College of Science and Engineering

Nuclear Safety and Risk Seminar

on

Restoration from Fukushima Daiichi nuclear power plant accident

presented by

Prof. Keizo Ishii
Tohoku University, Japan

Restoration from Fukushima Daiichi nuclear power plant accident

2015, January 22 The City University of Hong Kong

"Decontamination of hot area in Fukushima"

Keizo ISHII
Tohoku University, Sendai Japan

Contents

1）Outline of the great japan east earthquake and Fukushima first nuclear power accidents

2）Outline of radioactive pollution due to Fukushima nuclear accident

3）Affect of radiation to the human health

4）Development of soil decontamination technology

5）Contamination of foods in Fukushima

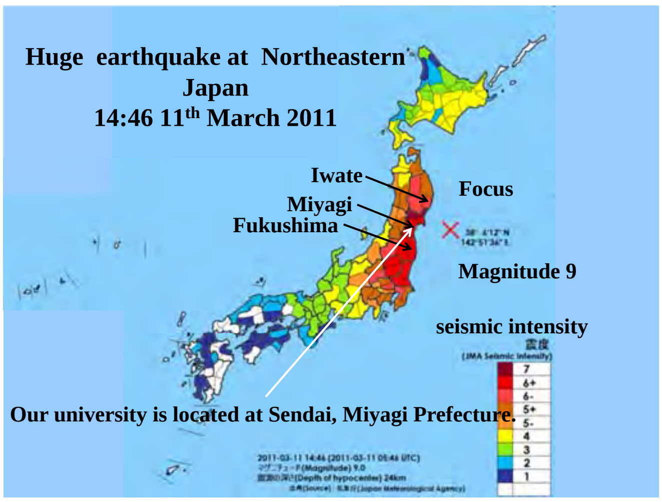
6）Development of radioactive inspection technology for contaminated foods

7）Conclusion

---

1. Outline of the great japan east earthquake and Fukushima first nuclear power accidents

---



Sendai station just after the earthquake

Platform of the Shinkansen broken by the intense shake.
The ceilings separated and fell.

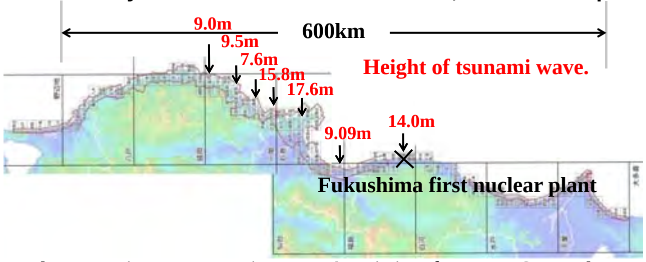
Our university was damaged very much.

3 buildings of departments of electric engineering, architecture and civil engineering, and materials science and engineering were broken and now renewed.

40 minutes after the earthquake, the big tsunami hit the northeast coast of Japan.

Tsunami destroyed all.

Area hit by the Tsunami of 11 March 2011, Northeast Japan



by Tsunami Damage Mapping Team, Association of Japanese Geographers

Scale of damage for Tohoku earthquake

death: 18,131 (Miyagi 10,365. Iwate 4,976. Fukushima 2,686)
missing: 2,829 (Miyagi 1,394. Iwate 1205. Fukushima 226)
complete destruction: 129,391
half destruction: 265,096
partial destruction:743,298
evacuees : 69,891
as of 28 September , 2012

Tsunami hit the Fukushima nuclear power plants .

Fukushima first nuclear plant

All electric power sources were lost and then nuclear fuels could not be cooled.

Tsunami just hit it.

March 12 2011, 15:00
No.1 reactor building hydrogen-exploded.
(From Fukushima central television)

March 14, 11:00
No.3 reactor building hydrogen-exploded.

(From Fukushima central television)

4 reactor buildings carried out hydrogen explosion.

March 12, 15:00
No.1 reactor

March 14, 11:00
No.3 reactor

March 15, 8:00
No.2 reactor

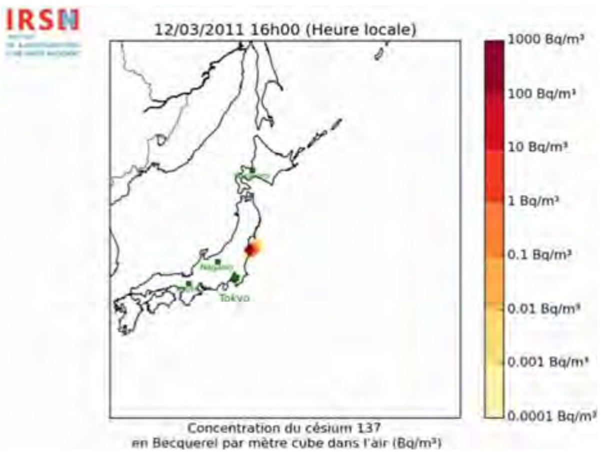
March 15, 9:00 ,
March 5:00,
No.4 reactor

(From Fukushima central television)

Present status of Fukushima nuclear power plants

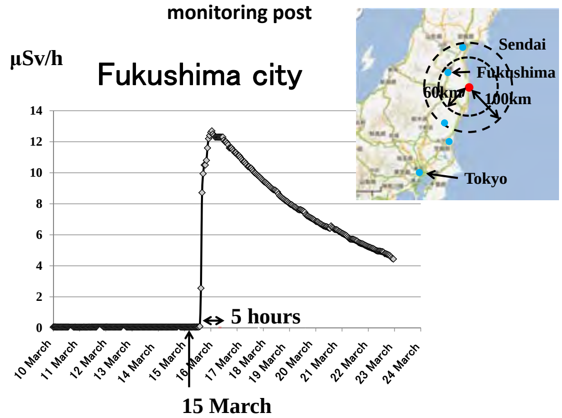
Now, we can visit the site and see many people who are working on clean up the nuclear plants. It is now carried out in a hurry but its accomplishment is considered to be after several ten years.

2. Outline of radioactive pollution due to Fukushima nuclear accident



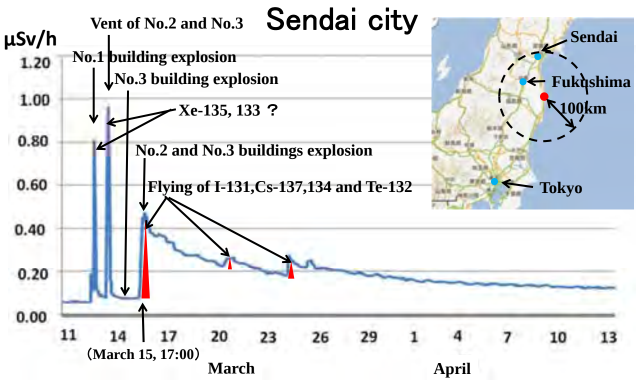
Flow simulation of cesium activity from the nuclear plants from March 12 to March 20 by IRSN(Institut de Radioprotection et de Surete Nucleare).

Dose rate of radiation at Fukushima medical university hospital monitoring post

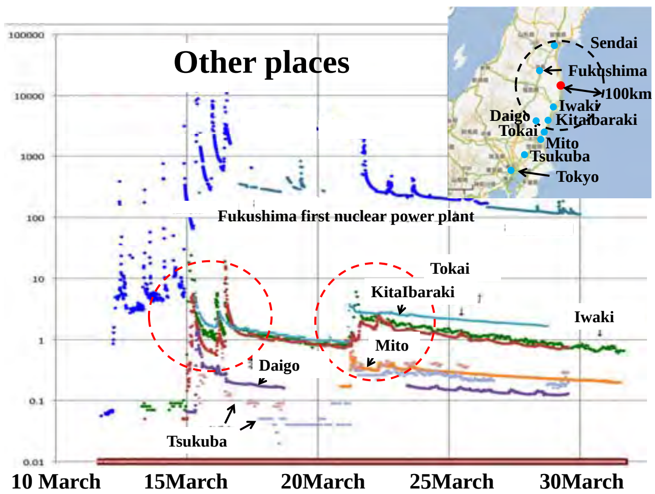


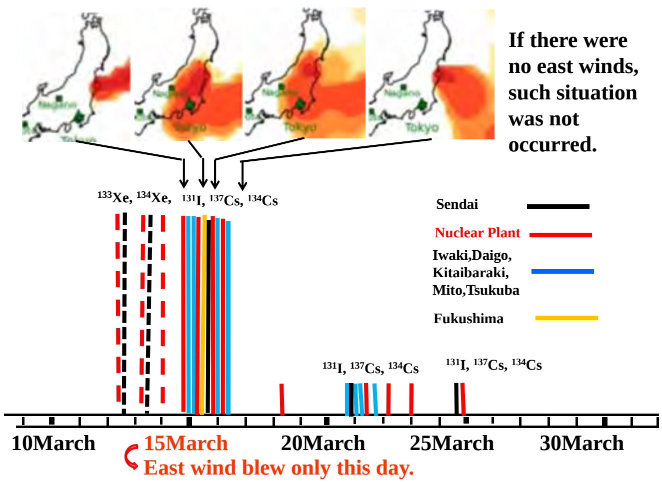
From Prof. Fumio Shishido, Fukushima medical university

Dose of radiation at Tohoku University hospital monitoring post

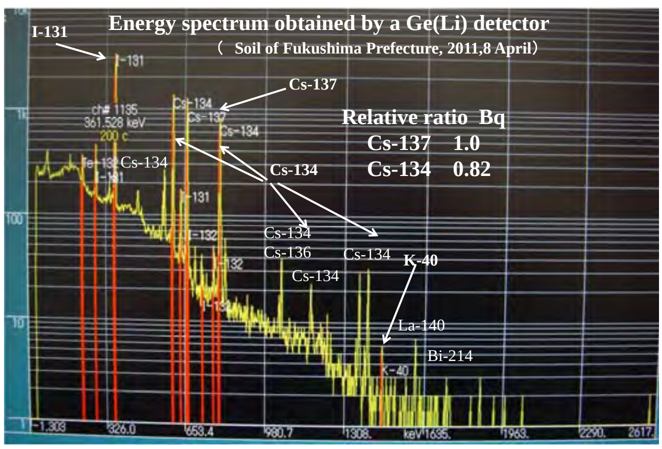


(The dose from the cyclotron of the hospital were deleted.)





If there were no east winds, such situation was not occurred.



Radioisotopes detected by Ge detector

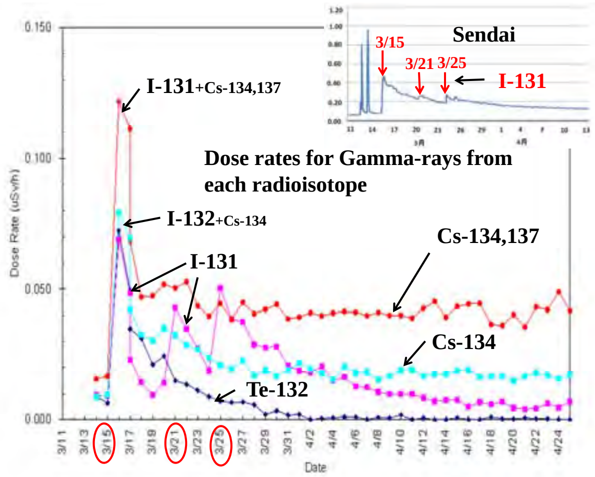
1. Cs-137 half life 30 years β-rays, γ-rays
2. Cs-134 half life 2 years β-rays, γ-rays
3. Te-132 half life 3 days β-rays, γ-rays
4. I-131 half life 8 days β-rays, γ-rays

I-131 of short life was a main component of space dose at the beginning, but, now, Cs is main.

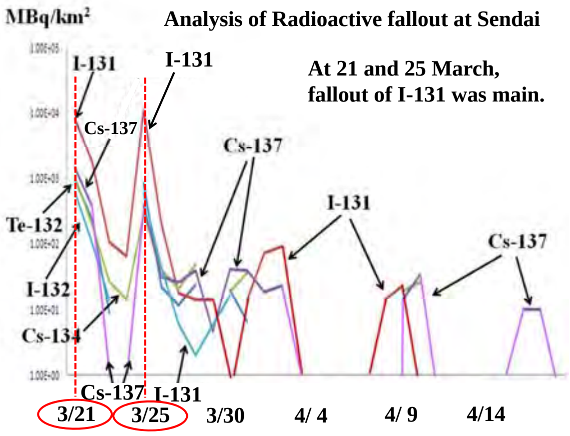
On the other hand, Sr-90 and Sr-89 were also generated by the nuclear reactor, but they do not emit gamma rays, therefore can not be identified. It seems that Sr-atoms were not released since this element has the high evaporating point.

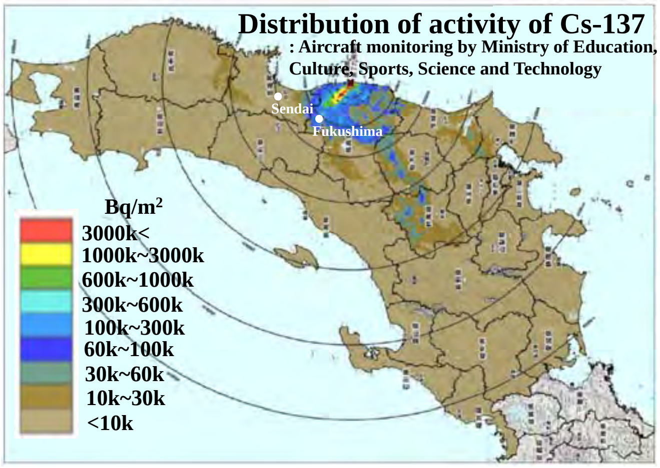
According to the measurement of the Ministry of Education, Culture, Sports, Science and Technology, Sr were detected a little.

	Sr-90 (half life 27.7years)	Sr-89（half life 50days）
	（Bq/kg）	（Bq/kg）
Fukushima City	77	54
Iidate-mura	120	1100

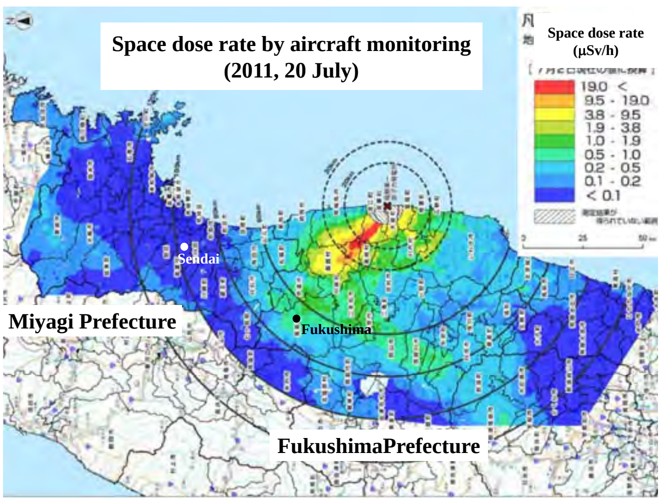


Analysis of Radioactive fallout at Sendai

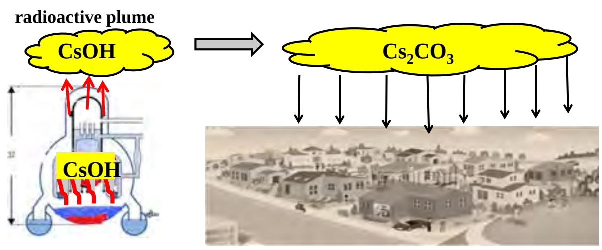




as of 5 November, 2011



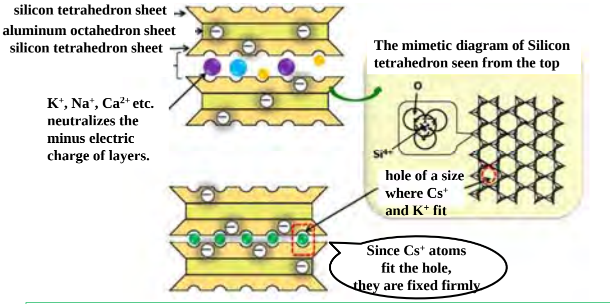
How was Fukushima contaminated ?



A fuel rod is uranium oxide (UO_2). When uranium fissions and cesium is made, cesium deoxidizes uranium oxide and turns into cesium oxide (Cs_2O). When fuel rods broke (namely meltdown), cesium oxide turned into cesium hydroxide (CsOH), and began to solve into water. From the nuclear reactors, they were splashed and dried, they became particulates, and diffused in the atmosphere. Cesium hydroxide turned into cesium carbonate (Cs_2CO_3) with carbon dioxide during drifting in the atmosphere. And they fell on towns in Fukushima in the evening of 15 March, 2011.

Cesium is firmly adsorbed by clay.

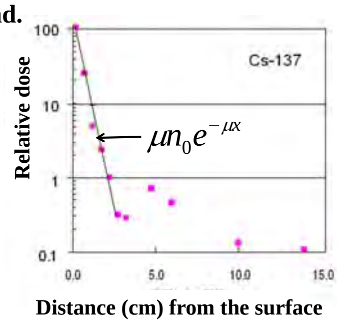
When cesium fell on the ground, 70% of cesium stuck to clay, and 30% stuck to ionic exchangers and macromolecules.
Clay consists of silicon tetrahedron sheets and aluminum octahedron sheets which overlap each other. Cs atoms replace K atoms in clay and are firmly fixed in the holes of tetrahedron sheets.



From Japanese Society of Soil Science and Plant Nutrition

Most radioactive cesium atoms are distributed on the surface of the ground.

Radioactivity is almost distributed over a thickness of about 5mm from the surface. Distribution is decreasing by the exponential function of the distance from the surface (expected theoretically.).



Therefore, most radioactive cesium atoms which fell on the ground, were adsorbed in clay.

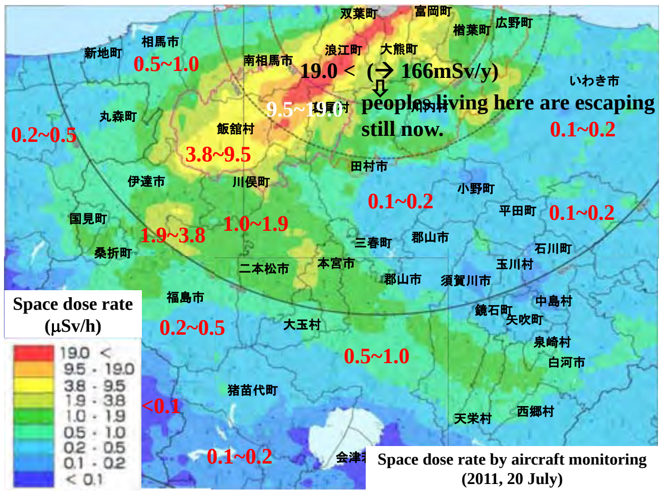
⇒ Space dose will decrease if the soil on the surface of ground is removed.

Character of the cesium fixed to clay

１． It does not dissolve in water.
⟶ Cesium is not contained in the tap water obtained by purifying the water of river

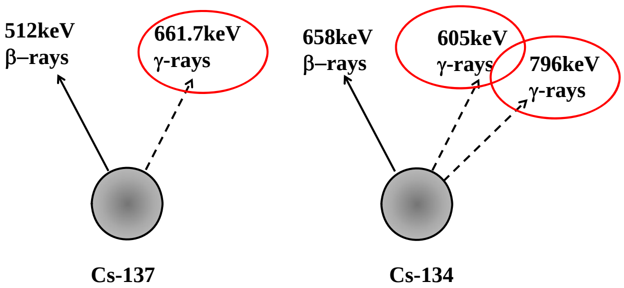
２． It does not dissolve into an acid or alkaline solution.
⟶ It is not absorbed in the body even if we eat Cs-clay.
⟶ It is excreted from the body with excrement.

３． Cesium atoms fixed to clay are not absorbed into the plant.



Space dose rate by aircraft monitoring (2011, 20 July)

Radiation from radioactive cesium



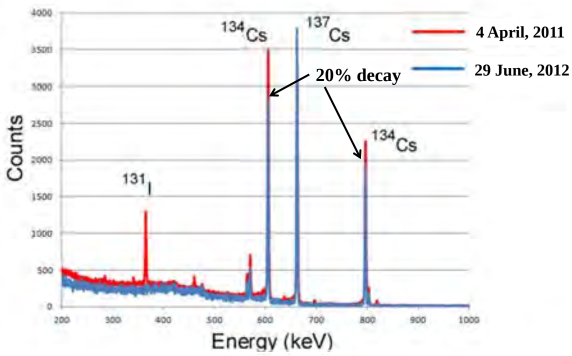
Half life 30 years　　Half life 2 years

Radioactivity ratio ~１ : １ at 11 March, 2011

After 4 years from June 2011, the space dose rate drops to about 1/2.

After 6 years from June 2011, the space dose rate drops to about 1/3.

Decay of activity of ^{134}Cs

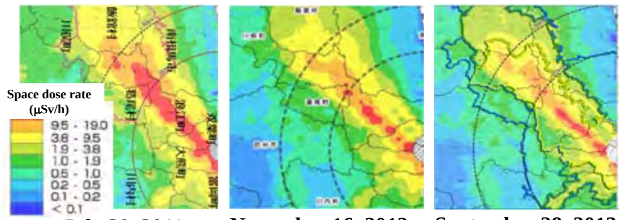


Gamma ray Energy spectrum of contaminated soil

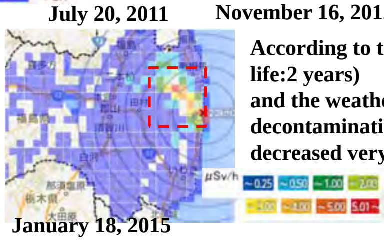
Reduction of space dose can not be explained by this effect.

Weathering effect

Time dependence of space dose rate at Fukushima



July 20, 2011 November 16, 2012 September 28, 2013



January 18, 2015

According to the decay of ^{134}Cs (Half life:2 years) and the weathering effect, the effort of decontamination, the space dose rate decreased very much.

A budget for the Project of Development of the remediation technology of the living environment contaminated with the radioactive material (2012～2022) was permitted by Japanese government.

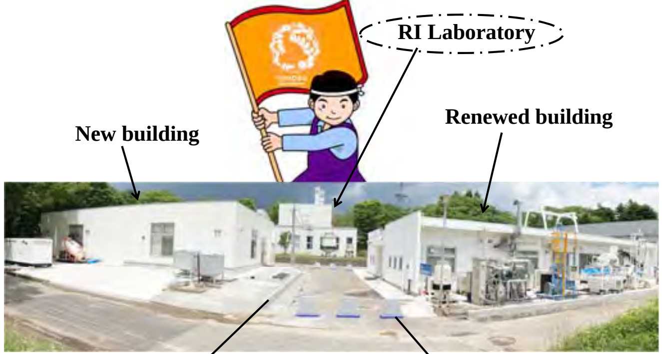
We established "Research Center for remediation engineering of living environment contaminated with radioisotopes" as an activity base of this project.

Effective utilization of an old institution : Cobalt 60 Irradiation laboratory

Fukushima Satellite of our center

Fukushima city radiation monitoring center

Our research organization towards remediation



Research center for remediation engineering of living environment contaminated with radioisotopes, Graduate School of Engineering, Tohoku University

Dynamitron Accelerator Laboratory

Peretron Accelerator Laboratory

Staffs of our center

Proper research staffs: 8
Keizo ISHII (Director), Hiromu ARAI, Toshiroh YAMAGUCHI, Hirotugu ARAI, Naoyuki OSADA, Tohru OHNUMA, Soudai TAKYU, Testuo MATSUYAMA

External research staffs from the department：5
Atsuki TERAKAWA, Shigeo MATSUYAMA, Seion KIM, Keitaro HITOMI, Mituhiro FUJIWARA

External engineer staffs from the department : 2
Kazuyoshi NAGAKUBO, Takao SAKURADA

Cooperation research staffs：2
Yuich NIIBORI, Akira HASEGAWA

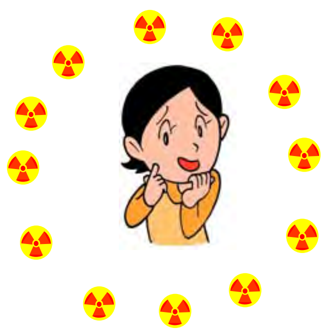
Clerks: 3
Yukutoshi UJIIE, Naomi KAWASHIMA, Mayumi UMEMIYA

Students:~10 Total ~30

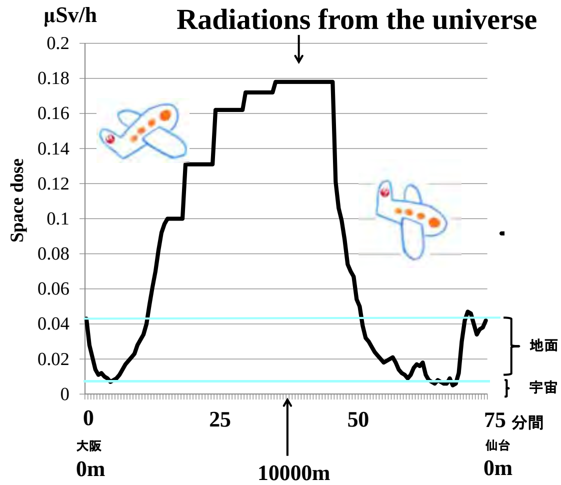
Cooperation : 14 Univ.

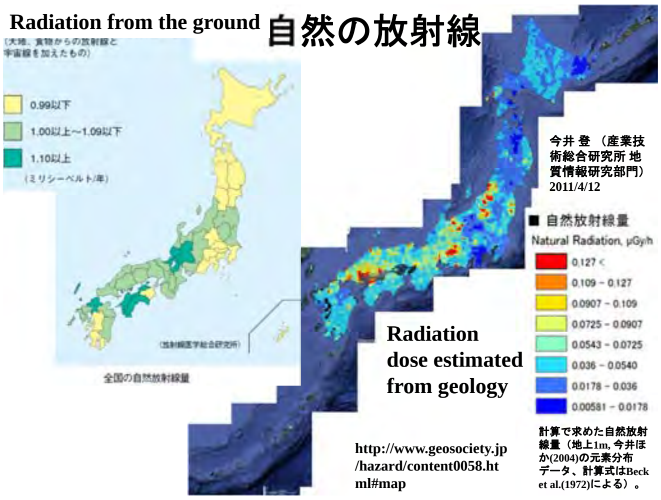
Hokkaido Univ., Tohoku Univ., Univ. of Tokyo, Tokyo City Univ., Tokyo Inst. of Tech., Tokai Univ., Nagoya Univ., Kyoto Univ., Osaka Univ., Kinki Univ.. Kobe Univ.. Fukushima Univ., Fukushima Medical City University of Hong Kong

3. Affect of radiation to the human health



Radiations are emitted from personal appearance.





Gamma rays from natural radioisotopes

1. ^{40}K 12.5×10^{8}years 1460keV
2. From daughter nuclides of ^{232}Th 140×10^{8}years
   ^{208}Tl 3 minutes 583keV,2610keV
   ^{212}Pb 10 hours 239keV
3. From daughter nuclides of ^{238}U 44×10^{8}years
   ^{214}Pb 26 minutes 352keV
   ^{214}Bi 20 minutes 609keV,1120keV,1764keV

Gamma rays from radioactive cesium nuclides

1. ^{137}Cs 30years 661keV
2. ^{134}Cs 2years 605keV,796keV

Contamination by natural radiation

Sources（２０１３ Dec.）	(mSv/year) effective dose
External exposure	
cosmic ray	0.3
From the earth	0.33
Internal exposure （Inhalation ingestion）	
^{222}Rn	0.37
^{220}Rn	0.09
^{210}Pb、^{210}Po（smoking）	0.01
^{238}U, etc	0.006
Internal exposure（Ingestion）	
^{210}Pb、^{210}Po	0.80
^{14}C	0.0025
^{40}K	0.18
total	2.09
Medical irradiation	＋ 2.25
Total effective dose	4.34

Comparison of the amount of natural radiation(μSv/h) in the world (from the 1993 U.N. National Science Board report etc.) (Guarapari Kerala 1982 report, Ramsar 1997)

Country Name	Average value (μSv/h)	Peak value (μSv/h)
Japan	0.049	0.14
China	0.062	0.342
Yangjiang	0.400	0.616
Hong Kongs	0.076	0.114
India	0.055	1.10
Kerala	0.433	4.00
Ramsar	1.16	29.7
Austria	0.042	0.152
Italy	0.057	0.500
Germany	0.054	0.433
Denmark	0.037	0.051
France	0.068	0.251
Ireland	0.041	0.180
Norway	0.072	1.20
USA	0.045	0.100
Guarapari	0.627	4.00

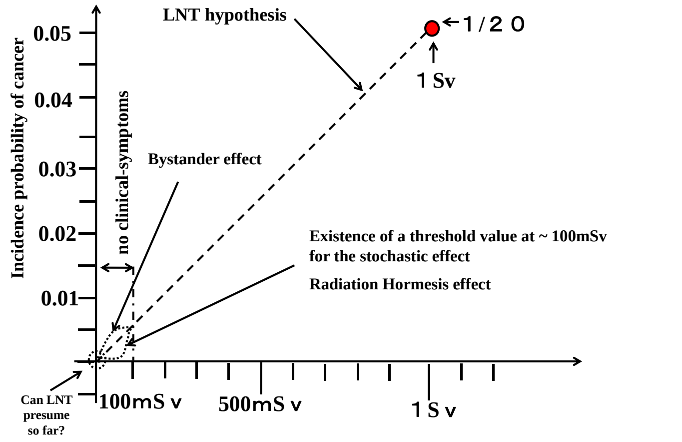
Affect of low dose exposure for health

The International Commission on Radiological Protection (ICRP) assumes "The effect of radiation exposure is deterministic or stochastic, therefore there is always a probability to get cancer and hereditary influence in proportion to exposure dose even any low doses (Linear-Non Threshold hypothesis : LNT) ".

Based on the data of the survivors of the atomic bombings of Nagasaki and Hiroshima (The probability to get cancer for the exposure dose of 1 Sv was 1/20.), as the additional exposure dose , ICRP advised a limit of 20mSv/y for the pursuer to not exceed the probability of 1/1000 par year and a limit of 1mSv/y for general public to not exceed 1/10000 par year.

There is no distinction between chronic exposure and momentary exposure in the LNT model. The affect by chronic exposure is smaller than by momentary exposure. When cells get damaged, they are restored by enzymes. Even if cancer cells are made, surrounding cells may disappear them. When a cell is damaged by *radiation*, it can send signals to bystander cells, which are the cells near the "hit" cell. The signals sent by the damaged cell may disrupt the normal function of it's neighboring cells (Bystander effect). Some people consider that there is a threshold value of around 100mSv for the stochastic effect. Furthermore, there is the hyposis of Prof. T.D.Luckey that small amount of the radioaction exposure promotes the health of a human body rather(the radiation hormesis effect).
These effects prevent the development of cancer cells.

We consider that the effect of low dose exposure will not be so serious.



We consider that the effect of low dose exposure will not be so serious.

Impact of radiation on the human Body

mSv/y

7000~10000 : 100% fatality rate if entire body exposed
1000 : Acute disorders such as vomiting and nausea, and clouding of vision
500 : Depletion of lymphocytes in peripheral blood
200 : Clinical symptoms have not been checked in a dose lower than this value.
100 : Lowest level at which health disorders have been attested
10 :Natural background radiation (annually) at Guarapari, Brazil
6.9 : Full-body CT scan
2.4 : Natural background radiation exposure per person (annual global average)
(Radioactivity from space 0.39, radioactivity from the ground 0.48, radioactivity from food 0.29, Radon exposure from the air 1.26)
1 : Maximum annual exposure for general public(excluding medical procedures)
0.6 : Stomach X-ray
0.2 :Tokyo-New York round-trip airplane travel
0.05 :Chest X-ray
Targeted annual radiation level for areas near light-water nuclear reactors

This 10 mSv / year can be considered as a safe and safty standard.

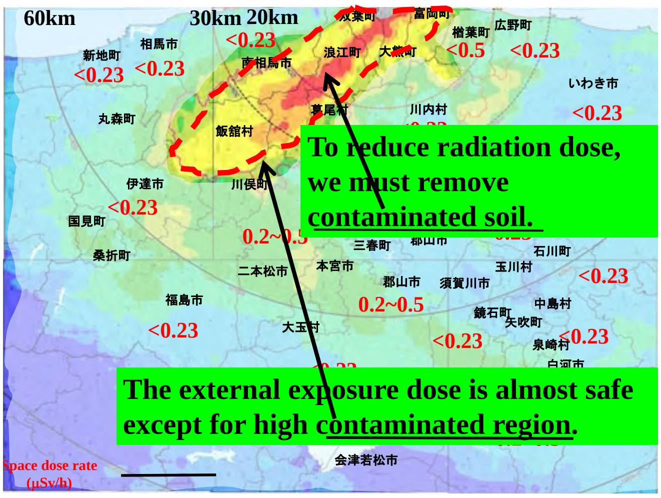
Source:"Genshi-ryoku 2010" (Nuclear Energy 2010) issued by the Japanese Agency for Natural Resources and Energy, and other materials

Guarapari Brazil 10mSv/year（natural radiation）

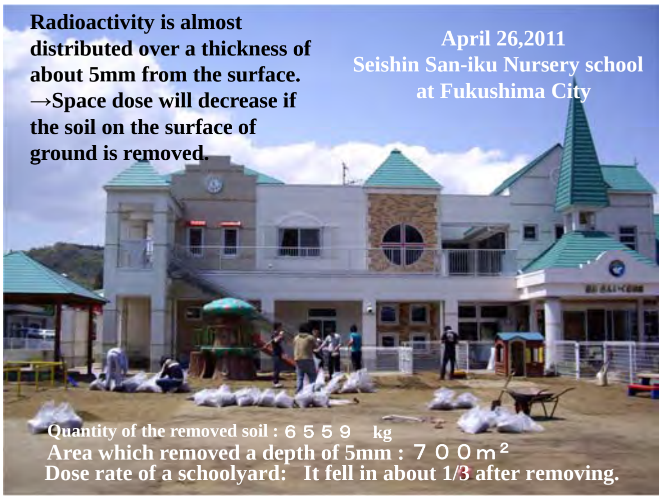
Area： ５９２ｋｍ²
Population： ～１１００００
Space dose rates：２.７ μSv/h at beach
Avearge １０ mSv/year
Radionuclide：^{232}Th (α-ray、γ-ray)

We measured here.

Guarapari Brazil



4. Development of soil decontamination technology



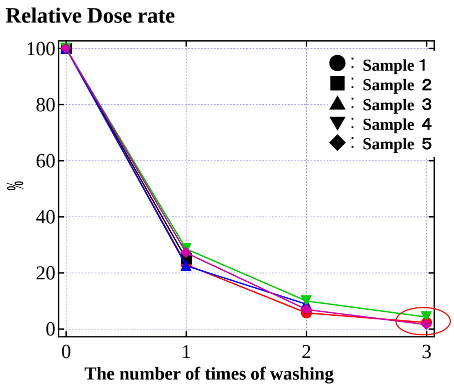
We washed the soil with the water and after 30 seconds took out it. We carried out this process three times. The activity of soil decreased 1/25.

Churning 5 minutes

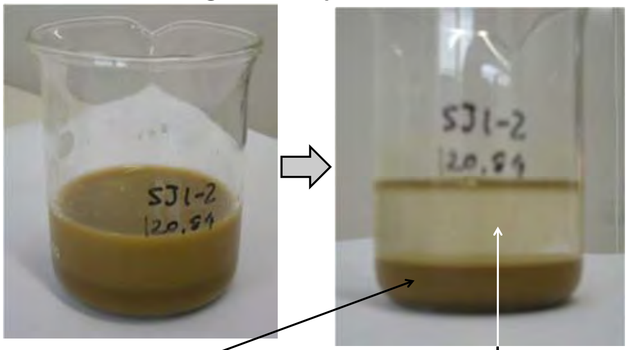
Filtration
210μm mesh
used

Washed soil

Decontamination effect of water washing of soil



Processing of Muddy water



After 15-minute, muddy water separates into water and clay.

The volume of contaminated soil reduced to 8/100.

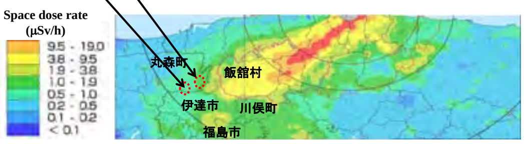
Radioactivity was not contained in the supernatant liquid which clay precipitated and was separated.

Practice of our decontamination method

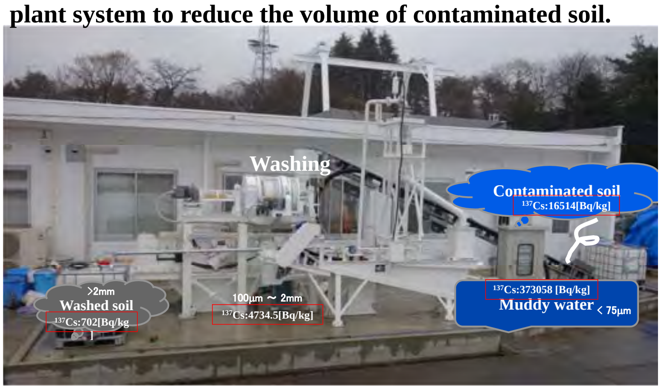
From June 29 to July 14

The schoolyards of two elementary schools in Marumori-cho and two nursery schools were decontaminated by our method.

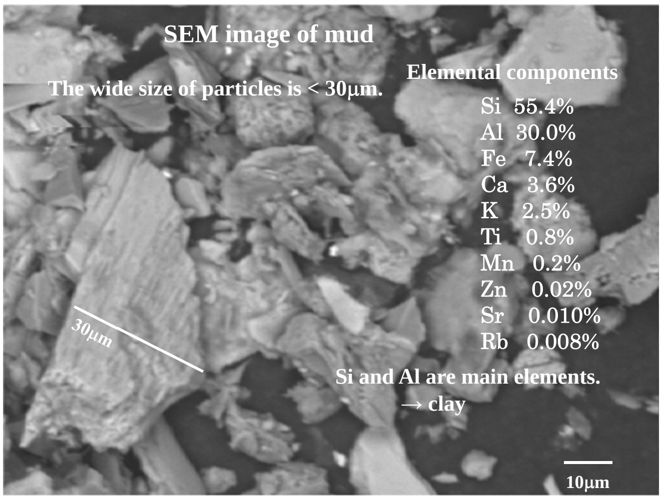
School name	Schoolyard area
Hippo elementary school	3,500㎡
Hippo nursery school	400 ㎡
Koya elementary school	2,500㎡
Koya nursery	400㎡



On the basis of this idea, we are now constructing a mini-plant system to reduce the volume of contaminated soil.



Clay is extracted from muddy water and is classified according to particle diameter with a centrifuge.



Mud, silt and clay are defined by the size of particle.

Mud < 1/16 mm (= Silt + Clay) <60μm

⇩

Silt 1/16 mm ~ 1/256 mm 4 ~ 60μm

⇩

Clay < 1/256 mm < 4μm

Kinds of clay

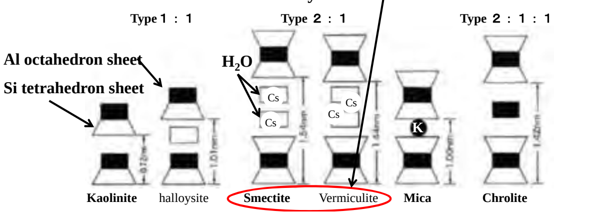
1:1 type argillite (kaolinite) : radioactive Cs atoms are not absorbed.

2:1 Type argillite :

Smectite and vermiculite : radioactive Cs atoms are well absorbed.

mica : radioactive Cs atoms are not absorbed because of occupation by potassium atoms.

Structures of clay



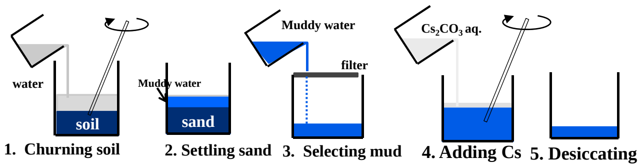
To develop the decontamination technique of soil, we research structures of contamination of Cs in silt or clay .
we make samples of soils contaminated with natural cesium solving cesium carbonate into muddy water.
And we investigate Cs distribution in the silt less than 60μm width with Micro-PIXE analysis.

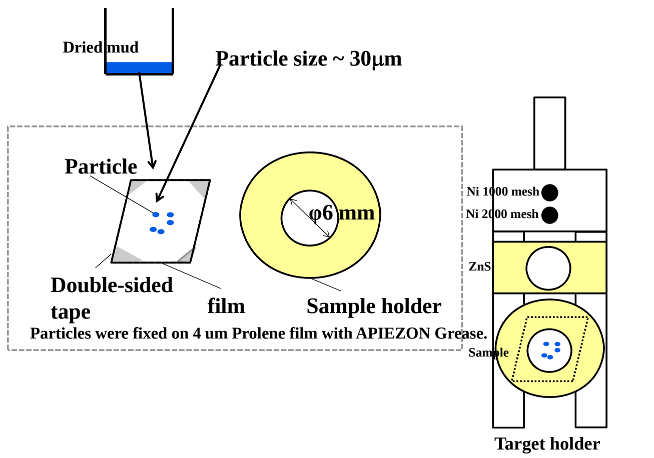
Preparation of Clay targets

We collected soil samples at 3 spots.

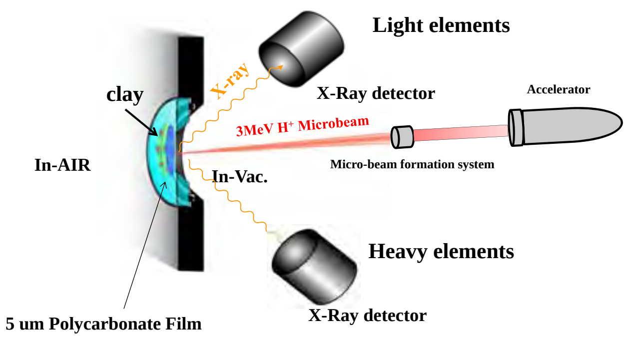
- **Rice field**
- **Vegetable field**
- **Mountain**

The soil samples were processed as follows





Maicro-PIXE analysis



Particle size ~30μm, main elements : Si, Al

Proton E=3MeV, Cs L-X-rays

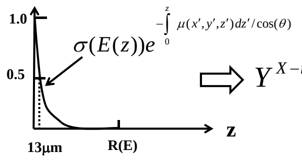
$$Y^{X-ray}(x,y) \propto \int_0^{Z_{max}} dz\,\rho(x,y,z)\sigma(E(z))e^{-\int_0^z \mu(x',y',z')dz'/\cos(\theta)}$$

$$\sigma(E(z)) \propto E^4(z)$$

$$R(E) \propto E^2, \quad R(E_0) = z + R(E) \rightarrow \quad E^2 \propto R(E_0) - z$$

$$\sigma(E(z)) \propto E^4(z) \approx const. \times (R(E_0) - z)^2$$

$$\left(\frac{\sigma(E(Z_{max}))}{\sigma(E_0)} (\approx 0.45) \times e^{-\bar{\mu}z} (= 0.35) \right) = 0.15 \quad \text{for } Z_{max}\text{~30μm}$$



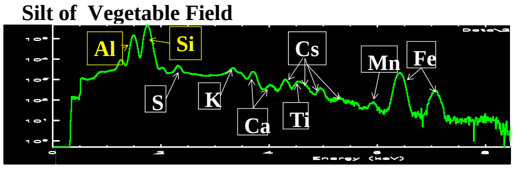
$$\Rightarrow Y^{X-ray}(x,y) \propto \rho(x,y,z_S)\sigma(E_0)\delta z$$

Z_s=surface position $\delta z \approx 13\mu m$

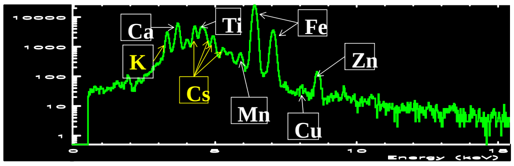
Projection data $Y^{x\text{-}ray}$ (x,y) reflects a surface distribution of sample.

Examples of *PIXE Spectra*

Silt of Vegetable Field



Detector for Low Energy X-ray (PGT LS10129)



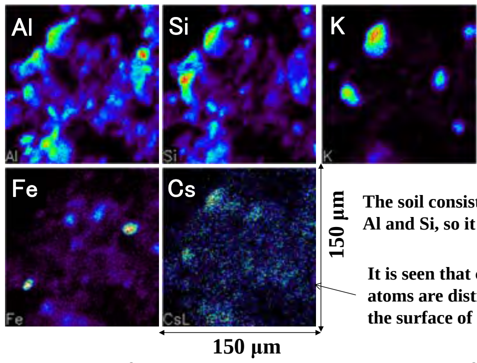
Detector for High Energy X-ray (PGT LS60148 with 200 um Mylar Film)

Experimental Condition

Particle : H^+
Beam Energy
: 3 MeV
Scanned Area
: 50 um * 50 um
Dose : [uC]

Obtained by TOHOKU

Elemental imaging by Micro-PIXE



The soil consists of mainly Al and Si, so it is clay.

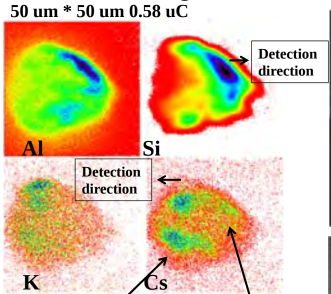
It is seen that cesium atoms are distributed on the surface of soil.

PIXE analysis is useful to research the decontamination method for contaminated soil. ⟶K.ISHII et al. The proceedings of PIXE 2013

Silt of Vegetable Field

PIXE Image obtained by TOHOKU

Proton 3 MeV Range:92 um
50 um * 50 um 0.58 uC

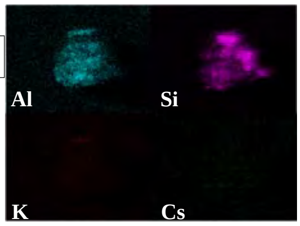


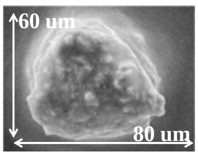
Vegetable field-1

Smectite or vermiculite kaolinite

EPMA-EDXRF

Beam Energy : 15 keV
Scanned Area : 80 um * 60 um



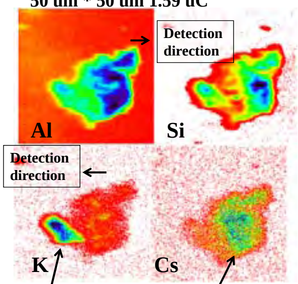


Secondary Electron Image

Silt of a Rice Field

PIXE Image obtained by TOHOKU

Proton 3 MeV Range:92 um
50 um * 50 um 1.59 uC

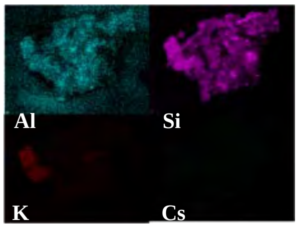


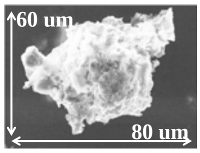
Rice field-1

mica Smectite or vermiculite

EPMA-EDXRF

Beam Energy : 15 keV
Scanned Area : 85.3 um * 64 um



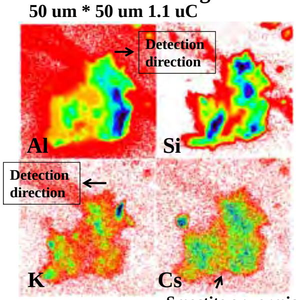


Secondary Electron Image

Silt of Mountain

PIXE Image obtained by TOHOKU

Proton 3 MeV Range:92 um
50 um * 50 um 1.1 uC

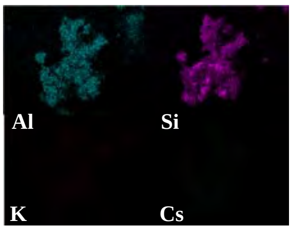


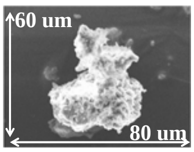
Smectite or vermiculite

Mountain -1

EPMA-EDXRF

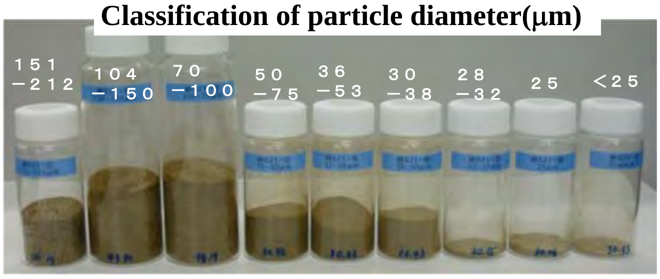
Beam Energy : 15 keV
Scanned Area : 128 um * 96 um

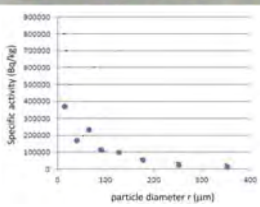




Secondary Electron Image

Classification of particle diameter(μm)





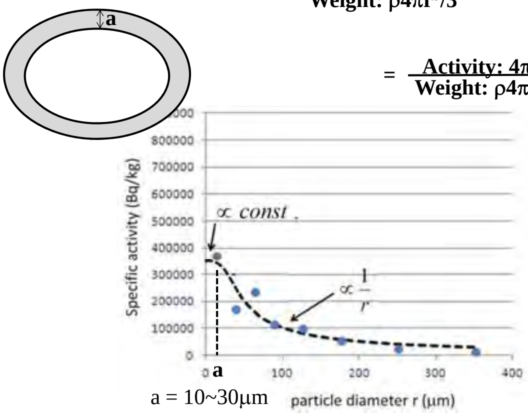
The specific activity depends on the diameter of particle.

Contaminated soil

Specific activity(Bq/g) $= \dfrac{\textbf{Activity: } 4\pi(r^3-(r-a)^3)/3}{\textbf{Weight: } \rho 4\pi r^3/3} \sim 3a/r \qquad r >> a$

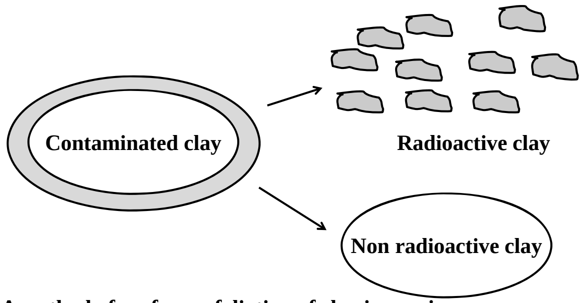
$4\pi(r^2 - ar + a^2/3)a$

$= \dfrac{\textbf{Activity: } 4\pi r^3/3}{\textbf{Weight: } \rho 4\pi r^3/3} \sim 1 \qquad r \le a$



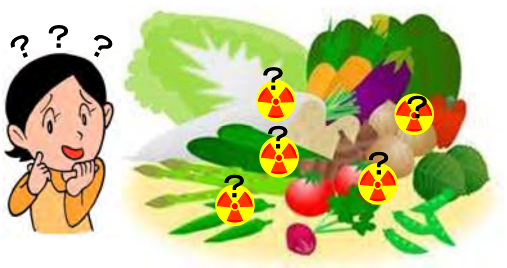
Radioactivity can be condensed by performing surface exfoliation of clay.

→ **Reduction of volume of contaminated soil**

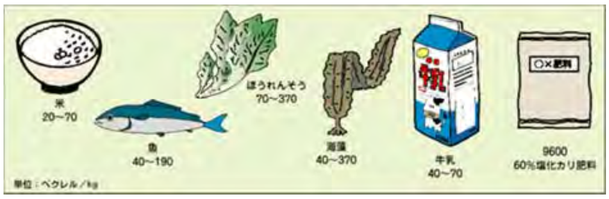


A method of surface exfoliation of clay is now in progress.

5. Contamination of foods in Fukushima



Natural radioisotopes in Food



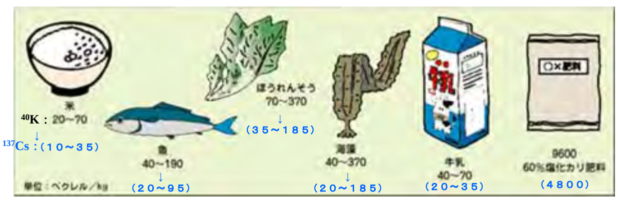
Concentration of ^{40}K in foods

^{40}K： Half life 12.8 ×10^8 years, 1.31 MeV β-rays (89%), 1.46 MeV γ-rays(11%)

Contamination by eating foods containing 40K is estimated 0.18 mSv/year.

出典:原子放射線の影響に関する国連科学委員会報告(1982)など

Safety standard for cesium radionuclide contamination in foods



出典:原子放射線の影響に関する国連科学委員会報告(1982)など

According to the conversion coefficient from Bq to Sv for ^{134,137}Cs and ^{40}K, the affect of 10 ~ 185 Bq/kg of ^{134,137}Cs to the health corresponds to that of 20 ~ 370 Bq/kg of ^{40}K.

Contamination of foods produced in East Japan

At the present, the control values of specific activity in Japan are 100Bq/kg for rice, vegetable, fishes and 50Bq/kg for water and milk. These values are just same as natural activity of K-40 in foods.

Tap water is below 1Bq/kg.
Almost all vegetables are below 1Bq/kg.
Almost all foods are below 100 Bq/kg.

However, foods exceeding 100Bq/kg are scarcely detected.
For an example, it is rice. Rice is a main food in Japan. At the present, all sacks of rice are checked by radiation detectors and the rice exceeding 100Bq/kg are not shipped to markets.

Screening for rice in Fukushima

Detection limit 25Bq/kg

1sack 30kg

2014 Year
Total 10,837,380 sacks
10,835,473sacks (99.98 %) < 25Bq/kg
1,893sacks (0.02 %) 25~50 Bq/kg
12sacks(0.0001 %) 51~75 Bq/kg
2sacks(0.00002 %) 76~100 Bq/kg
0sacks(0%) >100Bq/kg

2013 Year
Total 11,006,534 sacks
10,999,206sacks (99.93%) < 25Bq/kg
6,484sacks (0.06%) 25~50 Bq/kg
493sacks(0.004%) 51~75 Bq/kg
323sacks(0.003%) 76~100 Bq/kg
28sacks(0.0003%) >100Bq/kg

2012 Year
Total 10,346,074sacks
10,323,579sacks (99.79%) < 25Bq/kg
20,357sacks (0.20%) 25~50 Bq/kg
1,678sacks(0.016%) 51~75 Bq/kg
389sacks(0.0037%) 76~100 Bq/kg
71sacks(0.0007%) >100Bq/kg

Other foods in Fukushima

Results of monitoring

	2011	2012	2013	2014
	>100Bq/kg/total	>100Bq/kg/total	>100Bq/kg/total	>100Bq/kg/total
Cereals	3/607	10/2169	55/4428	2/2049
Vegetable fruit	145/6010	7/7264	0/5806	0/5630
Original milk	15/651	0/441	0/405	0/304
meat	0/5001	0/6310	0/4888	0/3387
egg	0/221	0/144	0/133	0/105
Grass and forage crop	162/773	48/1664	19/2368	11/1510
Marine product	227/3330	879/6037	237/8282	69/7505
Wild grass mushroom	127/922	90/1090	80/1377	24/1415
others	2/51	1./68	0/63	0/67

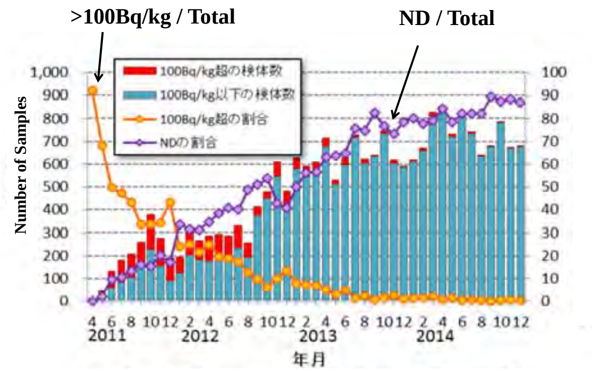
http://www.pref.fukushima.lg.jp/sec/36021d/monthly-report.html

Details

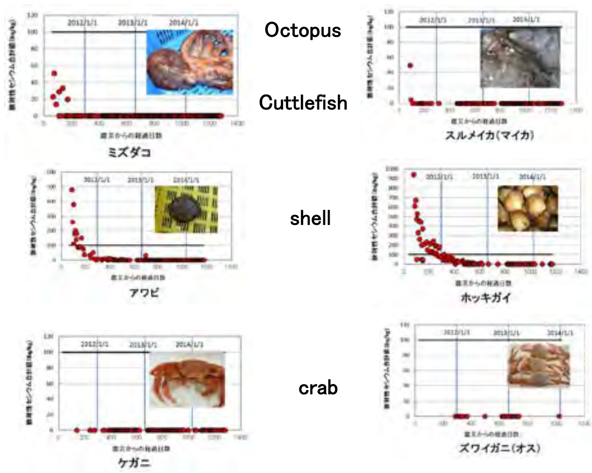
Agricultural products in Fukushima city
April 2014 ~November 2014

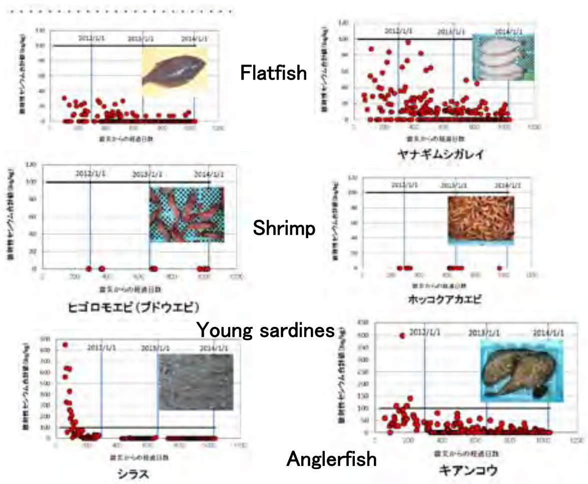
Classification	Sampling number /Ratio	134,137Cs (Bq/kg)					total
		0~20	20.1~30	30.1~50	50.1~100	100.1~	
Fruits	Sampling number	12,320	6	6	1	0	12,333
	Ratio	99.9%	0.05%	0.05%	0.01%	0%	100%
Vegetables	Sampling number	10,206	16	6	0	0	10,228
	Ratio	99.8%	0.2%	0.1%	0.00%	0%	100%
Mushroom Wild grass	Sampling number	317	5	5	1	0	328
	Ratio	96.6%	1.5%	1.5%	0.3%	0%	100%
total	Sampling number	22,843	27	17	2	0	22,889
	Ratio	99.8%	0.1%	0.1%	0.01%	0%	100%

Marine products:



http://www.pref.fukushima.lg.jp/uploaded/attachment/98528.pdf





2011	Sea urchin Sea cucumber	river lake	Culture	Seaweed
Sampling number	38	289	130	30
>100Bq/kg	20	125	3	20
Sampling number/ >100Bq/kg	52%	43%	2.3%	66%

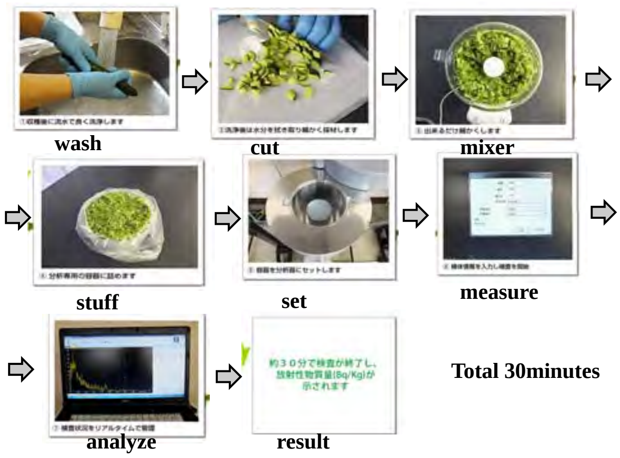
2012	Sea urchin Sea cucumber	river lake	Culture	Seaweed
Sampling number	68	542	177	29
>100Bq/kg	7	133	1	0
Sampling number/ >100Bq/kg	10%	24%	0.5%	0%

2013	Sea urchin Sea cucumber	river lake	Culture	Seaweed
Sampling number	98	479	139	26
>100Bq/kg	0	55	0	0
Sampling number/ >100Bq/kg	0.0%	11%	0.0%	0%

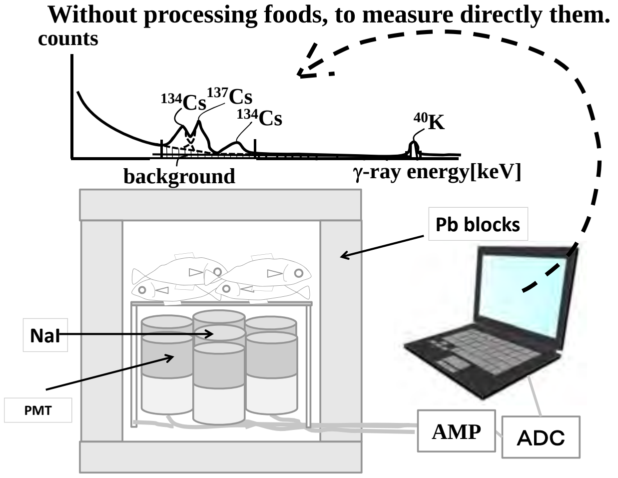
Activity of foods produced in forest are generally high.

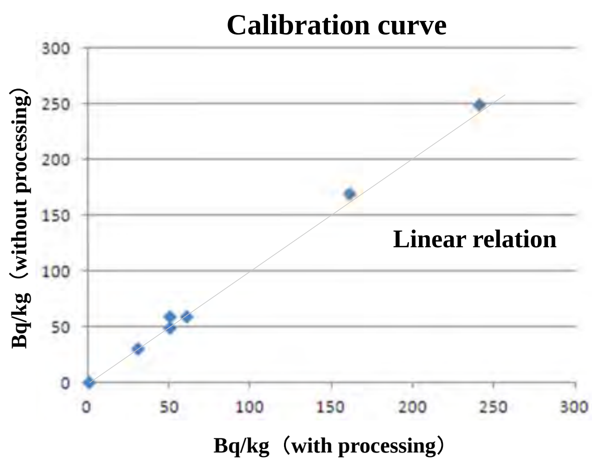
6. Development of radioactive inspection technology for contaminated foods

Usual method to examine the contamination in food



Without processing foods, to measure directly them.





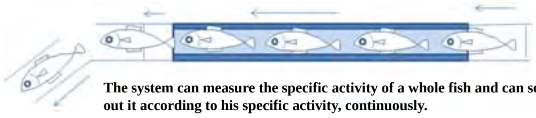
This system carries out at ten places in Fukushima

Measuring time: 5minutes,　Detection limit: 10Bq/kg

Now, it will produce commercially and sell by the company in Fukushima. (2.85 million Japanese yen)

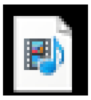
→ It contributes to reviving radiation measurement industry to Fukushima.

Continuous contamination monitoring system



The system can measure the specific activity of a whole fish and can sort out it according to his specific activity, continuously.

Ishinomaki harbor



ƒ^ƒPƒmƒRŒŸ

7. Conclusion:

For remediation of Fukushima, we are now developing the techniques of decontamination of soil, monitoring techniques for contaminated foods and seeking very low contaminated plants.

On the FIFA 2011 Women's World Cup Champions, Nadeshiko Japan taught us that, if we do our best without giving up, we can surely return Fukushima.