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The investigation on radioactive contamination around Jadugoda uranium mine

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1. Introduction

India has a population of 1 billion in the country of 3,290,000km². GNP is 340 dollars (1995) per person. Agriculture, forestry, and a fishery worker ratio is 61.6% (1995). A life expectancy is 60 years old of men and 61 years old of women (1992-1993). We can guess their living standard from these. It has severe caste system and there are many poor people still in it. Moreover, some people named "Untouchable" are set-aside even from the caste system. Although Gandhi called them "Hari Jean (child of God)", they have the history of distress. However, there are people with more distress history in this country. They are the aborigines (

Native Indian). Many of them have lived in Bihar state of eastern India, especially in Jharkhand of Bihar. Jharkhand won the independence from Bihar the year before last. It is said that 28% of population is an aborigines. It is a mineral rich state and the iron ore brought the first full-scale industrial city "Jamshedpur (Tatanagar)" in India.

The position of the nuclear related institution in India is shown in Figure 1, and the railroad map of Jharkhand is shown in Figure 2. In addition, And it has sole uranium mine in India, and it has contributed

to both of the development of nuclear weapon and 14 nuclear power plants working now.

It is told that the population of Jharkhand is about 100 million and 26 million people live around its capital Ranchi including a circumference part. There is West Bengal State on the east side and Orissa State on the south side. Jharkhand state has the long slender area called "East Singhbhum". It lies between West Bengal and Orissa. Tatanagar is a part of the area and three uranium mines, Narwapahar, Bhatin and Jadugoda, are near there. These uranium mines are managed by UCIL (Uranium Corporation of India Limited), the government enterprise of India. It is only 10km from Narwapahar to

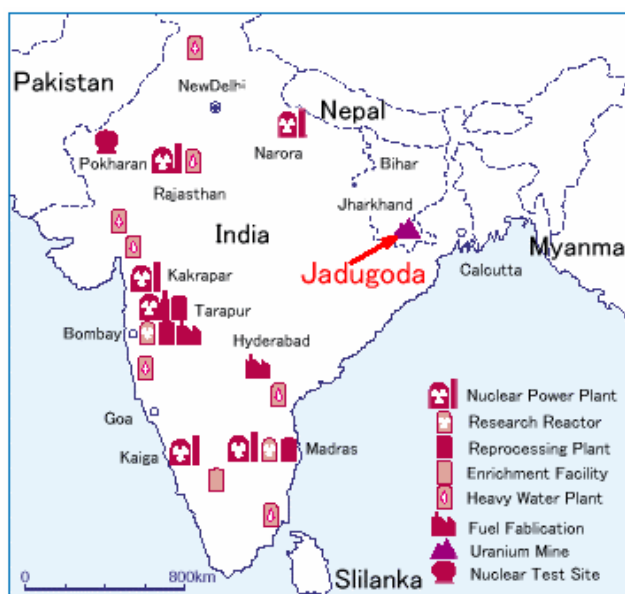


Figure 1 Nuclear Greatness, India

Jadugoda. Jadugoda has tailing ponds to throw away tailings of these three uranium mines. Figure 3 is an artificial satellite photograph that shows the position of uranium mines around Jadugoda and Jamshedpur (Tatanagar). The position of the central part of Jadugoda is east longitude 86-degree 20 minutes, and north



Figure 2 The Map of Jharkhand

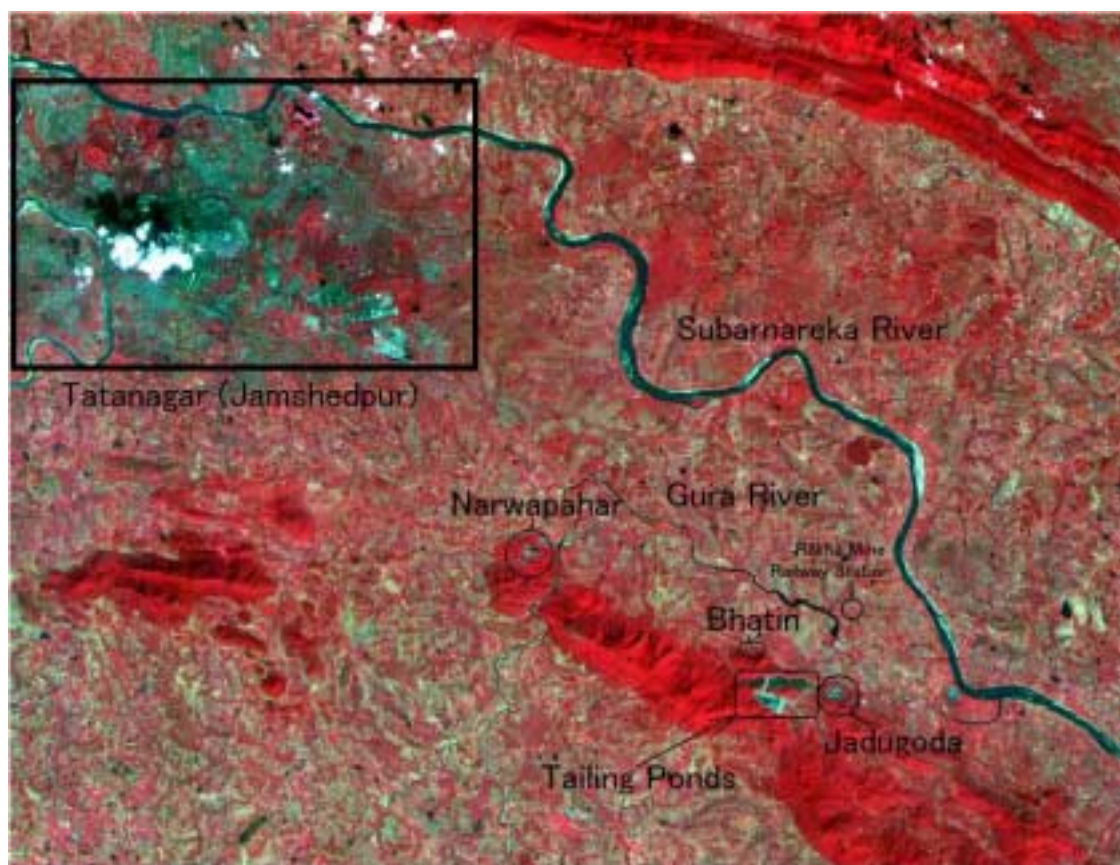


Figure 3 Satellite Photograph around Tatanagar and Jadugoda

latitude 22-degree 40 minutes. It is 24km from the Tatanagar station to Jadugoda in a straight line. The area around mines is mountainous land where the India aborigines have lived. Uranium is discovered here and they were deprived of their own land and polluted with radioactivity. They had to have a distress history for it. The wonder is that uranium was discovered in many aborigines' lands like in the U.S.A. and Australia.

2. The investigation method

As I already mentioned in the previous report¹⁾, under the cooperation of local residents I had performed the measurement of the air gamma dose by TLD and of the radioactivity in soil samples in autumn of 2000. The measurement of the radon concentration in air remained as an important subject. Radon is the radioactivity of the comparatively short life of half-life 3.8 days. The method of radon measurement which I am using consists of the following processes. First, activated charcoal sample is arranged in the measurement point. Second, activated charcoal adsorbs radon while it is being left for about one day. Third, samples are collected, and radioactivity is measured by gamma ray spectrometry. We have to perform the measurement in KURRI (Research Rector Institute, Kyoto University) with special measurement apparatus. If samples were mailed, it would be lost before measurement. Therefore, I decided to go to Jadugoda by myself and to return to KURRI immediately after the collection of radon. After adjusting the convenience of the local residents,

I made the investigation plan to leave Japan on December 22, 2001 and to return to Japan on the 29th. I prepared 24 sampling bottles for radon collection and sent them at the beginning of November 2001. In addition, I enclosed the survey meter in the parcel to make a map of air gamma dose. It usually takes one week to get there but my parcel did not reach until the end of the investigation. (After the year 2002 has come, there was connection from the custom office in Calcutta.) I made reluctantly only three activated charcoal samples and took a little powerless survey meter. Furthermore, since I visited Jadugoda by myself, I collected soil samples too. The collected soil sample arrived at KURRI early in April through the procedure of Japanese plant protection office. Then, the radioactive concentrations in these samples were measured. In this report, the results of the air-gamma dose rate, the radioactive concentration in soil, and the radon concentration in air are reported. The location of the villages and the measurement point of the air-gamma dose are shown in Figure 4.

The measurement of the air-gamma dose rate was performed using the Russian PDM-2 survey meter and, when the dose rate is low, this survey meter shows a somewhat higher value. Since I could not prepare only three samples for the collection of radon, I arranged them in three places shown in Table 1.

Table 1
The Measurement Point for Radon

| | |
|-----------|------------------------|
| 1(q) | Village (Tilaitand) |
| 2(a) | Tailing Pond (No. 1) |
| 3(near c) | Bhatin Mine's Gallery |

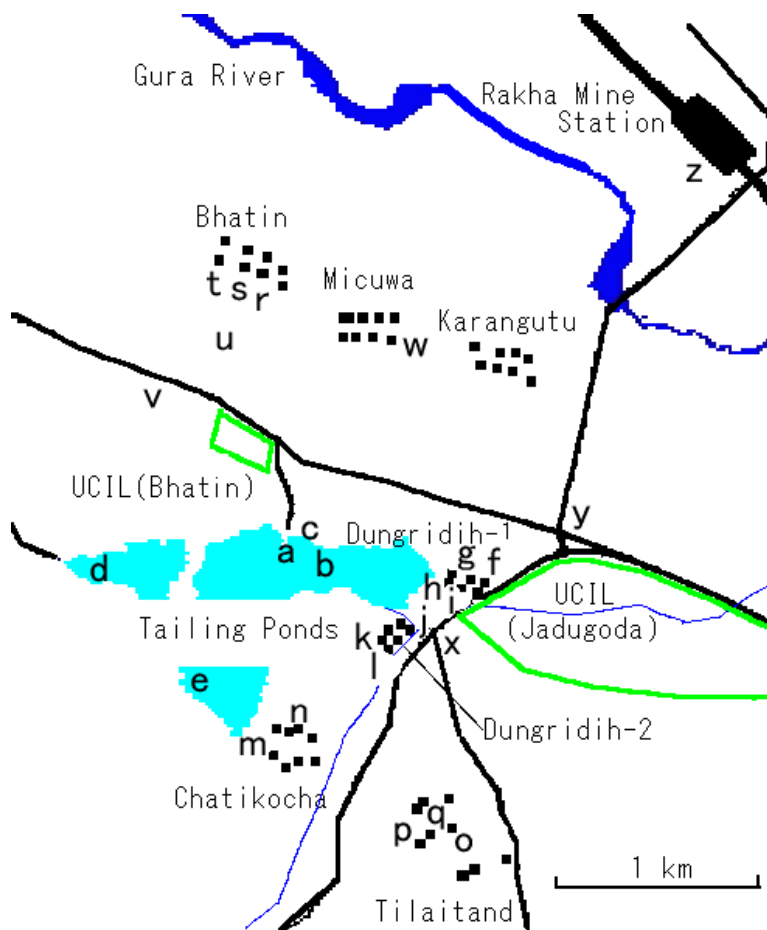


Figure 4 The Map around Jadugoda and measurement points of gamma dose

3. Results and Discussion

Air-Gamma Dose

The measurement result by the survey meter is shown in Table 2 and Figure 5 in accordance with the result by TLD(Thermo-Luminescence Dosimeter). Although not shown in this table, measurement has been performed in many places in villages. The dose rates are in 0.1-0.2 microSv/h anywhere except Dungridih, and this is the background value of the air-gamma dose in this area. As stated previously, the measured value by PDM-2 gives a little higher value than real. Therefore, although the value shown in

Table 2 approaches the usual background value in Japan etc., 0.05microSv/h, the background of this area is considered to be little high. In addition, the report²⁾ by Green Peace indicated that the background of this area to be 0.08-0.14 microSv/h, and a little higher than that of the usual area. However, although it is high, it is at most to this extent. The dose limit for the public by the artificial factor is determined as 1 mSv/y (0.11microSv/h) today. In Jadugoda, there are places where the external gamma dose by only natural factor exceeds this limit. This, however, is natural exposure and we cannot avoid it. On the other hand, the exposure

by the artificial factor can be avoidable. However, the artificial source of exposure exists in Jadugoda. The most remarkable source of contamination lies in tailing ponds, and there is the place where the amount of air-gamma dose exceeds 10mSv/y (1.1microSv/h). UCIL enclosed this area by the barbed wire but the area was farmland or village of residents. Above all, even now it is the place of an everyday life of residents. While I entered into a tailing pond and collected the sample, two women putting firewood on their head were crossing a tailing pond.

Table 2 The result of the measurement on Air-gamma dose rate

| | Point (remarks) | | This work (Survey Meter) | | Previous work (TLD) |
|---------------|--|----------------------------------|-----------------------------|---------|------------------------|
| | | | μ Sv/h | | μ Sv/h |
| | | | 1m | Surface | 1m |
| Tailing Ponds | | | | | |
| a | No.1 | | 0.84 | - | |
| b | No.1 | | 0.79 | 0.90 | |
| c | Boundary of No.1 | | 0.71 | 0.83 | 0.47 |
| d | No.2 | | 1.10 | 1.20 | 0.91 |
| e | No.3 | | 0.73 | 0.83 | |
| Village | | | | | |
| f | Dungridih 1 | Entrance | 0.13 | - | |
| g | | Center | 0.17 | - | 0.24 |
| h | | Fence | 0.34 | - | |
| i | | Former mine tailing pond | 0.39 | - | |
| j | Dungridih 2 | Entrance | 0.36 | - | |
| k | | Center (beside a dam) | 0.30 | - | |
| l | | Back | 0.16 | - | 0.11 |
| m | Chatikocha | Back (beside a dam) | 0.20 | - | 0.14 |
| n | | Sideway | 0.13 | - | 0.10 |
| o | Tilaitand | Garden (Mr. Biluri's house) | 0.12 | - | |
| p | | Filed (near a school) | 0.13 | - | |
| q | | Backyard (Mr. Biluri's house) | 0.13 | - | |
| r | Bhatin | Field | 0.14 | - | 0.11 |
| s | | Garden (once used mine tailings) | 0.16 | 0.21 | |
| t | | Garden | 0.12 | 0.12 | |
| u | | Pond | 0.13 | - | |
| Road Side | | | | | |
| v | Bhatin | | 0.22 | - | |
| w | Micuwa (mine tailings) | | - | 0.70 | |
| | Near copper mine | | 0.20 | 0.22 | |
| x | Entrance to Tilaitand | | 0.22 | - | |
| y | Main Crossing Road near Shidhu Kanu Chowk | | - | - | 0.14 |
| | | | | | |
| z | Rakha Mine Station | | 0.21 | - | |
| Control | | | | | |
| | Scheduled site of Shelter | | 0.14 | 0.16 | 0.23 |
| | Ranchi (garden of Mr. Shriprakash's house) | | 0.25 | 0.30 | |
| | KURRI (Kumatori, Japan) | | 0.08 | | 0.046 |

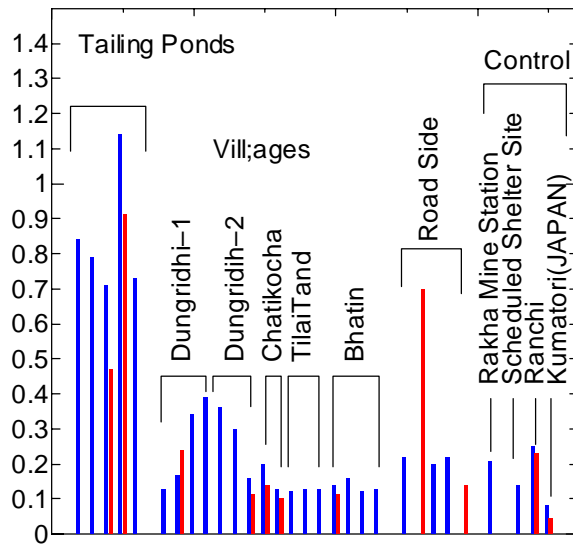


Figure 5 Air-Gamma Dose around Jadugoda and cotrols

Radioactive concentration in soil

Local residents performed collection of soil samples in autumn of 2000 at first. Next, I collected samples at the end of 2001. The radioactive nuclide was measured about these two kinds of samples. The result of these both measurements is reported.

A. Contamination unrelated to a uranium mine

At first, the concentration of radioactive nuclides unrelated to the uranium mine are shown in Table 3 and Figure 6. The typical radioactive material concentration in the crust hardly changes also in Jadugoda or in KURRI. But in Ranchi the concentration of K-40 and thorium is high. The reason the sample of Ranchi contains much K-40 and thorium will be

based on the character of the local crust.

The U.S.A., U.S.S.R. and few other countries conducted the atmospheric nuclear test more than 500 times in the 1960s. A lot of fission products polluted all over the world. However, since many of nuclear test sites were located in the Temperate Zone of the Northern Hemisphere, this area received high contamination especially. As Japan belongs to this area, it was expected that the value of Cs-137, which is main fission products, is higher than that in India. The measurement result here has supported the fact. That is, Cs-137 concentration in the soil in KURRI is several times higher than that in Jadugoda. However, Cs-137 concentration of the sample collected in the No.1 tailing pond is several times higher than that in KURRI.

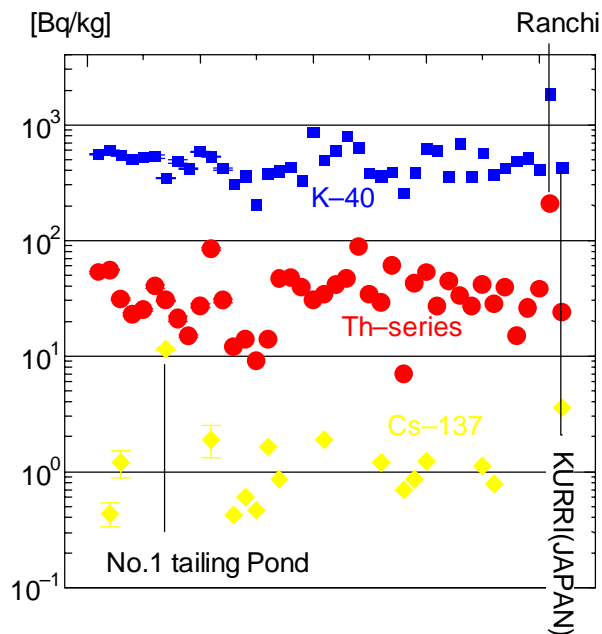


Figure 6 Concentration of unrelated Nuclides with Uranium

Table 3 Concentration of unrelated Nuclides with Uranium

| | | Th-series | | K-40 | | Cs-137 | |
|----------------------|--|-----------|-----|-------|-----|--------|-----|
| | | Bq/kg | SD | Bq/kg | SD | Bq/kg | SD |
| Rakha Station | | | | | | | |
| 2 | Railway station Rakha mines | 53 | 2.3 | 550 | 1.2 | | |
| 106 | Rakha Mine Station | 55 | 1.1 | 600 | 0.6 | 0.43 | 22 |
| Around tailing ponds | | | | | | | |
| 3 | Near tailing pond | 31 | 1.9 | 540 | 0.8 | 1.2 | 27 |
| 4 | Near tailing pond | 23 | 2.8 | 510 | 1.2 | | |
| 5 | Near tailing pond | 25 | 2.4 | 520 | 1.1 | | |
| 115 | Tailing Pond No.1 entrance | 40 | 3.3 | 530 | 2.6 | | |
| 6 | Tailing pond no. 1 | 30 | 1.6 | 350 | 1.1 | 11 | 2.2 |
| 116 | Tailing Pond No.1 | 21 | 5.1 | 480 | 2.6 | | |
| 8 | Tailing pond no. 2 | 15 | 2.8 | 420 | 1.2 | | |
| 117 | Tailing Pond No.2 | 27 | 3.5 | 590 | 1.6 | | |
| 7 | Tailing pond no. 3 | 84 | 1.8 | 530 | 1.7 | 1.9 | 30 |
| 118 | Tailing Pond No.3 | 30 | 3.9 | 420 | 2.6 | | |
| Villages | | | | | | | |
| 9 | Chatikocha near ratan's house | 12 | 1.4 | 310 | 0.6 | 0.42 | 12 |
| 10 | Chatikocha near ishwar's house | 14 | 1.7 | 360 | 0.7 | 0.60 | 12 |
| 107 | Chatikocha, front of Tailing Dum | 9 | 2.3 | 200 | 0.9 | 0.47 | 13 |
| 108 | Chatikocha, field in the village | 14 | 2.1 | 380 | 1.7 | 1.7 | 13 |
| 11 | Mechuwa (Dungridih) near prabhat baske's house | 46 | 0.9 | 400 | 0.9 | 0.86 | 17 |
| 109 | Dungridih, back in the village | 48 | 1.1 | 430 | 0.9 | | |
| Un04 | Dungridih, entrance to the village | 39 | 1.1 | 330 | 1.0 | | |
| Un01 | Dungridih, old tailing pond | 30 | 2.5 | 850 | 1.1 | | |
| 12 | Mechuwa (tuare Dungridih) near futani tati's | 34 | 1.1 | 490 | 0.6 | 1.9 | 5.9 |
| 13 | Mechuwa (tuare Dungridih) near tati's house | 41 | 1.0 | 590 | 0.5 | | |
| 112 | Dungridih 2, back in the Village | 46 | 1.4 | 790 | 0.7 | | |
| 113 | Dungridih 2, entrance | 88 | 1.4 | 630 | 1.1 | | |
| un03 | Dungridih 2, most back | 34 | 1.6 | 380 | 1.1 | | |
| 14 | Tilaitand near pulin banra's house | 29 | 1.0 | 360 | 0.6 | 1.2 | 7.2 |
| 20 | Tilaitand near tapash's house | 60 | 0.6 | 390 | 0.7 | | |
| un02 | Tilaitand, school | 7 | 2.2 | 260 | 0.8 | 0.70 | 9.1 |
| 15a | Mecuwa near mirja shoren's house | 42 | 0.9 | 380 | 0.8 | 0.87 | 11 |
| 16 | Bhatin near gundi hembrom's house | 53 | 0.7 | 620 | 0.5 | 1.2 | 8.2 |
| Road or River Side | | | | | | | |
| 104 | Mecuwa Road Side | 27 | 2.4 | 590 | 1.0 | | |
| 105 | Mecuwa Road Side (Mine tailing) | 44 | 2.1 | 350 | 2.1 | | |
| 17 | Near high school Jadugoda | 33 | 0.7 | 680 | 0.4 | | |
| 18 | The main crossing road near jagdish bastralaya | 27 | 1.4 | 350 | 0.9 | | |
| 19 | The main crossing road near shidhu kanu chowk | 41 | 1.1 | 570 | 0.5 | 1.1 | 11 |
| 21 | Gura river near lord shiva temple | 28 | 1.5 | 370 | 1.1 | 0.79 | 24 |
| 22 | Gura river near the big dam | 39 | 0.8 | 420 | 1.1 | | |
| 23 | Near the nala along the road side | 15 | 4.6 | 480 | 1.3 | | |
| un05 | Tailing Pond No.1 outlet stream at Dungridih 2 | 26 | 1.6 | 510 | 0.7 | | |
| 120 | UCIL Outlet | 38 | 2.3 | 410 | 2.0 | | |
| Control | | | | | | | |
| 24 | Ranchi | 210 | 0.4 | 1800 | 0.4 | | |
| 25 | KURRI, JAPAN | 24 | 1.0 | 430 | 0.6 | 3.60 | 2.6 |

Its value is 10 or more times higher than that of other samples in Jadugoda. It is reported that the radioactive waste from various parts of India has been carried and abandoned into the tailing pond of Jadugoda. The Cs-137 unusual contamination in No.1 tailing pond is considered to show this fact.

Contamination related to uranium mine

Of course, the index of the contamination related to uranium mine is uranium. However, as shown in Figure 7, uranium itself is a radioactive nuclide and the generated nuclide is also radioactive and repeats to decay one after another. Finally, it becomes a lead (Pb-206) changing a Figure into 14 kinds of radioactive nuclides. In addition, it can be proved physically that the radioactive intensities of these 14 kinds become the same as that of uranium if all these nuclides remain in the same place. Such a state is called "radioactive equilibrium". For example, when uranium is in a deep underground, such a state exists. Radium tends to solve into water compared with uranium, and radon is the gaseous nuclide which belongs to the rare gas. Therefore, when a uranium ore is taken out to surface of the earth, they move from the place easily. Moreover, if uranium is smelted, it will move to a product and will decrease in tailings. Then, in analysis of the uranium in soil, following three

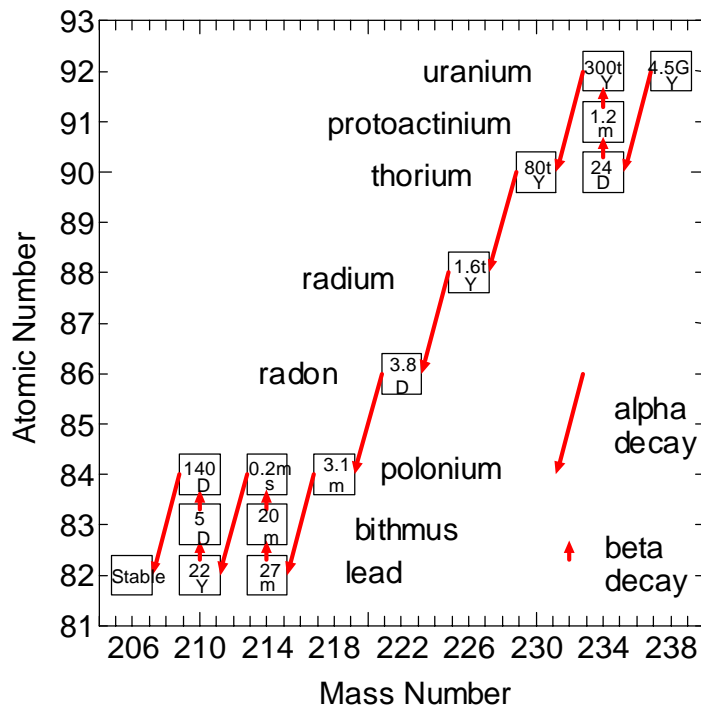


Figure 7 Decay Scheme of Uranium Series

kinds of radioactivity was determined. 1: From uranium-238 to thorium-230. 2: Radium-226. 3: The daughter nuclide below Polonium-218. The result is shown in Table 4 and Figure 8. The value in KURRI was shown in the right end, and it is a value without contamination of uranium mine. There are samples in the village, road and riverside of the Jadugoda that show the almost same value as the sample of KURRI. This shows that in Jadugoda there is the place that has not contaminated of a mine. However, also in the same village, the same road and the riversides, soil with extraordinarily high uranium concentration exists. Moreover, uranium concentration in the tailing pond is remarkably high. In almost all samples, the concentration of uranium, radium and daughter nuclides is same and does not move greatly from the state of "radioactive equilibrium" fundamentally.

Table 4 Contamination related to uranium mine

| | | U-series | | Ra-226 | | Daughter | |
|----------------------|--|----------|------|--------|------|----------|-----|
| | | Bq/kg | SD | Bq/kg | SD | Bq/kg | SD |
| | Rakha Station | | | | | | |
| 2 | Railway station Rakha mines | 64000 | 0.1 | 940 | 0.2 | 30 | 3.0 |
| 106 | Rakha Mine Station | 1200 | 0.5 | 25 | 2.4 | 44 | 0.7 |
| Around tailing ponds | | | | | | | |
| 3 | Near tailing pond | 1900 | 0.7 | 3400 | 0.5 | 2600 | 0.1 |
| 4 | Near tailing pond | 1700 | 0.9 | 1800 | 1.0 | 1400 | 0.2 |
| 5 | Near tailing pond | 1710 | 1.0 | 2700 | 0.8 | 1900 | 0.1 |
| 115 | Tailing Pond No.1 entrance | 1200 | 1.3 | 2600 | 1.3 | 1700 | 0.2 |
| 6 | Tailing pond no. 1 | 840 | 1.0 | 640 | 1.4 | 690 | 0.2 |
| 116 | Tailing Pond No.1 | 1300 | 3.0 | 1300 | 3.7 | 1100 | 0.4 |
| 8 | Tailing pond no. 2 | 540 | 1.7 | 2700 | 1.0 | 2000 | 0.1 |
| 117 | Tailing Pond No.2 | 1200 | 1.4 | 1400 | 2.3 | 1100 | 0.3 |
| 7 | Tailing pond no. 3 | 6500 | 0.7 | 3100 | 0.7 | 7300 | 0.1 |
| 118 | Tailing Pond No.3 | 790 | 3.0 | 1100 | 3.1 | 1100 | 0.4 |
| Villages | | | | | | | |
| 9 | Chatikocha near ratan's house | 20 | 4.1 | 23 | 13.0 | 14 | 1.1 |
| 10 | Chatikocha near ishwar's house | 34 | 5.5 | 19 | 14.0 | 23 | 1.0 |
| 107 | Chatikocha, front of Tailing Dum | 18 | 16.0 | 12 | 19.0 | 17 | 1.1 |
| 108 | Chatikocha, field in the village | 26 | 2.2 | 12 | 25.0 | 22 | 2.2 |
| 11 | Mechuwa (Dungridih) near prabhat baske's house | 140 | 1.9 | 91 | 5.9 | 65 | 0.7 |
| 109 | Dungridih, back in the village | 590 | 5.1 | 210 | 3.6 | 190 | 0.4 |
| un04 | Dungridih, entrance to the village | 160 | 2.1 | 88 | 5.7 | 88 | 0.5 |
| un01 | Dungridih, old tailing pond | 1200 | 1.3 | 1200 | 1.8 | 1300 | 0.2 |
| 12 | Mechuwa (tuare Dungridih) near futani tati's house | 210 | 1.4 | 150 | 2.9 | 130 | 0.4 |
| 13 | Mechuwa (tuare Dungridih) near tati's house | 350 | 1.1 | 260 | 2.0 | 250 | 0.3 |
| 112 | Dungridih 2, back in the Village | 450 | 1.2 | 340 | 2.4 | 340 | 0.3 |
| 113 | Dungridih 2, entrance | 560 | 2.3 | 480 | 4.0 | 540 | 0.4 |
| un03 | Dungridih 2, most back | 370 | 1.8 | 310 | 3.3 | 420 | 0.3 |
| 14 | Tilaitand near puling banra's house | 58 | 43.0 | 28 | 9.6 | 26 | 0.8 |
| 20 | Tilaitand near tapash's house | 130 | 2.0 | 84 | 6.5 | 72 | 0.5 |
| un02 | Tilaitand, school | 12 | 4.6 | | | 4 | 3.6 |
| 15a | Mecuwa near mirja shoren's house | 85 | 1.9 | 63 | 7.3 | 52 | 0.7 |
| 16 | Bhatin near gundi hembrom's house | 62 | 19.4 | 34 | 12.0 | 26 | 0.9 |
| Road or River Side | | | | | | | |
| 104 | Mecuwa Road Side | 960 | 1.1 | 840 | 1.7 | 940 | 0.2 |
| 105 | Mecuwa Road Side (Mine tailing) | 610 | 2.1 | 200 | 6.9 | 330 | 0.6 |
| 17 | near high school Jadugoda | 67 | 18.0 | 23 | 11.0 | 21 | 0.9 |
| 18 | the main crossing road near jagdish bastralaya | 790 | 0.7 | 580 | 1.4 | 640 | 0.2 |
| 19 | the main crossing road near shidhu kanu chowk | 250 | 1.3 | 160 | 3.8 | 190 | 0.3 |
| 21 | Guar river near lord Shiva temple | 970 | 0.9 | 2000 | 1.8 | 1100 | 0.1 |
| 22 | Gura river near the big dam | 56 | 22.0 | 35 | 12.0 | 21 | 1.1 |
| 23 | Near the nala along the road side | 1300 | 1.7 | 2400 | 0.9 | 2820 | 0.1 |
| un05 | Tailing Pond No.1 outlet stream at Dungridih 2 | 810 | 0.9 | 950 | 1.3 | 1000 | 0.1 |
| 120 | UCIL Outlet | 860 | 3.1 | 2000 | 1.2 | 61 | 0.3 |
| Control | | | | | | | |
| 24 | Ranchi | 210 | 1.2 | 76 | 9.2 | 49 | 0.8 |
| 25 | KURRI, JAPAN | 29 | 6.8 | 19 | 15.0 | 12 | 1.5 |

The only exception is the sample collected at the Rakha mine station; in this sample only uranium existed by high concentration remarkably.

In order to see this point in detail, it is Figure 9, which shows only the measurement result around tailing ponds and Rakha Mine Station. In the sample around tailing ponds the concentration of uranium, radium, and daughter nuclides show almost same value, only a Rakha Mine Station sample shows only uranium concentration is extremely high compared with radium and other daughter nuclides. This shows that the uranium obtained by smelting fell around the station and extended contamination. In addition, the fact that there is a big difference in uranium concentration in two samples collected in the station shows that the actual shipment work has been done in the restricted area.

Figure 10 shows only the data about villages that is taken out among the data shown in Figure 8. In the village of the Jadugoda, the uranium concentration in Dungridih-1 and Dungridih-2 is high and it is clear that these villages were contaminated by tailings. In addition, there are big differences in the uranium concentration in the same village. This fact shows that the tailing is carried into the village, which has not been contaminated originally, as construction

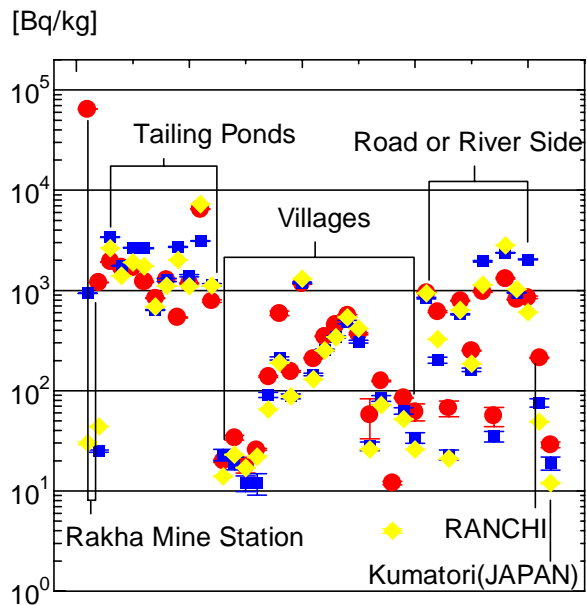


Figure 8 Concentraion of Uranium and its Daughter Nuclides

● ; U-238 ■ ; Ra-226 ▲ ; Doughters

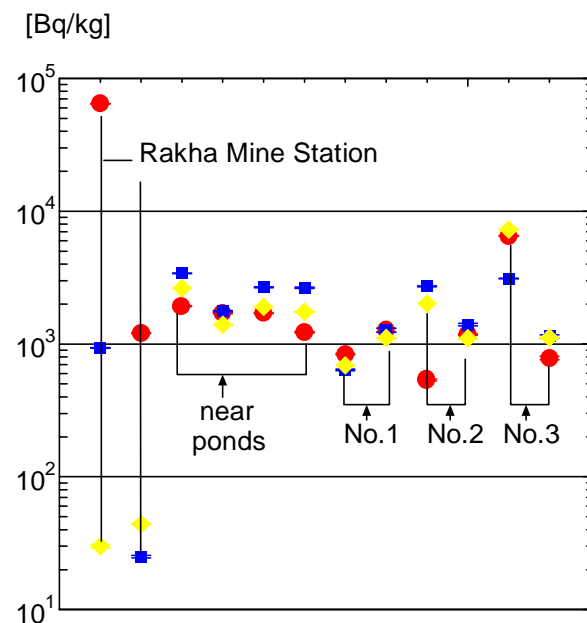


Figure 9 Concentraion of Uranium and its Daughter Nuclides (in and around tailing ponds)

● ; U-238 ■ ; Ra-226 ▲ ; Doughters

materials of houses. This will become still clearer if we check about the sample along a road. Figure 11 shows the data of the soil of the road, the riverside, and the brook that flows from a tailing pond and UCIL. The value about the sample of Ranchi and KURRI (Japan) is also shown in this figure as control. It turns out that uranium concentration is remarkably changed in the sample of the same road or the river. This shows that whether tailings were used for the construction materials of the road and the bank of river has great influence. Moreover, the water that has flowed out of a tailing pond or UCIL is polluted with uranium, so a river is also contaminated.

Radon concentration in air

Although satisfied data has not been obtained yet about the radon concentration in air, three measured value are shown in Table 5. Since the radon concentration of the usual outdoor environment is about 10 Bq/m³, the radon concentration in the village of the Jadugoda has been high. Although the reason will be caused naturally, the value in tailing ponds is dozens times, and it seems that the contamination of radon has spread from the tailing

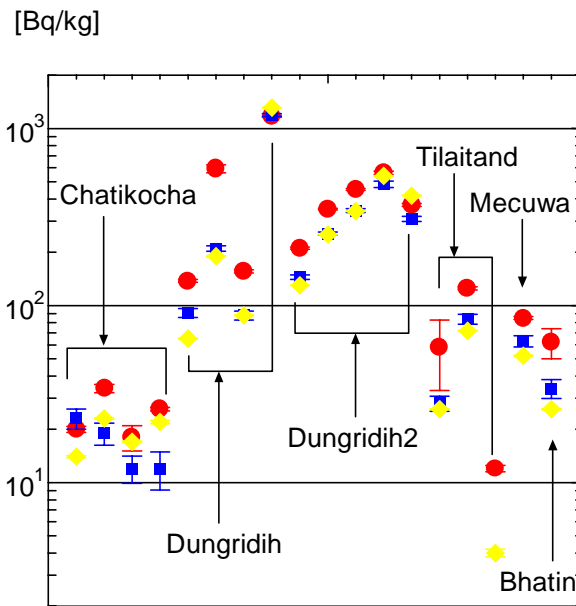


Figure 10 Concentraion of Uranium and its Daughter

Nuclides (in and around villages)
 ● ; U-238 ■ ; Ra-226 ▲ ; Doughters

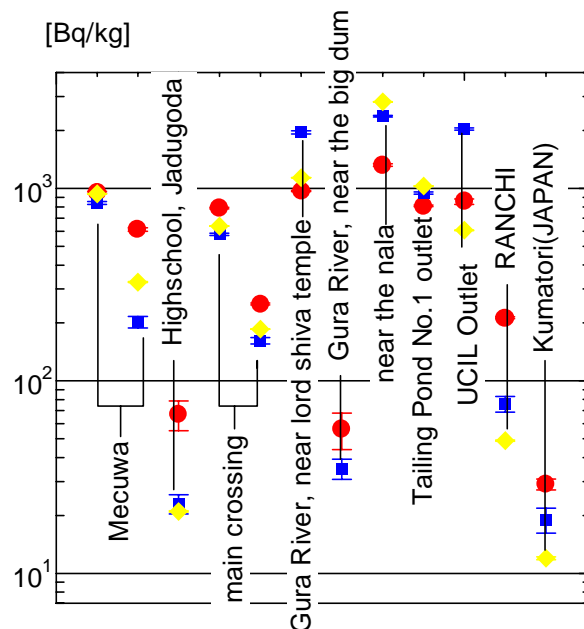


Figure 11 Concentraion of Uranium and its Daughter Nuclides (Road or River Side and Control)

● ; U-238 ■ ; Ra-226 ▲ ; Doughters

pond. Moreover, the value in the exhaust gallery of a Bhatin mine is further 10 times. Exposure of the laborers who work in a tunnel is anxious. Especially the grade of the uranium ore of Jadugoda is low, and it is said that the digging tunnel that was a depth of about 500 to 600m at the beginning has now become no less than 1000m depths of the earth. The healthy problem of the aborigines currently mustered as mining laborers may be just the biggest problem of Jadugoda

Table 5 Radon Concentration in air

| Point | Concentration |
|-----------------------|-------------------|
| | Bq/m ³ |
| Village (Tilaitand) | 45 |
| Tailing Pond (No.1) | 260 |
| Bhatin Mine's Gallery | 2400 |

4. Conclusion --- Serious Problem A. Contamination exists.

Although it is a matter of course, contamination exists. If uranium is exploited and is left on the surface of the earth, there will be no reason which contamination does not produce. Moreover, if unmanageable tailings are positively used for the construction materials of the building or the road, contamination will be expanded further. According to the request of JOAR (Jharkhand Organization Anti-Radiation) the Environment Committee of the Bihar Legislative Council was installed. The committee issued the last report in December 1998 after investigating the

investigating the circumference over two years. The report indicated, "There should be no village up to at least 5km., from the dumping ground area." However, according to my investigation, contamination centering on tailing ponds seems to have not spread yet broadly. Since two villages, Dungridih-1 and Dungridih-2, are in contact with the tailing pond, soil is polluted and the air-gamma dose is high. On the other hand, in the village that is not directly in contact with tailing ponds including Tilaitand the air-gamma dose is not high. In addition, the contamination from tailings is not measured in soil samples, either.

However, as the Environmental Committee of the Bihar Legislative Council has already pointed out, the tailing pond is the place of an every-day life of residents, and residents are frequenting the tailing pond daily, while they have not told the danger of radioactivity. Residents receive excessive contamination by the gamma ray from the ground only by entering into these tailing ponds, and they receive further exposure by inhaling the radon that escapes from the ground and by making tailings adhere to the body.

The result of this investigation is summarized below.

- 1. The contamination from a uranium mine has spread in Jadugoda.**
- 2. The amount of air -gamma dose exceeds 1 mSv/y in the villages, and reaches 10 mSv/y around the tailing ponds**
- 3. The circumference of tailing ponds is polluted with uranium. The strength of**

the pollution is of 10 to 100 times is high in comparison with the place without contamination.

- 4. No.1 tailing pond has contamination of cesium. This fact shows that radioactivity was brought from another polluted source which was not uranium mine.**
- 5. Especially Dungridih that is in contact with the tailing pond has high contamination. However, other villages have not contaminated seriously yet.**
- 6. There is a shade of uranium contamination also in a same village, as high contamination has been measured at Tilaitand or other village. This cause is because tailings were used for the building materials.**
- 7. There are places where uranium concentration is high in the road or the riverside, and it is thought that tailings are used for construction material.**
- 8. At the Rakha Mine station the soil is polluted by only uranium. Its concentration is remarkably high. This shows that the uranium obtained by smelting fell and extended contamination.**
- 9. Not only K-40 or thorium but uranium concentration is high in Ranchi.**

B. About the construction of Shelter

Due to the native abnormalities are occurring frequently in children in Jadugoda, the support organization "the fund of Buddha's sorrow" born in Japan is forming a plan to newly build a "shelter" in the place about 20km away from

Jadugoda, and evacuate Jadugoda children into it. A plan was already beginning to promote and the construction has started. As the amount of air-gamma dose in that place was already shown in Table 1, it does not change with the ordinary village in Jadugoda except Dungridih-1 or Dungridih-2. Therefore, exposure cannot be reduced even if the children of villages other than Dungridih or Chatikocha were accommodated in the shelter. Jadugoda is not the society where everyone can use cars like of Japan. Then, is it good to accommodate children in the shelter far distant from the place of their life? Ranchi, Jharkhand state's capital, has the high concentration of the thorium and potassium of the natural origin in the crust, the amount of air-gamma dose is high as shown in Table 1. Therefore, if the shelter for the children is built at Ranchi and children are accommodated there, exposure of children will increase rather.

However, efforts of the aborigines for shelter construction are already progressing with involving in much villages and residents, and become the big power for building aborigines' solidarity.

C. Structure of discrimination

Jadugoda was an aborigines' land originally. However, uranium was exploited and residents were deprived of land. The residents, who were deprived of the farmland or the village itself, live in the village of Dungridih or Chatikocha. When I visited Dungridih, one resident came and told us something by the angry face. I heard later that he had said, "I understand that

this village is dangerous. However, where we can live really?"

D. We have to avoid the exposure without a reason.

Even if it may be very low dose, exposure to radiation accompanies risk. However, since the natural radioactivity exists on the earth and there is radiation such as a cosmic ray, from the first, we cannot escape the exposure completely. There is also an area where the content of the uranium or thorium in soil are high, and peoples are received exposure of 10 or more times in such a place compared with other areas. There is no other way but to accept. Ranchi, the capital of Jharkhand, is one of such the places. On the other hand, man's act may induce exposure. One example is going on in Jadugoda. Moreover, the aborigines prevented even from caste are having the exposure forced. The aborigines of Jadugoda were destroyed their life by depriving of their land. They were destroyed their health by becoming the laborers of a huge government enterprise. Moreover, radioactivity is thrown away into the place of their every-day life and they have been exposed further.

References

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