Japan Geoscience Union Meeting 2013
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MAG35-P01 Room:Convention Hall Time:May 21 18:15-19:30

Grasping changes in the sea bottom induced by the Tohoku earthquake using radionuclides

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Large seafloor faults, fissures and a landslide were confirmed in the sea bottom at the epicenter of the March 2011 Tohoku earthquake. Radionuclides were released into the environment by the associated accident at the Fukushima Daiichi Nuclear Power Plant (FDNPP). These flowed into the ocean and were eventually deposited in the seafloor sediments. By analyzing ^{137}Cs and ^{134}Cs radionuclides in the marine sediments from shore to open sea, we have been able to better assess the radioactivity scattered from FDNPP and understand the changes in the marine sediment induced by the seismic activity of the Tohoku earthquake. Marine sediment samples were obtained from offshore of Fukushima, the Japan Trench and the Shatsky Rise during the R/V *Hakuho-maru* KH-11-7 cruise in 2011. A non-invasive X-ray CT scanner was used to obtain images of the internal structure of the sediment. Further, sediment samples were sliced from the sediment core every 0.5-2.0 cm and the radioactivity of the Gamma ray nuclide was measured using a Ge semiconductor detector. ^{137}Cs and ^{134}Cs in the sediment from offshore Fukushima and the Japan Trench were detected. Through analysis of the ratio of ^{134}Cs/^{137}Cs, it was suggested that most ^{134}Cs was derived from FDNPP. However, the result showed that it had no influence on the environment by FDNPP through detecting the ^{134}Cs in the sediment of open sea. Abundance of ^{137}Cs and ^{134}Cs was different between the most surface layer of the sediment and the whole sample, so it was necessary to analyze the whole sample when evaluating the environment radioactivity in the research area. Focusing on vertical profiles of ^{137}Cs and ^{134}Cs, higher abundance was detected in the surface layer, however high abundance was also detected in the subsurface layer. In addition, it was suggested that the classify of detailed marine sediment changes can be divided into the following three types: I) formation of turbidite by principal earthquake (11 March 2011); II) formation of turbidite by principal earthquake and aftershock; III) formation of turbidite several times by principal earthquake and aftershock.

Keywords: radioactiv cesium, assess the radioactivity, marine sediment change

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MAG35-P02 Room:Convention Hall Time:May 21 18:15-19:30

The distribution of radioactive strontium in coastal area of Fukushima Prefecture, Japan

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At National Institute for Environmental Studies, Japan, cryogenically archived environmental samples in Environmental Time Capsule Program can be utilized for a retrospective study of an environmental pollutant. In March 2011, radioactive strontium (Sr-89 and 90) was accidentally released from Fukushima Dai-ichi Nuclear Power Plants (NPP), Japan, to both atmospheric and marine environments, similar to radioactive cesium. Although it has been considerably interested in abundance and dynamics of radioactive strontium in environment, they have been poorly understood. In this study, we determined the distribution of radioactive strontium in coastal environment of Fukushima Prefecture based on analyzing Sr in the collected bivalves.

Field sampling was performed at coastal area of Ibaraki Prefecture (Oarai town), Fukushima Prefecture (Iwaki city, Hirono town, Minamisoma and Soma city), Miyagi Prefecture (Ishinomaki city), and Aomori Prefecture (Higashidori village) from June to August 2011 and in May 2012. Soft tissue of bivalve samples was digested using nitric and hydrochloric acid at 180 degree C. Seawater sample was concentrated by carbonate precipitation, and then the precipitates were dissolved in nitric acid. Separation of strontium from these digested and concentrated samples was performed using crown ether resin. Radio activities of Sr-89 and 90 and radioactive yttrium (Y-90) were measured by low background gas flow counter.

Sr-90 activities of bivalves in 2011 were decreased with increasing the distance from NPP. The highest Sr-90 activity of the measured bivalves in 2011 was 0.17 Bq/kg at Hirono town, approximately 23 km south from NPP. Ratios of Sr-90 concentration between bivalves and seawater were 2.9 at Iwaki city, 48 km south from NPP, and 1.2 at Soma city, 37 km north from NPP. This indicates a relatively high tendency of bioconcentration of Sr-90 in bivalves. Sr-90 / Cs-137 activity ratio of bivalve was 0.0008 - 0.0015 in each sampling site of Fukushima Prefecture. Overall, our results suggest that concentration of the Sr-90 tended to be higher at south and near NNP site as well as Cs-137. Sr-90 actives of bivalves in 2012 also tended to be higher at south than north sites from NPP, but lower than that in 2011. Sr-90 / Cs-137 activity ratio of bivalve was 0.017 at Hirono town and 0.011 at Iwaki city in 2012. These results show the decrease of Sr-90 of bivalve from 2011 to 2012 and the difference in residence time between Sr-90 and Cs-137 in bivalves. Consequently, our results suggest that radioactive strontium derived from Fukushima Dai-ichi NPP in coastal area of Fukushima Prefecture was distributed to the south, probably as a result of the southward direction of oceanic current.

Keywords: Radioactive strontium, the Fukushima accident, Bivalve

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MAG35-P03 Room:Convention Hall Time:May 21 18:15-19:30

Transfer of fallout radiocaesium from catchment to coast in the region impacted by the Fukushima nuclear accident

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There is considerable concern about redistribution of radiocaesium from catchment soils to the coastal zone via river networks in the region impacted by the Fukushima Daiichi Nuclear Power Plant accident. This poster reports the magnitude of fluvial transfer of Cs-134 and Cs-137 through river networks located across the fallout region from June 2011 to present. Data from 30 sites provide a regional-scale measure of fallout radiocaesium transfer by river networks to the coastal zone. Study catchment areas range from 8 to 5,172 square kilometers and span a large range in average radioceasium catchment inventories based on MEXT inventory mapping. Flow and turbidity (converted to suspended sediment concentration) were measured at river gauging stations (n=30) while bulk suspended sediment samples were collected at regular intervals using time-integrated samplers to allow measurement of Cs-134 and Cs-137 activity concentrations by gamma spectrometry. Preliminary data explore the relationship between catchment inventory and sediment activity concentration. In the context of high resolution river monitoring data, this permits exploration of the interplay between suspended sediment loads and levels of contamination on the total flux and regional-scale variability of transfer to the coastal zone.

Keywords: Fukushima, sediment flux, radiocaesium, rivers

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MAG35-P04 Room:Convention Hall Time:May 21 18:15-19:30

About the configurationality of catchment area unit and ChIbarakiTo Plume

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A lot of radioactive materials were emitted by the Fukushima Daiichi nuclear disaster in March, 2011.Those of them; Cs-134 and Cs-137 have comparatively long half-life cause the radioactivity geo pollution in the east Japan. In fact, it is not explained completely how to spread, move and absorb cesium. However, it seems that there is a certain law of nature. That is to say, we should measure radioactive materials according to the law of generation (decay), movement, deposition and take necessary actions under the Katori- Narita-Itako Declaration of IUGS GEM (IUGS-GEM, 2011).

We followed this declaration and have continued measurement by use of RT-30 and RT-50(both of made by GEORADIS). This paper describes the bit of the answer from the result to distribution and the form of the radioactive geo pollution in the Pleo-Kantoh Great Depth submarine Basin.

Keywords: Cesium-134, Cesium-137, radioactive geo pollution, Fukushima Daiichi nuclear disaster, ChIbarakiTo Plume

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MAG35-P05 Room:Convention Hall Time:May 21 18:15-19:30

Change of the Radioactive Material Pollution in the Kanto District

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A large quantity of radioactive material was released by an accident of the Tokyo Electric Fukushima first Nuclear Power Plant with the East Japan great earthquake disaster of March 11, 2011 and pour into the outskirts, and a hotspot (the point where a radiation dose resists locally) has occured in a part of the away far-off Kanto district, and it is a very serious problem. It was brought mainly by the rain of March 21, and the radiation hotspot of the Kanto district is observed over the belt-shaped range of South Ibaraki, Northwest Chiba, and East Tokyo.

The radiation dose of the garden soil of the apartment complex first floor with Kashiwa-shi equal to the heartland of the hotspot of the Kanto district was 42,000Bq/m^2 on April 18. This is bigger than a value in Gomel of Belarus that suffered great damage by Chernobyl nuclear plant accident of 1986, and it corresponds to a management area or the refuge area. In June, the radiation dose of the soil precisely was measured with a plastic scintillator, and recorded 13,000 Bq/kg. In addition, an energy spectrum of the radiation dose was analyzed with a Ge semiconductor detector. The main nuclide was ^{141}I (half-life: 8 days), ^{143}Cs (half-life: 2 years), and ^{147}Cs (half-life: 30 years).

In a part of the Kanto district, area distribution of the radiation dose was measured with GPS linked dosimeter on a car, automatically. As a result of having clarified a change of the distribution of a half year by comparison of the measurement of the winter (from January to March in 2012) and the summer (from July to September in 2011), the radiation dose had decreased.

Furthermore, dose of radioactivity in seven places of the apartment in Kashiwa-shi every three months were measured. The dose of radioactivity was fell down by winter in 2011 and did not change too much afterwards. It is thought that radioactive material which attached to dust moved and spread, and faded away by rain and wind. But it is reported that the radioactive material is concentrated on another place. A more unpredictable situation continues.

I wish to thank Dr. Takeshi Saito, Dr. Zolotoukihina Tatiana, Mr. Noriaki Tanabiki, and Dr. Tadayuki Takahashi.

Keywords: Radioactive Material, Pollution, Kanto District

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MAG35-P06 Room:Convention Hall Time:May 21 18:15-19:30

Detailed monitoring of transfer of 137Cs at the hillslope scale by in situ HPGe spectrometry and landsurvey

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This study takes place after the Fukushima Daiichi Nuclear Power Plant disaster of March 2011, which was triggered by the Tohoku earthquake and the tsunami that followed. A large amount of radionuclides was released in the environment and settled in the form of fallout that contaminated the underlying soil. To provide a rapid assessment of the soil contamination and its potential redistribution, intensive scientific monitoring has been conducted since July 2011 in our study site, located in the Yamakiya district of Kawamata town, in the Fukushima prefecture, 37 km North-West from the crippled power plant.

At the hillslope scale, the main radiocesium movements are expected to occur via the redistribution of soil, namely erosion and deposition. As such, understanding erosion processes at the highest possible resolution allows for a better understanding of the fate of radiocesium.

Inside a 5 m x 22 m bounded hillslope plot, we deployed multiple innovative monitoring methods in addition to the measurements of runoff volumes and sediments radiocesium concentrations. Each major rainfall event was followed by a large number of spatially-distributed in situ gamma spectrometry measurements. The method is calibrated outside of the study plot using manual, high resolution, depth sampling (slices of 2 mm) of the soil and laboratory gamma spectrometry. From this calibration, maps of the radioactivity and soil redistribution can be constructed at the meter resolution.
In 2011 and 2012, several high resolutions Digital Elevation Models were acquired with a terrestrial laser scanner to assess the surface topography changes. After processing, and although the precision of the final DEMs (˜2mm) is not enough to precisely identify and quantify the soil losses for a short interval of time, these DEMs do provide some information about the potential erosion and deposition sites.

Finally both methods permitted to observe physical processes of soil redistribution at the (big) rainfall event scale, including interrill and rill erosion, as well as local deposition and remobilization phenomenon. They provide information on the erosion spatio-temporal variability and the associated radionuclides transfers.

Keywords: 137Cs, Erosion, HPGe spectroscopy, Laser scanner, radiocesium, Fukushima

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MAG35-P07 Room:Convention Hall Time:May 21 18:15-19:30

Deposition of radioactive materials in Iwate Prefecture, due to the Fukushima Nuclear Power Plant accident

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A catastrophic earthquake occurred on March 11, 2011, and the tsunami it triggered caused severe damage along the Pacific coastline of northeast Japan. The tsunami also caused an accident at Fukushima Dai-ichi Nuclear Power Plant (FNPP), resulting in the release of a massive amount of radioactive materials all over northeast and central Japan. MEXT, Japan, carried out several airborne monitoring surveys. However, it is not possible to determine the distribution of material deposited with low-level radioactivity of less than 0.1 micro Sv/h from airborne monitoring surveys. Radioactive materials have been detected in Iwate Prefecture in farm and livestock products, making it necessary to understand the accurate contamination status in this region.

Behavior of radioactive material is very similar to that of ashfall from volcanic eruptions. Therefore, it is possible to apply techniques from volcanology to the evaluation of the natural radiation dose. The author carried out detailed contamination mapping across Iwate Prefecture.

The results have already been released on the Internet (http://www.poly.iwate-pu.ac.jp, in Japanese), and more than 35,500 people have accessed it thus far. They use the survey results as a hazard map for radiation doses.

Keywords: The Great East Japan Earthquake, Fukushima Dai-ichi Nuclear Power Plant accident, Iwate prefecture, Radioactive materials, diposition

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MAG35-P08 Room:Convention Hall Time:May 21 18:15-19:30

Dynamics of radiocesium in terrestrial water at headwaters

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We investigated behavior of radiocesium in terrestrial water in headwaters, Yamakiya district, Kawamata town, Fukushima prefecture. We observed radiocesium concentration, stable isotopes, inorganic solutions, and CFCs concentrations of the rain water, soil water, groundwater, spring water and stream water, leading to the result that transfer of the radiocesium in the terrestrial water was very low.

Keywords: terrestrial water, hydrological cycle, radiocesium

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MAG35-P09 Room:Convention Hall Time:May 21 18:15-19:30

Release of Radionuclides from Natural River, Abukuma as Suspended Particulate Matter into Pacific Ocean

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Most of radioactive material released from Abukuma River Basin, one of the largest stream near the contaminated zone of Fukushima, flowing most of the contaminated plane zone then flow into the Pacific Ocean, are in the suspended particulate form, being estimated more than 90 % in the upper stream and 70 % near the river mouth. Most of radionuclides in particulate form are still trapped bottom sediment in the middle of the basin, however we find that significant amount are released during the heavy precipitation event. We also found that, at hydrological extremes the total loading increase more than 1000 times higher than the normal stream condition. The total flux of radiocesium into the Pacificic Ocean estimated at the Iwanuma Station from 10 August 2011 to 10 May 2012 become 9.11 Terabecquerel during 274 days for Cs-137, and 6.81 Terabecquerel during 274 days for Cs-134.

Keywords: Radionuclides, River transport, Ocean, Suspended particulate matter, Flux

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MAG35-P10 Room:Convention Hall Time:May 21 18:15-19:30

Mat-forming cyanobacteria effectively decontaminate radioactive cesium

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The accident at the Fukushima I Nuclear Power Plant released radioactive cesium around the plant. The cesium was trapped in fine surface soil (< 0.125 mm in diameter); particularly, the soil from the ground surface to a 1 cm depth was seriously polluted (Yamanishi *et al*., 2012; Inagaki *et al*., 2012). The following three points are thought to be important for decontamination of the cesium: 1) fixation of the polluted soil to its original area, 2) removal of the soil and 3) continuation of decontamination. From a Geological perspective, bacterial mat formation often sustains sedimentary structure. So, we aimed to develop a decontamination technique by artificial formation of bacterial mats, specifically cyanobacterial mats. In this study, we formed artificial cyanobacterial mats and measured ^{137}Cs concentration of the mats and the residue of soil separated from the mat. The used soil was gathered from the Planned Evacuation Area in Kawamata, Fukushima. The soil was divided to fine (< 0.125 mm) and coarse (0.125 ? 1 mm). We placed both types of soil with a depth of about 5 mm on the dish and tried to form a cyanobacterial mat on the soil. We used three filamentous cyanobacteria. The incubation was carried out at 25 degree centigrade, dark : light = 12 h : 12 h cycle. The formed mat was dried and peeled from the soil, was washed by distilled water to the extent that the soil did not separate from the mat, dried it again and then measured ^{137}Cs concentration using a germanium semiconductor detector in Kinki University Atomic Energy Research Institute. The residue soil of the final wash was also measured.

After a 2-month cultivation, we got cyanobacterial mats of 1 - 2 mm thickness. The mat covered the entire surface of the dish soil. The strength of the peeled mats differed between cyanobacterial strains. Measured ^{137}Cs concentration was very high in all samples: 180 ? 380 Bq/g in the fine soil and 70 ? 600Bq/g in the coarse. The ^{137}Cs concentration of the residue soils was 90 ? 240 Bq/g in the fine and 5 ? 19 in the coarse. As for almost all the residue soils, the ^{137}Cs concentration was decreased from the control soil. ^{137}Cs removal ratios, calculated from the ^{137}Cs concentration of the control soil and residue soils were 45 - 54 % on the fine soil and 30 ? 50 % on the coarse. Both ^{137}Cs concentration and removal ratios differed between cyanobacterial strains. In comparison with all measured ratios, the removal ratios were significantly higher with the fine soil compared with the coarse, for the ratios were thought to depend on the surface size of the particles of the soil. The ^{137}Cs concentration ratios calculated from ^{137}Cs concentrations of the mats and the residue soils were 1.3 ? 53. These ratios were equal to or higher than the ratios reported from higher plants (Dushenkov *et al.*, 1999). Thus, our results demonstrate that cyanobacteria efficiently decontaminated radioactive cesium. Particularly, the efficiency of the fine soil decontamination should be effective in the phytoremediation of the paddy fields.

Keywords: cyanobacteria, phytoremediation, radiocesium, decontamination, bacteria mat, Fukushima I NPP

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MAG35-P11 Room:Convention Hall Time:May 21 18:15-19:30

Radio-cesium accumulation during decomposition of leaf litter accelerated by fungal grazers

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Vast forest area in eastern Japan has been contaminated with radio isotopes by the Fukusima NPP accident. Most of the area is covered by deciduous broad leave forests and some parts are conifer plantation forests. The forest floor in deciduous forests, and canopy of evergreen forest were most contaminated by fall out. Radio-cesium is known to stay bioavailable in forest ecosystems for long time, and it is necessary to terminate the cycling process to decontaminate the forest ecosystem. Ecological process to recycle radio-Cs in forest ecosystem should be studied to enhance decontamination of radio-cesium. Mushrooms (fungi) have been know to show high concentration of Cs. Although mushroom biomass in a forest ecosystem is small, fungal mycelium in detritus and soil is large, thus fungi contain substantial amount of radio-Cs. It is well known that concentration of some nutrients, such as nitrogen and phosphorus, increase, whereas potassium decreases during the leaf litter decomposition. We observed radio-Cs concentration of leaf litter during decomposition on a forest floor where radio-Cs (134+137) contamination was ca. 100 kBq/kg. We put 16 g (dry weight) of newly fallen mixed deciduous leaf litter (half of which was oak, Quercus serrata) into 25 cm x 25 cm litter bag in a deciduous forest about 50 km from Fukushima NPP. Coarse (2 mm) and fine (0.2 mm) mesh size bags were prepared to detect soil invertebrate effects on litter decomposition. Fresh litter 137-Cs concentration was ca. 3,000 Bq/kg in December 2011. During the decomposition process on the forest floor, litter 137-Cs increased exponentially and exceeded 10,000 Bq/kg after 6 months, indicating that Cs and K show contrasting dynamics during early decomposition phase. Increase in fungal biomass in the early stage of litter decomposition was observed. Therefore, this upward movement of Cs from humus and soil layer suggests fungal translocation of nutrients from outside of litter substrate. The litter in the coarse mesh showed higher concentration of Cs, therefore Interaction between fungal species and grazing effect on fungi by fungivorous invertebrates will enhance the translocation of radio-Cs from soil to decomposing litter.

Keywords: Fukushima Daiichi Nuclear Power Plant, radio-cesium, forest ecosystem, fungi, soil animals, decomposition system