenium, and manganese within the range to Zarafshan up to 1.5km. Moreover, a pulverization has been generated on the surface of dam.

The gamma rays of the sillage storing dam is 300~500 μ R/h according to the radiation monitoring data in 1998, and the extent of the impact is 300~400 m.

Waste by the gold production is piled up on the waste from the uranium production in the sillage storing dam now. To ease the ecological effect with this sillage storing dam, the following measures are taken: The ooze solvent is returned to the disposal factory by 24 pumping out well drain systems; regular monitoring observes the change in the chemical composition of underground water in the sillage region at 108 observation wells.

Environmental surveillance around Yangiabad deposit

The Yangiabad deposit is located along Dukentsay river. Dukentsay Valley is located in the North-Eastern part of Chatkal mountains ridge of Tien Shan mountainous area. The river is formed by confluence of two small mountain streams - Alatanga and Chilten. Large left tributary -Kattasay- inflows to Dukentsay near Yangiabad township. When coming out from mountains the river is full of rapids and then it joins bigger river - Akhangaran which in its turn feeds Tuyabuguz reservoir before flowing into Syrdarya. Dukentsay has rapid flow and unstable hydrogeological regime. Maximum water level appears in spring and early summer. Ecological state of Dukentsay Valley depends on worked out deposits of uranium which forms Kattasay-Alatanga ore field of 50 km² total area. During the exploration and operation 64 mines were developed. All of these mines have wastes stockpiles with higher content of natural radionuclide. Besides, several industrial radioactive waste piles are located in the valley. The Dukentsay Valley is a radon generation region with radioactive waste. Waste consists of the rock and the abandonment mining equipment put out along with ore and digging in the tunnel that exists in the nonequilibrium state. The capacity is 500,000 m³, and everything approaches the Dukentsay.

The National Geological Group Kyzyltepageologia jointly made a site investigation of Yangiabad in October 1998 with us. The aquatic sample was first gathered from two branches of Alatanga and Chilten that was the source of the Dukentsay and the outflow water from the tunnel of an old uranium mine was gathered. Afterwards, the aquatic sample of the Akhangaran and the Tuyabuguz reservoir was gathered from the Dukentsay mid and downstream.

At each final sampling point, following field data were measured simultaneously: global position by SONY GPS; pH, electronic conductivity, turbidity, dissolved oxygen, water temperature, and salinity by Horiba multiple water quality monitoring system U-10. Table 1 shows these field data. Sampled water of 250 or 300 ml was immediately filtered by Millipore filter of 5 micrometer and 0.45 micrometer respectively and stored in 100, 50 and 20 ml polypropylene bottles that had been pretreated in Japan by hydrochloric acid after cleaned up by surface active cleansing agent.

After the expedition, alkalinity was measured in Tashkent by titration of 0.02N H₂SO₄ down to pH 4.3. After coming back to Japan, following ion concentrations were measured by Shimadzu ion chromatographic analyzer HIC-6A: Na⁺, K⁺, Mg²⁺, Ca²⁺, Cl⁻ and SO₄²⁻.

| No. | Lat | | | Long | | | alt m | pH | Cond mS/cm | DO mg/l | w.Temp °C | Salinity % |
|-----|-----|-----|-------|------|-----|-------|----------|-------|---------------|------------|--------------|---------------|
| | deg | min | sec | deg | min | sec | | | | | | |
| 1 | 41° | 6' | 48.6" | 70° | 5' | 18.4" | 1342 | 8.38 | 0.211 | 7.7 | 14.1 | 0 |
| 2 | 41° | 6' | 48.6" | 70° | 5' | 18.4" | 1342 | 8.42 | 0.61 | 5.82 | 18.1 | 0.02 |
| 3 | 41° | 6' | 57.3" | 70° | 5' | 28.8" | 1261 | 8.42 | 0.241 | 7.4 | 15.5 | 0 |
| 4 | 41° | 7' | 23.4" | 70° | 6' | 21.0" | 1342 | 7.88 | 0.097 | 7.3 | 15.2 | 0 |
| 5 | 41° | 8' | 9.9" | 70° | 7' | 11.7" | 1338 | 8.22 | 0.338 | 7.12 | 17.6 | 0.01 |
| 6 | 41° | 8' | 48.0" | 70° | 7' | 59.4" | 1335 | 8.06 | 0.115 | 6.88 | 14.1 | 0 |
| 7 | 41° | 7' | 31.6" | 70° | 5' | 45.0" | 1558 | 8.58 | 0.153 | 7.01 | 15.1 | 0 |
| 8 | 41° | 8' | 11.7" | 70° | 5' | 45.7" | 1393 | 8.71 | 0.155 | 6.91 | 15.9 | 0 |
| 9 | 41° | 8' | 11.7" | 70° | 5' | 47.7" | 1393 | 8.65 | 0.304 | 6.86 | 15 | 0.01 |
| 10 | 41° | 8' | 37.5" | 70° | 5' | 44.7" | | 8.58 | 0.152 | 6.66 | 13.4 | 0 |
| 11 | | | | | | | | 8.16 | 0.147 | 6.62 | 14.9 | 0 |
| 12 | | | | | | | | 8 | 0.325 | 5.58 | 15.8 | 0.01 |
| 13 | 41° | 9' | 13.2" | 70° | 5' | 35.4" | 1261 | 8.22 | 0.158 | 6.76 | 14.1 | 0 |
| 14 | 41° | 9' | 13.2" | 70° | 5' | 35.4" | 1231 | 8.38 | 0.118 | 6.66 | 15 | 0 |
| 15 | 41° | 9' | 13.2" | 70° | 5' | 35.4" | 1261 | 7.88 | 0.134 | 6.69 | 14.4 | 0 |
| 16 | 41° | 9' | 22.8" | 70° | 5' | 27.3" | 1500 | 8.05 | 0.147 | 6.8 | 13.1 | 0 |
| 17 | 41° | 9' | 22.8" | 70° | 5' | 27.3" | 1500 | 8.24 | 0.374 | 3.79 | 14.3 | 0.01 |
| 18 | 41° | 9' | 22.8" | 70° | 5' | 27.3" | 1300 | 8.32 | 0.146 | 6.83 | 13.2 | 0 |
| 19 | 40° | 7' | 39.3" | 70° | 6' | 38.1" | 1371 | 8.34 | 0.138 | 8.34 | 8.9 | 0 |
| 20 | 41° | 7' | 12.3" | 70° | 5' | 55.8" | 7.83 | 0.103 | 0 | 11.9 | 0 | 14 |
| 21 | 41° | 6' | 12.3" | 70° | 5' | 16.2" | 1150 | 8.18 | 0.739 | 7.85 | 10.1 | 0.03 |
| 22 | 41° | 6' | 12.3" | 70° | 5' | 16.2" | 1150 | 8.28 | 0.234 | 7.76 | 11 | 0 |
| 23 | 41° | 6' | 12.3" | 70° | 5' | 16.2" | 1150 | 8.07 | 0.271 | 7.75 | 10.8 | 0.01 |
| 24 | 41° | 5' | 25.0" | 70° | 5' | 15.3" | 1130 | 8.57 | 0.737 | 7.65 | 10.1 | 0.03 |
| 25 | 41° | 4' | 3.9" | 70° | 5' | 21.3" | 1039 | 8.2 | 0.422 | 7.33 | 13.2 | 0.01 |
| 26 | 41° | 2' | 37.5" | 70° | 5' | 33.6" | 1010 | 8.93 | 0.333 | 7.76 | 13.1 | 0.01 |
| 27 | 41° | 2' | 14.8" | 70° | 6' | 0.6" | 1039 | 8.87 | 0.335 | 7.57 | 13.1 | 0.01 |
| 28 | 40° | 58' | 42.3" | 70° | 2' | 53.7" | 922 | 8.82 | 0.371 | 8.38 | 13.7 | 0.01 |
| 29 | 40° | 58' | 6.9" | 70° | 3' | 6.3" | 837 | 8.25 | 0.299 | 7.72 | 14.7 | 0.01 |
| 30 | 40° | 37' | 15.0" | 70° | 2' | 53.3" | 800 | 8.36 | 0.663 | 8.05 | 11.6 | 0.02 |
| 31 | 40° | 39' | 42.4" | 70° | 6' | 40.3" | 760 | 8.58 | 0.269 | 7.41 | 14.9 | 0.01 |
| 32 | 41° | 0' | 42.7" | 70° | 8' | 9.0" | 986 | 8.54 | 0.174 | 7.6 | 14.5 | 0 |
| 33 | 40° | 56' | 6.0" | 69° | 54' | 2.1" | 657 | 9.09 | 0.34 | 8.51 | 16 | 0.01 |
| 34 | 40° | 54' | 3.9" | 69° | 36' | 1.3" | 555 | 8.55 | 0.43 | 8.3 | 15.3 | 0.01 |
| 35 | 40° | 53' | 5.7" | 69° | 31' | 33.0" | 442 | 7.68 | 0.561 | 7.52 | 17.4 | 0.02 |
| 36 | 40° | 57' | 46.0" | 69° | 22' | 39.0" | 379 | 8.29 | 1.01 | 6.87 | 13.9 | 0.04 |

Table 1 Position of Sampling Sites and Its Field Data

Site without longitude and latitude is the same with the preceding site.

Dissolved inorganic nitrogen (DIN), dissolved inorganic phosphorus (DIP) was measured by Technicon Instruments Corporation Auto Analyzer II. Standard for NH_4 , NO_2 and NO_3 were special grade reagents of $(\text{NH}_4)_2\text{SO}_4$, NaNO_2 and KNO_3 from Wako Pure Chemical Industries, Ltd. These reagents were first dried for one hour at a temperature of 110°C , and adjusted to each concentration after cooled in desiccators. Standard PO_4 from Wako Pure Chemical Industries, Ltd. was also used. Note that the unit of DIN and DIP is the amount of simple elements of nitrogen and phosphorus, while that of NH_4^+ and NO_3^- is the amount of molecular weight of each ion.

Metal concentration was analyzed by Hewlett Packard HP 4500 inductively coupled plasma mass spectrometer (ICP-MS) for U^{238} , Pb^{208} , Au^{197} , Sb^{121} , Cd^{111} , Se^{82} , As^{75} , Zn^{66} , Cu^{63} , Ni^{60} , Fe^{57} , Fe^{56} , Mn^{55} , Cr^{53} , and Al^{27} . B^{11} was also measured. Standard solutions were adjusted to blank, 2.50, 5.00, 10.0, 25.0 and 50.0 ppb for Zn^{66} , Fe^{57} , Fe^{56} , Mn^{55} , Al^{27} and B^{11} . Standards for U^{238} and Sb^{121} were blank, 0.05, 0.10, 0.20, 0.05 and 1.00 ppb. Standards for other elements were blank, 0.50, 1.00, 2.00, 5.00 and 10.0 ppb. Samples were diluted to one hundredth and internal standards method was applied. Ga^{69} , In^{115} and Bi^{209} were added to be of 50 ppb for elements whose mass numbers is less than 82, for Cd^{111} and Sb^{121} , and for Pb^{208} and U^{238} respectively. Integral time was 3 seconds. For comparison of uranium analyses, integral time of 10 seconds was also tried. Calibration was a logarithmic linear regression curve.

Table 1, Fig. 11 and Table 2 show the result. The uranium concentration is shown and the one that logarithm circle of each point was displayed in Fig. 12.

Collection point 5 is drain from the uranium ore mountain tunnel before. Collection point 6 is a drinking water head of a river for Yangiabab. Collection point 12 is ooze water from the pit where the bore investigation was done before. In collection point 16, there is a headrace tunnel over a few km of upstream, and the river before is a withering valley.

To confirm the correspondence of the ICP-MS analysis, the uranium concentration of 20 samples was independently analyzed in the Kanazawa University Low-level Radiation Research Facilities. The correlation coefficient of the analysis value of us and Kanazawa University indicated a high value, and it was confirmed that it was an analysis value to which the result in Table 2 was steady.

. We found that the uranium concentration of the river water around Yangiabab was unbelievably high (10 to 1,000 ppb- U^{238}). Annual discharge of U^{238} was estimated to be three tons per year. U^{235} from Dukentsay to Akhangaran was estimated to be at least of 22 kilogram per year. This is equivalent to the amount of two nuclear bombs of Nagasaki type

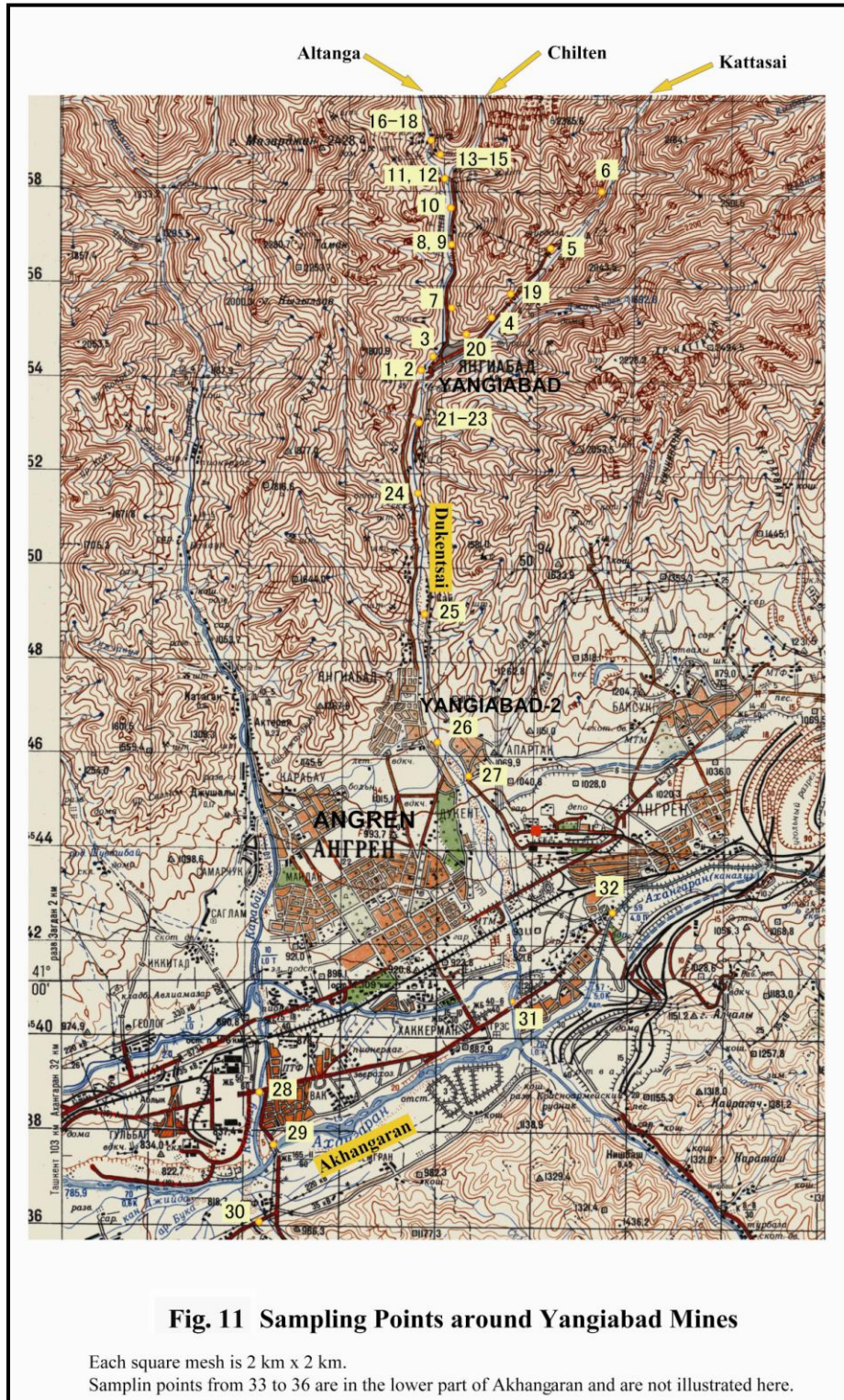


Fig. 11 Sampling Points around Yangiabad Mines

Each square mesh is 2 km x 2 km.

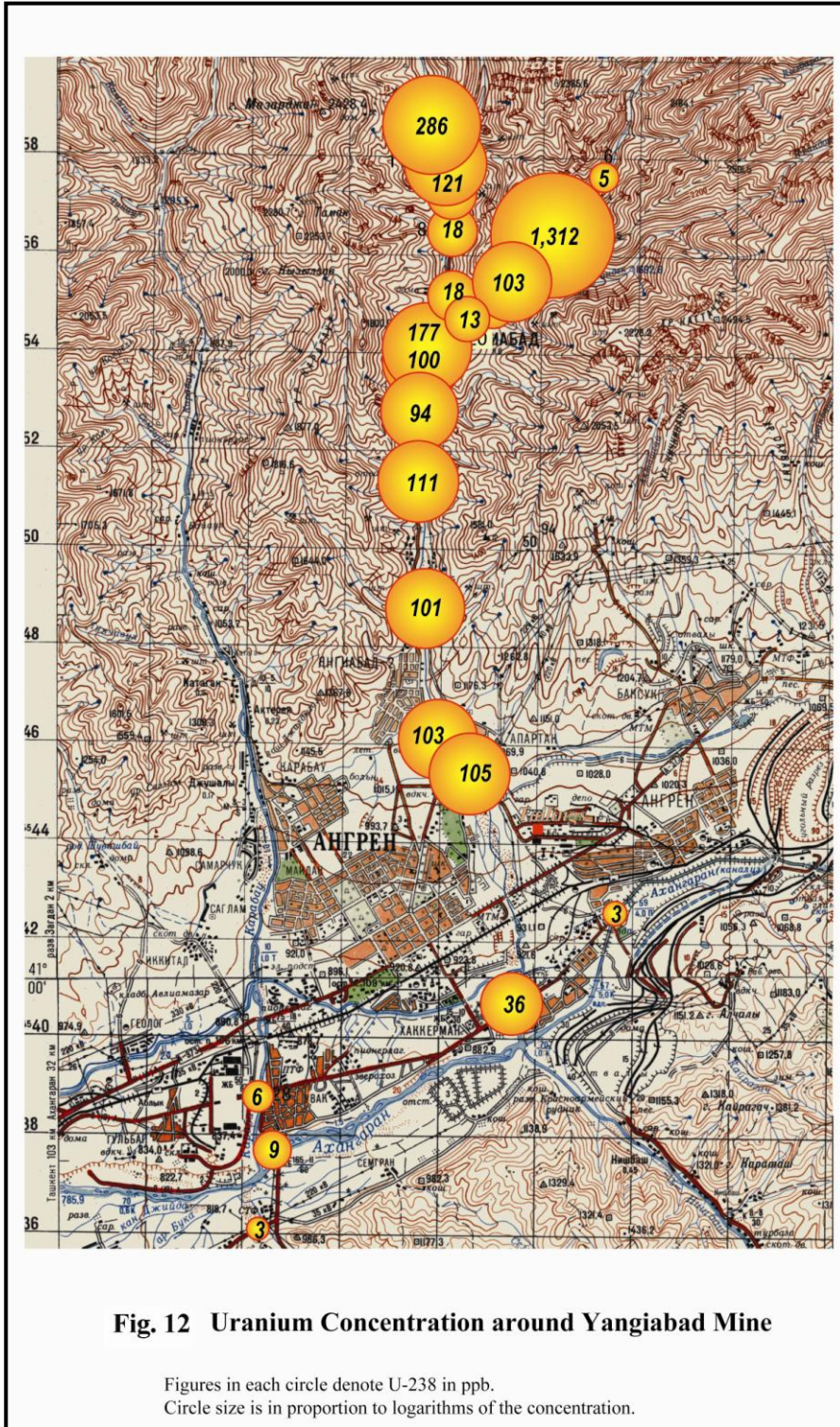
Samplin points from 33 to 36 are in the lower part of Akhangaran and are not illustrated here.

(unit : ppb)

| | B ¹¹ | Al ²⁷ | Cr ⁵³ | Mn ⁵⁵ | Fe ⁵⁷ | Ni ⁶⁰ | Cu ⁶³ | Zn ⁶⁶ | As ⁷⁵ | Se ⁸² | Mo ⁹⁵ | Cd ¹¹⁵ | Sb ¹²¹ | Au ¹⁹⁷ | Pb ²⁰⁸ | U ²³⁸ | Kanazawa |
|-----|-----------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|-------------------|-------------------|-------------------|-------------------|------------------|----------|
| 1 | 78.9 | 75.3 | 14.5 | 9.58 | 298 | 5.8 | 18.5 | 13.3 | 2.9 | 37.2 | 37.4 | 2.5 | 1.1 | 4.9 | 5.5 | 100.2 | 101.2 |
| 2 | 251.7 | 47.8 | 17.0 | 6.20 | 301 | 6.8 | 22.3 | 15.7 | 5.8 | 37.2 | 8.7 | 2.1 | 0.9 | 5.1 | 5.9 | 8.3 | |
| 3 | 81.8 | 52.2 | 14.4 | 7.05 | 333 | 8.6 | 19.2 | 28.0 | 3.5 | 35.3 | 53.3 | 1.5 | 0.9 | 3.9 | 7.8 | 176.9 | 159.9 |
| 4 | 72.7 | 67.0 | 13.2 | 6.18 | 319 | 8.1 | 15.0 | 21.4 | 2.5 | 33.7 | 10.3 | 1.4 | 0.7 | 3.6 | 7.5 | 13.2 | |
| 5 | 70.9 | 51.4 | 13.3 | 6.60 | 326 | 14.1 | 18.9 | 99.5 | 4.8 | 37.1 | 320.6 | 1.6 | 1.5 | 3.1 | 7.0 | 1312.0 | 1156.6 |
| 6 | 119.2 | 53.3 | 12.8 | 6.65 | 328 | 8.7 | 17.8 | 25.3 | 2.4 | 29.8 | 13.4 | 1.4 | 0.7 | 4.2 | 13.3 | 5.6 | 4.6 |
| 7 | 82.8 | 58.2 | 12.1 | 6.65 | 348 | 8.4 | 15.9 | 21.6 | 3.0 | 30.7 | 17.5 | 1.4 | 0.7 | 3.9 | 5.4 | 18.1 | 15.7 |
| 8 | 72.0 | 55.7 | 11.8 | 6.58 | 329 | 8.4 | 16.3 | 22.5 | 2.9 | 29.3 | 16.5 | 1.3 | 0.8 | 3.6 | 7.1 | 17.8 | |
| 9 | 74.9 | 47.5 | 11.6 | 6.43 | 347 | 9.0 | 18.7 | 21.9 | 4.0 | 30.6 | 12.4 | 1.5 | 0.9 | 3.6 | 8.8 | 4.3 | 3.8 |
| 10 | 61.5 | 58.6 | 12.0 | 6.35 | 326 | 8.8 | 17.9 | 20.1 | 2.8 | 30.5 | 14.6 | 1.3 | 0.7 | 3.7 | 9.7 | 15.6 | |
| 11 | 55.6 | 56.4 | 11.8 | 6.51 | 326 | 9.4 | 17.4 | 18.6 | 2.7 | 30.7 | 14.0 | 1.3 | 0.6 | 3.2 | 16.3 | 15.4 | 13.2 |
| 12 | 57.2 | 55.4 | 11.5 | 7.33 | 394 | 9.6 | 24.4 | 44.7 | 3.7 | 32.2 | 278.1 | 1.5 | 1.3 | 2.6 | 149.5 | 121.0 | |
| 13 | 46.2 | 50.8 | 11.7 | 7.05 | 408 | 9.2 | 16.1 | 22.6 | 1.9 | 34.1 | 15.6 | 1.7 | 0.7 | 2.1 | 6.2 | 6.5 | 15.5 |
| 14 | 41.8 | 51.0 | 11.6 | 6.77 | 416 | 9.3 | 15.9 | 16.1 | 1.7 | 34.8 | 6.8 | 1.6 | 0.6 | 2.1 | 6.9 | 2.7 | |
| 15 | 104.3 | 49.0 | 11.5 | 6.71 | 365 | 8.6 | 18.0 | 18.4 | 2.8 | 31.3 | 14.3 | 1.4 | 0.7 | 3.5 | 7.5 | 17.9 | 15.6 |
| 16 | 72.2 | 75.4 | 11.6 | 8.16 | 359 | 10.0 | 316.2 | 285.4 | 2.6 | 29.3 | 8.0 | 1.4 | 0.7 | 3.9 | 21.9 | 8.4 | 7.4 |
| 17 | 73.9 | 49.9 | 11.3 | 6.59 | 353 | 8.9 | 17.2 | 22.0 | 31.6 | 30.7 | 87.1 | 1.4 | 2.5 | 4.1 | 8.1 | 285.8 | 246.5 |
| 18 | 36.0 | 47.1 | 12.3 | 7.49 | 465 | 9.5 | 14.0 | 14.2 | 1.7 | 37.9 | 6.4 | 1.7 | 0.7 | 2.0 | 8.7 | 5.5 | 4.9 |
| 19 | 56.3 | 54.5 | 11.4 | 7.03 | 344 | 9.1 | 17.7 | 36.2 | 2.4 | 30.2 | 32.2 | 1.5 | 0.7 | 3.0 | 11.2 | 103.6 | 89.8 |
| 20 | 53.1 | 47.2 | 11.4 | 8.46 | 339 | 9.3 | 17.9 | 43.3 | 1.8 | 30.5 | 9.0 | 1.4 | 0.7 | 3.0 | 13.5 | 13.1 | |
| 21 | 273.2 | 50.4 | 11.6 | 7.61 | 346 | 9.3 | 26.0 | 70.1 | 2.5 | 31.4 | 8.3 | 1.4 | 0.9 | 2.9 | 15.9 | 7.3 | 6.4 |
| 22 | 60.9 | 40.8 | 11.0 | 8.10 | 375 | 8.4 | 13.3 | 14.6 | 2.5 | 31.5 | 14.6 | 1.5 | 0.7 | 2.9 | 6.5 | 79.2 | |
| 23 | 86.8 | 40.8 | 11.2 | 7.09 | 351 | 8.6 | 14.5 | 14.9 | 3.1 | 32.2 | 32.9 | 1.4 | 0.7 | 3.0 | 4.3 | 94.4 | 81.6 |
| 24 | 171.1 | 46.3 | 11.7 | 7.14 | 370 | 8.9 | 16.7 | 13.8 | 4.9 | 31.7 | 40.0 | 1.5 | 1.7 | 2.9 | 18.4 | 111.8 | |
| 25 | 180.6 | 48.2 | 11.3 | 7.12 | 343 | 9.2 | 20.7 | 17.7 | 5.4 | 31.3 | 40.1 | 1.4 | 1.0 | 3.9 | 6.1 | 101.4 | 87.1 |
| 26 | 123.2 | 43.6 | 11.8 | 6.96 | 342 | 8.5 | 15.2 | 14.5 | 4.1 | 29.8 | 35.3 | 1.4 | 0.9 | 3.3 | 11.9 | 103.7 | |
| 27 | 104.3 | 63.6 | 11.8 | 7.67 | 339 | 10.9 | 18.6 | 21.2 | 4.8 | 31.3 | 35.2 | 1.5 | 0.9 | 3.8 | 19.5 | 105.4 | 92 |
| 28 | 90.8 | 39.3 | 11.7 | 7.03 | 353 | 8.7 | 14.8 | 12.9 | 2.2 | 34.4 | 7.0 | 1.6 | 0.8 | 2.9 | 3.4 | 6.2 | 5 |
| 29 | 104.0 | 57.9 | 11.9 | 8.11 | 435 | 9.4 | 14.4 | 14.8 | 2.2 | 35.6 | 10.9 | 1.8 | 0.8 | 2.9 | 3.6 | 9.0 | |
| 30 | 145.4 | 160.9 | 12.5 | 298.10 | 466 | 11.6 | 27.8 | 31.0 | 1.8 | 37.8 | 6.2 | 2.5 | 1.0 | 5.0 | 13.8 | 3.6 | 2.9 |
| 31 | 115.8 | 86.8 | 12.3 | 8.68 | 482 | 9.5 | 15.7 | 17.7 | 3.3 | 38.6 | 20.9 | 1.9 | 1.0 | 3.1 | 6.6 | 36.0 | |
| 32 | 51.6 | 50.7 | 12.1 | 8.18 | 475 | 9.5 | 14.2 | 11.2 | 2.3 | 38.7 | 7.6 | 1.8 | 0.8 | 2.3 | 3.8 | 3.9 | 3.1 |
| 33 | 115.8 | 61.9 | 12.7 | 8.45 | 491 | 9.7 | 17.9 | 15.7 | 2.7 | 39.3 | 10.4 | 1.8 | 0.9 | 2.6 | 9.2 | 9.3 | |
| 34 | 107.2 | 48.1 | 12.5 | 7.92 | 502 | 9.9 | 17.0 | 105.8 | 2.1 | 38.5 | 8.8 | 1.9 | 1.0 | 2.7 | 15.9 | 8.0 | |
| 35 | 152.6 | 45.1 | 12.5 | 7.99 | 528 | 9.8 | 15.6 | 13.6 | 1.7 | 38.6 | 6.6 | 1.8 | 0.9 | 2.6 | 4.6 | 15.1 | |
| 36 | 146.6 | 41.7 | 15.1 | 7.64 | 475 | 9.4 | 19.8 | 15.0 | 2.3 | 39.0 | 6.1 | 1.8 | 0.8 | 3.0 | 8.8 | 5.0 | |
| G-1 | 5,000 | 200 | 50 | 100 | 200 | 50 | 1,000 | 5,000 | 50 | 10 | | | 5 | | 50 | 10 | |
| G-2 | 5,000 | 5,000 | 100 | 50 | 5,000 | 200 | 200 | 2,000 | 100 | 20 | 10 | 10 | | | | | |

Table 2 Result of Ultimate Analysis by ICP-MS

Colored Value shows higher one than other sites. G1 is the Guideline of drinking water of WHO, EEC, or Canada, while G2 is the Guideline for irrigation water by FAO. Kanazawa means the analysed value of U²³⁸ by Kanazawa University for cross check.



The following three points are paid to attention if consideration of the water quality around Yangiabad is added based on the above-mentioned analysis result.

- 1 It is iron, a selenium, a molybdenum (irrigation rainwater), and a uranium that exceeds the guideline value. Especially, the uranium is high density in the Dukentsay, and about 100 ppb is kept in the middle and lower reaches. There is a mineral water manufacturing factory along the river. This is a remains of the temporary favor of radioactive mineral spring.
- 2 The point where higher density is shown compared with other points is near an old tunnel such as 5, 12, 16, and 17. Moreover, 30 point is a lower part of Gushsay river that flows from the south into Akhangaran. There are a lot of mines in the upper part of Gushsay river.
- 3 Dukentsay should not be used for the drinking water source as an interim measure, and water transmission from the Kattasay upstream and the Karabau river (river that goes parallel in the west to Dukentsay) should be promoted. However, the infestation of Islam guerrilla comes to common in the Yangiabad region, and a big social problem exists in the background of the river securing.

Up-to-date analysis results (Table 2) and collected bibliography shows exceeded value of limited specific intensity (370 Bq/kg) for all sediments samples. The highest level occurs in Kattasay, where river washes rock piles along the river. Bottom sediments are specified with high value of summary alpha-activeness reaching 4,000-5,000 Bq/kg, expositional doze of 60-110 μ R/h. In total, Dukentsay has lower value of specific alpha-activeness as compared with Kattasay and Jekindeksay samples.

Problems and Conclusion

There are many urgent problems posed to the present and future generation. First is the possibility of the spillage of uranium and other toxic metals flowing from the tailings in Fergana Valley into Syrdarya basin. Recent land sliding process has been intensified in this area. The development of this process can cause the destruction of the tailing ponds and environmental pollution.

Second is the constant discharge of uranium and other metals from the tailings and old mining galleries. We estimated annual amount of U^{235} discharged from Yangiabad mines, and got 30 kg/year. This is equivalent to the materials of three nuclear weapons.

Third is the discharge of uranium into atmosphere. Angren is famous for its production of open pit coal in Uzbekistan. This coal contains not only carbon but uranium also. After the

burning of carbon, the ash that is reinforced the content of uranium is discharged into the air and falls down in the vicinity of power plants.

Fourth is the contamination of food chain in and along the river, canal, drainage, well, etc. that originate the pollution of water and soil. In the era of USSR, Uzbekistan was, in some sense, fortunately a cotton producing country. But agriculture itself is the source of industry, intensive labor, culture preservation and independence of the country.

There is no investigation of the health of people, especially from the epidemiological viewpoint. Exception is the investigations made in the area of Charkesar settlement (number of the population is 8,900 people.) It indicated that in 50% of the houses investigated ionizing radiation and radon exaltation level was higher than it is allowable. People used to make bricks from tailings and live inside the radon exposing houses. Population of the area is suffering from cancer deceases, including lung cancer, it is said.

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