Frequently Asked Questions for USGS Publications:

Fission Products in National Atmospheric Deposition Program Wet Deposition Samples Following the Fukushima Dai-Ichi Nuclear Power Station Incident, March 8 - April 5, 2011
U.S. Geological Survey Open-File Report 2011-1277, 2011, 34p., Gregory A. Wetherbee, Timothy M. Debey, Mark A. Nilles, David A. Gay, and Christopher M.B. Lehmann.

Wet Deposition of Fission-Product Isotopes to North America from the Fukushima Dai-ichi Incident, March 2011, Environmental Science and Technology, **doi**:10.1021/es203217u, March 6, 2012, Gregory A. Wetherbee, David A. Gay, Timothy M. Debey, Christopher M.B. Lehmann, and Mark A. Nilles.

More information:

USGS - wet deposition of fission product isotopes to North America:	http://bqs.usgs.gov/fukushima/
USGS - precipitation chemistry monitoring and research program:	http://water.usgs.gov/ntn/
National Atmospheric Deposition Program:	http://nadp.isws.illinois.edu/

What is radioactive fallout?

Radioactive fallout is the deposition of radioactive materials that descend from the atmosphere onto the earth’s surface. In precipitation (rain, sleet or snow) samples, radioactive fallout, or wet deposition, is the product of the concentration of the radioactive element in picoCuries per liter (pCi/L) and the amount of precipitation. This deposition is commonly expressed as Becquerels per square meter (Bq/m^2).

What is radioactive decay and what is meant by radioactive half life?

Radioactive decay is the process by which the unstable nucleus of an atom disintegrates and releases radiation.

Half-life is the time any substance takes to decay by half of its original amount. Radioactive half-life is the time required for a quantity of a radioactive element to decay by half. For example, because the half-life of iodine-131 (^{131}I) is about 8 days, a sample of ^{131}I that has 10 pCi of activity on January 1, will have 5 pCi of activity 8 days later, on January 9. After ten half-lives, a radioactive material will have less than 0.1% of its original amount. For more information, see http://www.bt.cdc.gov/radiation/glossary.asp

How long does the radioactive fallout identified in this study persist in the environment?

Iodine-131 is an important radioisotope of iodine and is formed as a product of nuclear fission. It was a significant contributor in the first weeks in the Japanese nuclear crisis. Iodine-131 has a radioactive decay half-life of 8.02 days.

Cesium-137 (^{137}Cs) is a radioactive isotope, like Iodine-131, that is formed as a product of nuclear fission. It has a half-life of about 30.17 years. Its half-life makes it the principal medium-lived fission product along with strontium-90 - both are responsible for most of the radioactivity of spent nuclear fuel during the period of several years to several hundred years after the fuel was stopped being used. Cesium-134 (^{134}Cs) also is produced directly as a fission product from nuclear fission. Cesium-134 has a half-life of 2.06 years.

Can particles all the way from Japan really make it to North America?

Gases and small particles (in liquid or solid form) can be transported very long distances in the atmosphere. Many agencies and organizations worldwide detected radioactive fallout in air and precipitation in the days and weeks following the Fukushima Dai-ichi nuclear power facility incident and major explosions on March 12 and 14, 2011. This includes regions very far away from the facility in Japan, such as over North America and even across Europe. Radioactive fallout in areas far from the source of the release can be detected and quantified by analyzing environmental samples, including precipitation. It is estimated that it took 18 days for the radioactive particles to circle the earth.

Who conducted the study?

The U.S. Geological Survey (USGS) led the study design, laboratory analysis and report preparation, with participation by scientists from the National Atmospheric Deposition Program (NADP) Program Office of the Illinois State Water Survey, part of the Prairie Research Institute at the University of Illinois. The precipitation samples were obtained from NADP, which consists of over 100 federal, state, and local agencies and organizations, including the USGS, which have worked together to monitor precipitation chemistry throughout the United States since 1978.

Why was the study done?

This project was implemented to add to the body of knowledge about radioactive fallout from the March 12-14, 2011 incident and to test the capabilities of the NADP in response to an unexpected atmospheric release. The USGS, in partnership with the NADP, have monitored the chemistry and deposition of chemical compounds in precipitation in North America for several decades at several hundred locations. Utilizing the extensive NADP network to obtain precipitation samples precipitation amount, the USGS provided cost effective observations of the radioisotope activities and deposition (radioactive fallout) in precipitation over North America from 167 NADP sites. These sites are in locations that are not monitored by any other organization. This is the second time samples from the NADP network have been used to measure radioactive fallout, the first being after the Chernobyl reactor failure in 1986. This network and specialized USGS analytical expertise provides additional national capabilities to gather important information following these kinds of disasters should one occur in the future.

What did you find?

The study found concentrations and fallout (deposition) of radioactive iodine and radioactive cesium in precipitation samples collected in the United States directly after the nuclear incidents on March 12 and March 14, 2011. Detectable quantities of Iodine-131 and Cesium-137 and Cesium-134 were observed at 21% of the locations where precipitation was sampled, during the sampling period from March 15 to April 5, 2011. Concentrations of I-131detected in 5 samples ranged from 29.6 to 1090 picocuries per liter (pCi/L). Concentrations of Cs-134 detected in 23 samples ranged from 0.4 to 55 pCi/L. Concentrations of Cs-137 in 33 samples ranged from 0.70 pCi/L to 39 pCi/L. Radioactive iodine and radioactive cesium are often some of the largest contributors to people's radiation doses after an accident at a nuclear reactor. The analytical techniques used were not capable of detecting strontium-90 in NADP precipitation samples.

What parts of the United States received radioactive fallout after the nuclear incidents in Japan?

Detections and measurable deposition of fallout via rainfall was observed primarily at NADP sites located along the West Coast of the US, the central Rocky Mountain region and northern Great Plains, the central and upper Mississippi River Valley and eastern mountainous regions ranging from Virginia northward through Vermont. Deposition was also observed at NADP sites in Alaska.

Are the levels you found harmful to humans?

The USGS does not set health standards or determine likely human health effects. The U.S. Environmental Protection Agency (USEPA) is a regulatory agency that makes human health determinations. The Nuclear Regulatory Commission and U.S. Department of Energy also evaluate radiation dose to humans. The USGS/NADP results, like those reported by USEPA RadNet, found Iodine -131, Cesium-134 and Cesium-137 in some precipitation samples analyzed and at similar levels.

According to the USEPA, in reference to levels of Iodine -131found in RadNet samples; "While the levels in some rainwater samples exceeded the applicable Maximum Contaminant Level (MCL) of 3pCi/L for drinking water, it is important to note that the corresponding MCL for iodine-131 was calculated based on long-term chronic exposures over the course of a lifetime 70 years. The levels seen in rainwater were expected to be relatively short in duration."

For more information from the EPA regarding RadNet radiation monitoring following the Fukushima incident, please visit: http://www.epa.gov/japan2011/rert/radnet-data-map.html

How is this study different from U.S. Environmental Protection Agency (USEPA) studies that also measured radioactive fallout from the Fukushima incident?

The USEPA "RadNet" is a national network of monitoring stations that regularly collect air, precipitation, drinking water, and milk samples for analysis of radioactivity. This network has the emergency fast-response analysis and reporting capability for the nation and has 40 sites for monitoring precipitation, nearly all of which are located in or near major US urban areas.

In contrast, the USGS/NADP study utilized sites from the much larger 250 site NADP National Trends Network and 100 site NADP Mercury Deposition Network. The USGS/NADP was limited to the analysis of precipitation and analysis of the filter materials used routinely in the network to remove insoluble particles larger than 0.45 microns from the precipitation samples. The USGS/NADP study did not analyze dry deposition (which is material that deposit to the earth's surface when precipitation is not occurring) for radioactive fallout. The NADP samplers have a precipitation-activated lid that covers the sampler when it is not raining or snowing to ensure that only precipitation is collected in the sample container. Many NADP sites are located away from major urban areas so that they are more representative of the US landscape as a whole. This study is complimentary to the RadNet results, and together these data will allow for a better picture of the deposition of radioactive fallout across the United States.

Why is the USGS measuring this?

The USGS is the lead federal agency for the monitoring of wet atmospheric deposition (chemical constituents deposited from the atmosphere via rain, sleet, and snow) in the United States. The USGS provides: 1) leadership and participation in the NADP and 2) research and assessment to evaluate the effects of atmospheric deposition on ecosystems. USGS has analytical capability to measure gamma-emitting radioisotopes. The USGS, (as well as many other NADP participating agencies) have conducted numerous other special studies utilizing NADP samples as needs and opportunities have arisen over the past three decades. This latest study is an example of the added-value capabilities that can be derived from long-term, national scale environmental monitoring networks.

Is it possible for radioactive fallout to occur without precipitation?

Radioactive fallout can occur as dry deposition, without the presence of precipitation. Dry deposition fallout tends to produce lower concentrations of radioactivity than precipitation fallout. Dry deposition fallout also tends to concentrate the radioactive material on vegetation while precipitation fallout tends to concentrate the radioactive material on the ground surface.

Has this USGS/NADP monitoring network ever been used to measure radioactive fallout in the past?

Following the 1986 Chernobyl nuclear disaster, NADP provided precipitation samples to the U.S. Department of Energy.

Could this network be used for this purpose in the future? Does USGS/NADP have adequate capability to measure radioactive fallout if another disaster happens?

Using the lessons learned from this study, the USGS/NADP is now even more prepared to a respond to disasters in the future. The USGS nuclear reactor research facility in Lakewood, CO has capabilities for the detection, identification and analysis of radionuclides in environmental samples by gamma spectrometry analysis to support research studies such as this. However, the USGS/NADP network does not have real-time or fast-response emergency reporting capabilities. The USGS/NADP first response in this incident and in any future incidents was/is to offer assistance (such as providing precipitation samples) to US agencies that do have real-time or faster response duties and reporting capabilities.

The earthquake in Japan happened in March. Why is this report just coming out now?

Utilizing both the extensive NADP network to obtain U.S. precipitation samples and the analytical capabilities of the USGS TRIGA nuclear reactor research facility in Lakewood, CO, the USGS provided cost effective observations of radioactive fallout in precipitation over North America from 167 NADP sites. USGS/NADP detected and quantified radioactive fallout at 21% of these locations. This study modified existing NADP protocols and existing NADP and USGS capabilities. Data analysis and quality assurance for this kind of study requires careful review before the data are validated and finalized. Several more months are then required for publication preparation, scientific peer review and final report and article preparation. The objective of this study was to document the fallout of fission product radionuclides from much more extensive network of sites and be complimentary to what was available from emergency networks that produced fast-response information closer to the time of the incident.

What is the status of USGS publications on detection of fission products in US precipitation from NADP sites?

A USGS Open File Report, containing the basic study data and a summary of study finding has been prepared and released as an online publication on February 21, 2012. Also on February 21, an interpretive article on the findings was published on-line in Environmental Science and Technology (ES&T), a peer-reviewed scientific journal. This journal article is in the March 6, 2012 print edition of ES&T. A USGS news release was distributed at the time of on-line publication of the report and article.

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