Learning environmental dynamics research in river basin

—Students experienced field investigation and analysis in river—

Japan Atomic Energy Agency (JAEA) conducts internships (summer vacation training: hereafter referred to “training”.) every year during summer vacation for university students, graduate students and college students. In the Environmental Analysis Group (located in the Fukushima Prefectural Centre for Environmental Creation, Miharu Town), Fukushima Environmental Evaluation Research Division, Collaborative Laboratories for Advanced Decommissioning Science (CLADS), Sector of Fukushima Research and Development, JAEA, the training has been conducted on the theme of the investigation on the behavior of radioactive cesium in the environment of Fukushima Prefecture.

In 2021FY, eleven students participated in this training. Among them, three students of University of Tsukuba Graduate School, and each one student of Meiji University Graduate School, Osaka University Graduate School, Saitama University Graduate School, and Tokyo City University participated in the training on the theme of the investigation of radioactive cesium in rivers from August 2 (Mon) to August 6 (Fri), 2021. In the training this time, for the measures against infection of new coronavirus, the students made the records on the body temperature and the action histories from two weeks before the beginning of the training to one week after the training. In addition, the

students wore masks, and kept a distance each other during the training. In this way, the training was held “under new life-style”, like the training in last year.

Preparation before the training

First, the orientation was held before starting the training on the field investigation in rivers (hereafter referred to “field investigation”). In the orientation, the students learned the background of the research in the training, the purpose of the field investigation, and the working procedures. For the necessity to conduct the field investigation safely, the students learned the measures against heatstroke, bees, and snakes. In addition, the students learned how to predict in advance where the potential dangers are, that is, the “danger prediction activity (KY activity)”, in conducting field investigation. After that, measurement instruments in the center and the past research results were explained to the students. Through the lectures, the students were able to deepen understanding for the instruments to be used and the contents of the training.

The students seemed to be particularly interested in the explanation about the currently ongoing “FaCE!: Fukushima Comprehensive Environmental Information Site”. In this site, the data and the results of research and development obtained by the field investigation in rivers etc. are summarized, and its contents can be used by the general public and specialists.

One of the pages of “FaCE!S”.

Field investigation in the river


Students collecting sediment in river basin.

The field investigation was conducted in the Ukedo river, Namie Town, Fukushima Prefecture. For safety, the students conducted the investigation while wearing helmets and work clothes such as long sleeves and long pants, and taking appropriate breaks. The students were divided into two groups, and considered where radioactive cesium is distributed in the river, based on the knowledge obtained in the orientation. Then, they collected and brought back soil, sediments and river water in the river basin for the analysis on the next day.


Students collecting river sediment.

From pretreatments to analysis

Students working on pretreatments.

For the samples that were collected in the field investigation and brought back, the students performed the pretreatments such as “filtration” and pulverization, according to each analysis. After that, radioactive cesium and the concentration of other elements in the samples were measured by a Ge semiconductor detector[*1)], and an ICP-MS and ICP-MS/MS[*2)]. In the analysis by the ICP-MS/MS, extremely small amount of contamination down to ppt level (one trillionth) can be detected, so the students carefully treated the samples so as not be contaminated.

Students observing samples by digital microscope.

Further, after selecting characteristic minerals based on the observation by a digital microscope[*3)], the students analyzed the elemental composition in the minerals using electron probe microanalyzer (EPMA)[*4)]. For sediments, they also measured the characteristics of the minerals using an X-ray diffractometer[*5)].

Looking back the training

After analyzing the data, the students summarized the training reports on the experimental results and discussion in each group, and made presentation for each group. In the presentation, there was a report on the adsorption property of cesium on minerals, obtained by the investigation of cesium distribution in the river. After the presentations by the students, the staff of JAEA described their impression about the training, and made advices as to the other elements that should be focused on from the analytical results in considering the distribution of radioactive cesium. Then, discussions continued as time allowed.

After the training, two students responded to the interview, and described about their impressions and future plans.

—Mr. Satoshi Inose, Meiji University Graduate School

“In the university, I am investigating the dynamics of radioactive cesium in Tamagawa River. But our university does not have analytical instruments such as ICP-MS/MS. Therefore, the obtained data were fresh for me. It was a valuable experience for me to be able to actually analyze using the instruments of JAEA. In addition, I could experience the research atmosphere in JAEA. My will to become a researcher had become stronger.”

—Mr. Satoshi Iguchi, University of Tsukuba Graduate School

"In the university, I am studying the migration of soil containing radioactive cesium in forests. I participated in this training in river because I thought the training would be new experience for me. I could learn the methods that can directly analyze solids without pretreatments. I think that I will utilize these methods for my future study. In addition, I was able to broaden my horizons through the exchange with the researchers and the students."

The CLADS, JAEA will enhance the program of the training based on the training results such as the opinions by the students who had participated in the training, and will continue developing human resources that will bear the future. Furthermore, we will promote the research and development for the environmental restoration of Fukushima.

【Terminology】

***1) Ge semiconductor detector**

A radiation detector using semiconductor. It is an instrument that measures the concentration of radioactive materials.

***2) ICP-MS and ICP-MS/MS**

ICP-MS is the abbreviation of Inductively Coupled Plasma Mass Spectrometry. In an ICP-MS, Inductively Coupled Plasma (ICP) that is produced by applying a high frequency electric power to argon gas is used as an ion source. Nebulized liquid sample is introduced to the ICP, and the elements in the sample, which are ionized by the plasma, is separated/detected by a mass spectrometer (MS). Since only one mass spectrometer is used in this measurement, the ionized components are directly detected by the mass spectrometer. Therefore, it is sometimes difficult to analyze molecules, or multiple nuclides with the same mass.

On the other hand, an ICP-MS/MS (right photograph) is an instrument where two mass spectrometers are connected in series. In the first mass spectrometer, the specific ions are selected, and they are collided with inert gas. Then, the ions to be analyzed are separated by the second mass spectrometer, and their masses are analyzed. Using an ICP-MS/MS, the accuracy in sample analysis is expected to be improved for molecules, or multiple nuclides with the same mass.

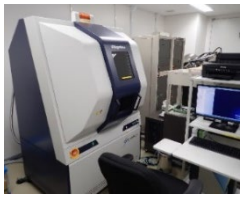
***3): Digital microscope**

A microscope equipped with a digital camera. In a general microscope, a sample is observed with the naked eye by looking into the eyepiece. On the other hand, in a digital microscope, a sample can be observed by projecting a larger image on a monitor through the digital camera. Therefore, many people can observe a sample at the same time, so it has an advantage that the information sharing is easy.

***4) Electron Probe Micro Analyzer (EPMA)**

An analytical instrument that can observe surface structure/ morphology and analyze elements in a localized region at micrometer order, by irradiating finely focused electron beam on the surface of a solid sample in vacuum. It is indispensable instrument to analyze the micro parts of many solid samples such as metal materials, geological minerals, ceramics, electronic materials, semiconductor materials, polymer materials, foods, and biological samples.

***5) X-ray diffractometer**



An instrument where X-rays are irradiated on a sample, and the composition of minerals in powder sample such as soil is analyzed from the angle of the scattered X-rays. It is used in investigating the composition of minerals in samples with relatively high radioactive cesium concentration among soil and sediments in river systems. From the result of the investigation by an X-ray diffractometer, the minerals that strongly absorb radioactive cesium and move radioactive cesium in river systems can be specified. Thereby, the results can be utilized to estimate the migration behavior of radioactive cesium in environment.

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