Distribution and origin of highly radioactive microparticles in Fukushima revealed

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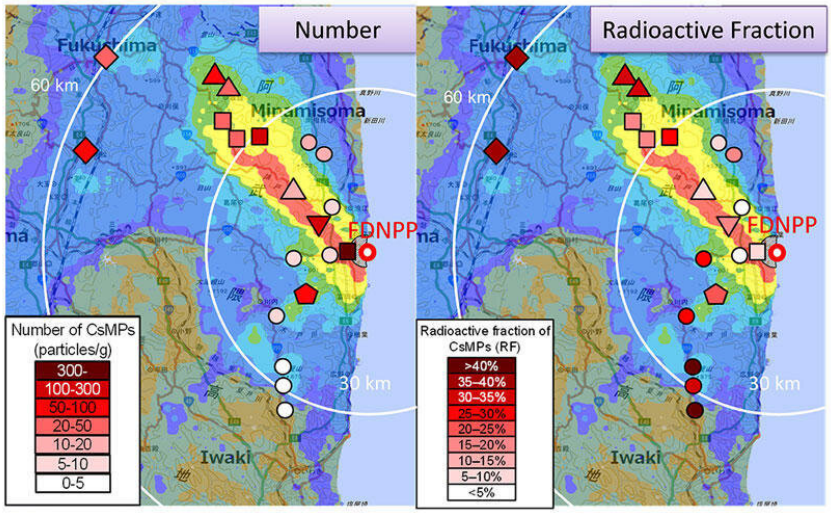

Figure showing the number of cesium-rich microparticles per gram of soil, and the fraction of total soil cesium radioactivity associated with the microparticles, for a range of samples collected around the Fukushima Daiichi Nuclear Power Plant. Credit: FDNPP

A large quantity of radioactivity was released into the environment during the 2011 Fukushima Daiichi Nuclear Power Plant accident. The released radioactivity included small, poorly soluble, cesium-rich microparticles. The microparticles have a very high radioactivity per unit mass (~1011 Bq/g), but their distribution, number, source, and movement in the environment has remained poorly understood. This lack

of information has made it hard to predict the potential impact of the radioactive microparticles.

However, a study just published in the scientific journal *Chemosphere*, involving scientists from Japan, Finland, France, and the U.S., addresses these issues. The team, led by Dr. Satoshi Utsunomiya, Ryohei Ikehara, and Kazuya Morooka (Kyushu University), developed a method in 2018 that allows scientists to quantify the amount of cesium-rich microparticles in soil and sediment samples.

They have now applied the method to a wide range of soil samples taken from within, and outside, the Fukushima Daiichi nuclear exclusion zone, and this has allowed them to publish the first quantitative map of cesium-rich microparticle distribution in parts of Fukushima region.

Team members (Satoshi Utsunomiya and Ryohei Ikehara) completing a radiation survey in the now overgrown Fukushima nuclear exclusion zone. Credit: Satoshi Utsunomiya

Three regions of interest within 60 km from the Fukushima Daiichi site

Dr. Utsunomiya says, "Using our method, we have determined the number and amount of cesium-rich microparticles in surface soils from a wide range of locations up to 60 km from the Fukushima Daiichi site. Our work reveals three regions of particular interest. In two regions to the northwest of the damaged nuclear reactors, the number of cesium-rich microparticles per gram of soil ranged between 22 and 101, and the amount of total soil cesium radioactivity associated with the microparticles ranged from 15–37 percent. In another region to the southwest of the nuclear reactors, 1–8 cesium-rich microparticles were found per gram of soil, and these microparticles accounted for 27–80 percent of the total soil cesium radioactivity."

Prof. Gareth Law (University of Helsinki), a co-author of the study, says that the paper "reports regions where the cesium-rich microparticles are surprisingly abundant and account for a large amount of soil radioactivity. This data, and application of our technique to a wider range of samples could help inform clean-up efforts." Utsunomiya also added that the work "provides important understanding on cesium-rich microparticle dispersion dynamics, which can be used to assess risks and environmental impacts in inhabited regions."

The authors found that the cesium-rich microparticle distribution was consistent with the trajectories of the major radioactivity plumes released from the Fukushima Daiichi site during the late afternoon of

March 14, 2011, to the late afternoon of March 15, 2011. This may indicate that microparticles only formed during this short period. Utsunomiya adds: "based on the distribution and known sequence of events during the accident, our data suggests that reactor unit 3 was the most plausible source of the cesium-rich microparticles at the beginning of the release period."

More information: Ryohei Ikehara et al. Abundance and distribution of radioactive cesium-rich microparticles released from the Fukushima Daiichi Nuclear Power Plant into the environment, *Chemosphere* (2019). DOI: 10.1016/j.chemosphere.2019.125019

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