Finding and analyses of soil particles adsorbing radioactive cesium in Fukushima

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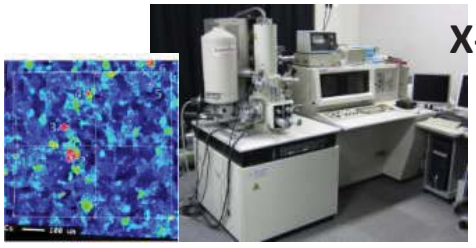
Contents

Identification and analyses of soil particles which adsorb radioactive Cs is one of the most fundamental researches. However,



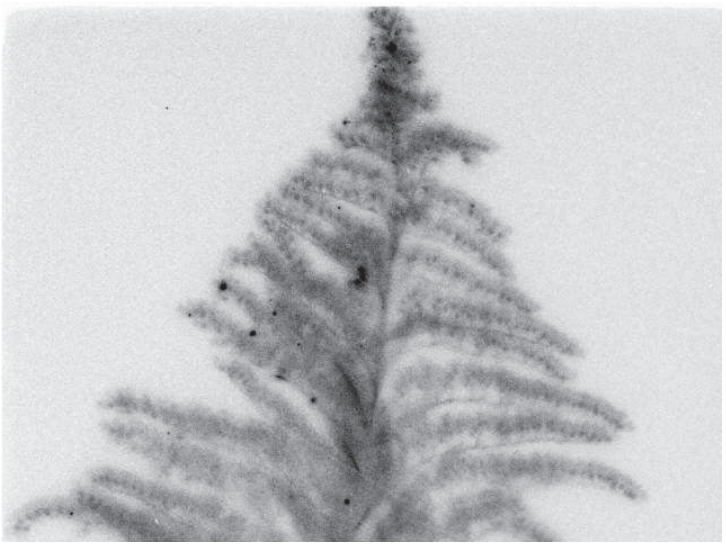
X-ray microanalysis (EPMA, XRF)
~ 1000 ppm

SR-XRF ~ 10 ppm

Nano-SIMS ~ 1 ppm

Actual concentration of radioactive Cs in Fukushima Soil is ~ 0.1 ppb, still far below the detection limits of microanalyses available!

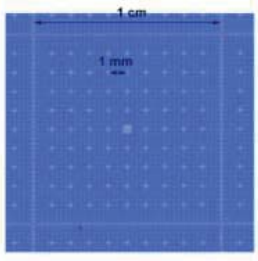
Autoradiography is probably the only method to find radioactive soil particles

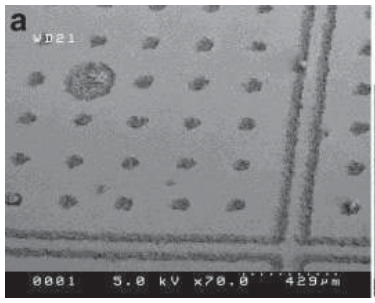


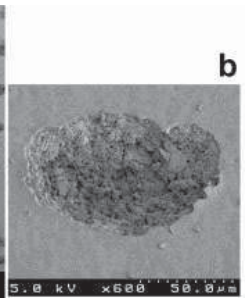
http://gardenlife-klimt.blogspot.jp/2012/08/autoradiography.html

How we identify the radioactive soil particles on the imaging plates (IP) and move into electron microscopes?

Wave length: 532 nm

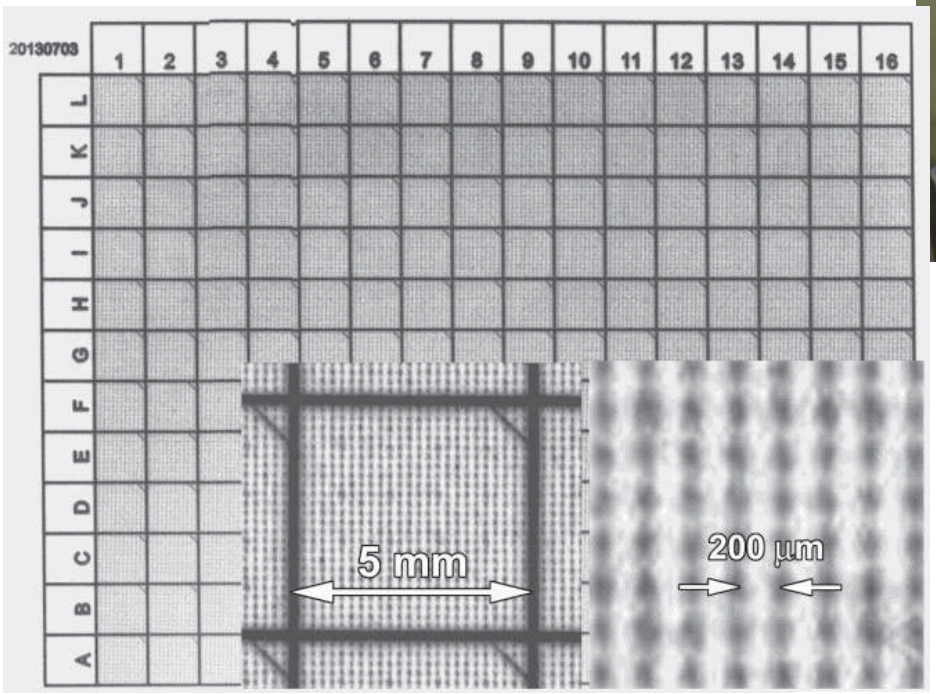






IP : Fuji Film FDL-UR-V 10 cm x 8 cm

Formation of micro-grids using a laser-marker



Fuji Film FLA-7000

Read-out image of Imaging plate (IP) with laser-marked micro-grids

Specimen investigated : Litter soil on the ground of forest in Iitate village, Fukushima-pref. (Donated by Dr. T. Hatta, JIRCAS)

Dry the litter soil in an oven

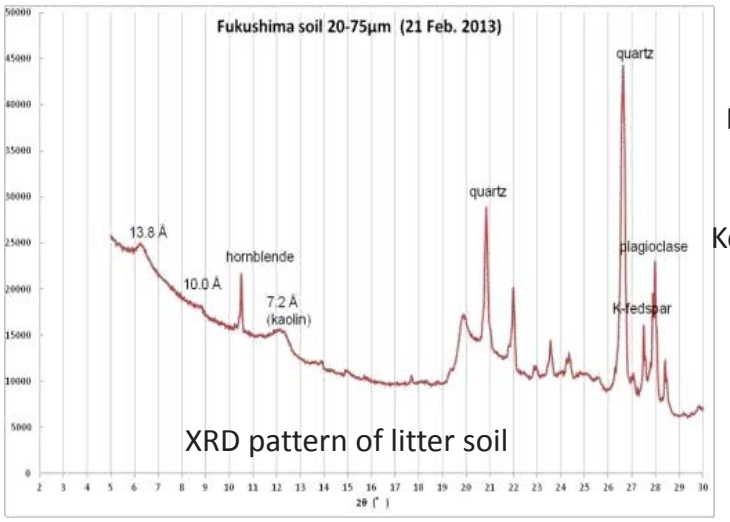
Sieved to particles of 20-75 μm using a sieve shaker

(^{137}Cs 1.4kBq/Kg)

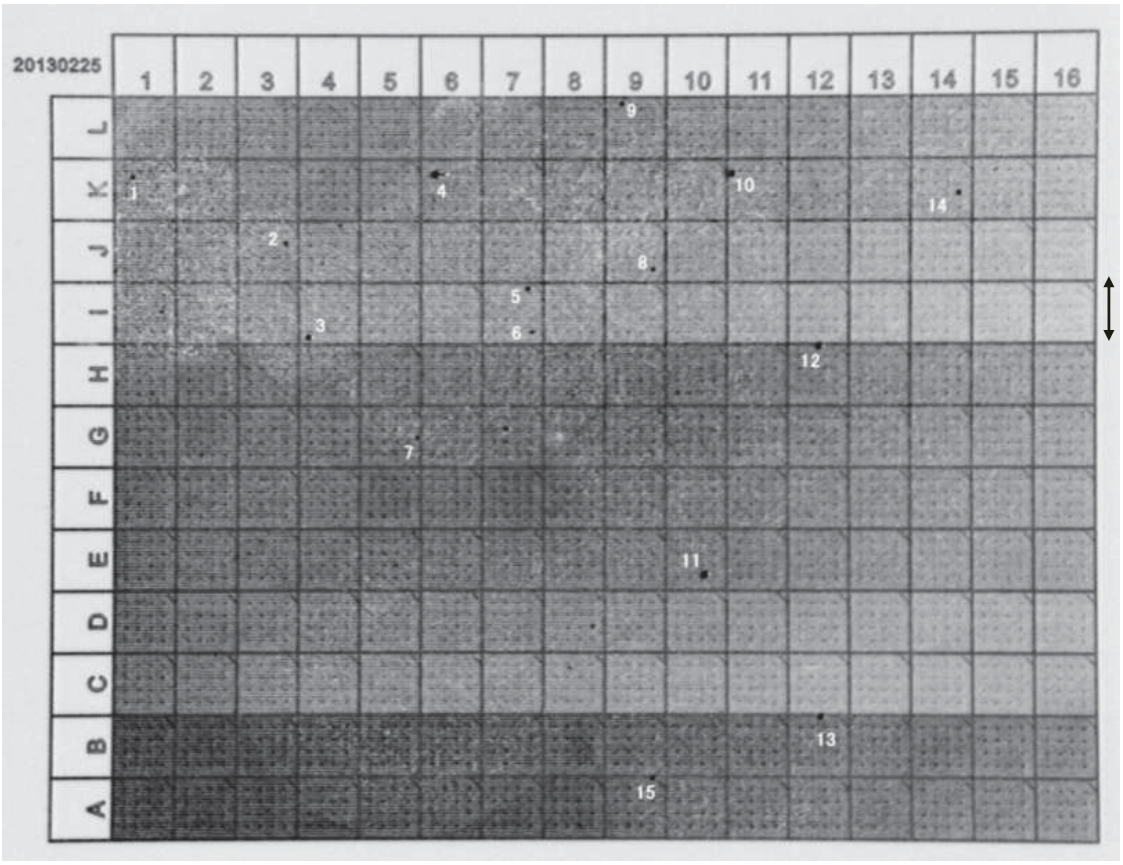
Dispersed in ethanol and dropped on IP

Keep in the dark for a month for exposure

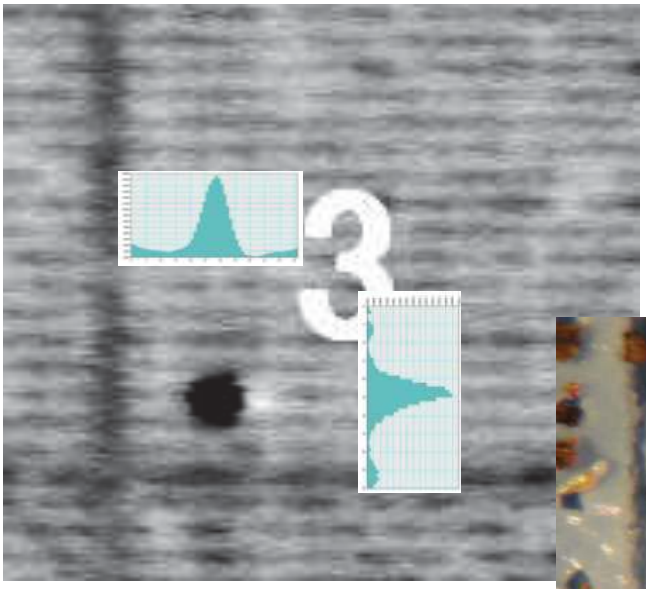
Read-out IP using IP-reader



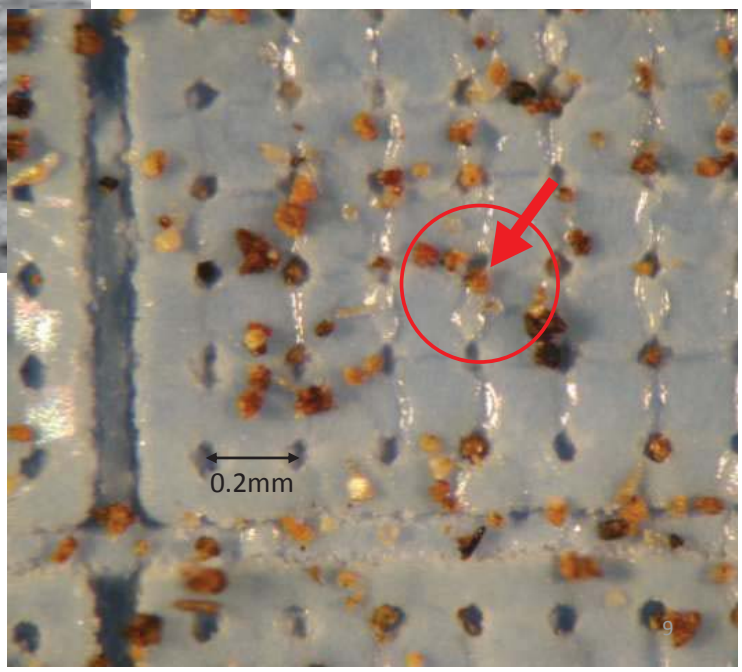
XRD pattern of litter soil



The number of radioactive particles is very low, ~ 1/1000 of all particles



Read-out image after one month exposure by radiation from dispersed soil particles on the IP



Corresponding OM micrograph of the soil particles dispersed on IP

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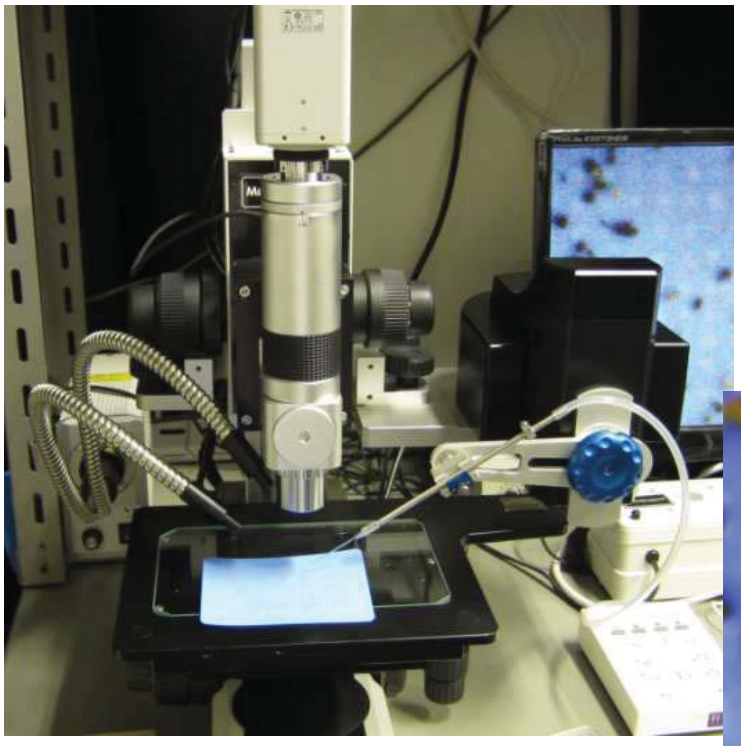
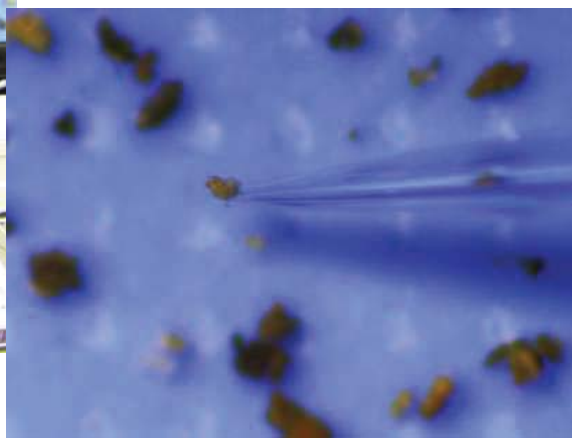
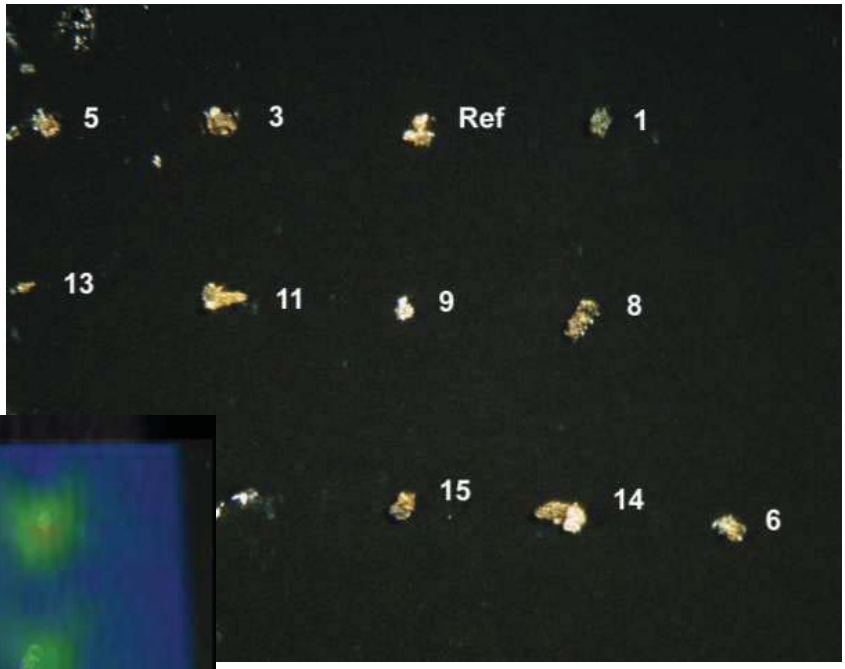


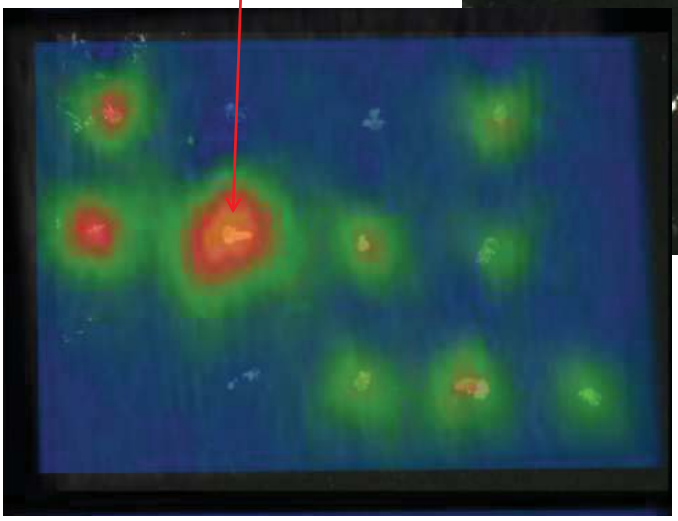


Micro-manipulator with vacuum tweezers

Radioactive soil particles collected on carbon conductive tape using the manipulator



ca. 0.6Bq (~ 1 ppm Cs)



IP-0403

Double check the radiation from the particles using IP covered and exposed on the particles

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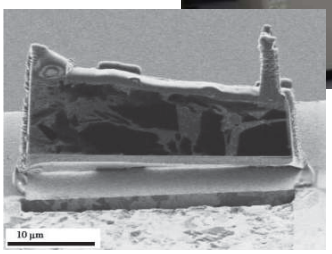
SEM-EDS

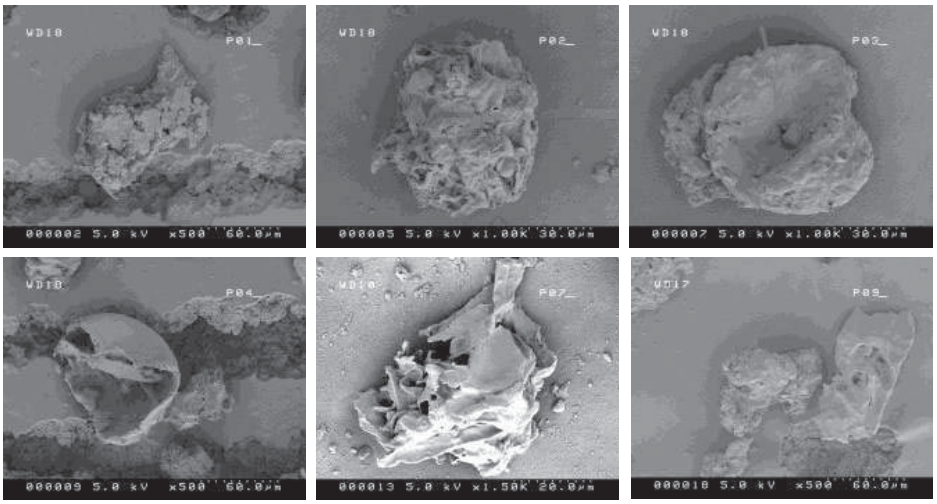
Focused Ion Beam (FIB)



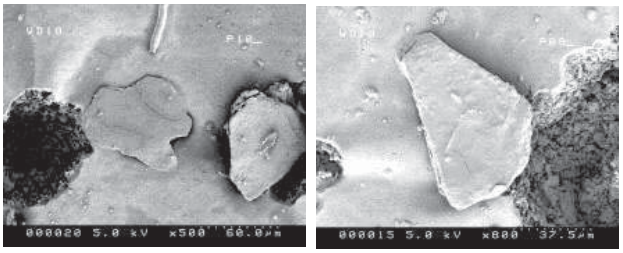
TEM specimen prepared by FIB

TEM-EDS

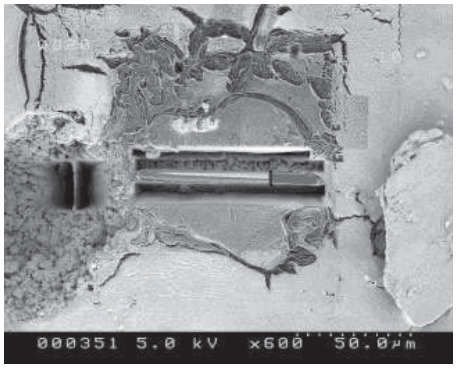
IP-0399



organic-clay composites

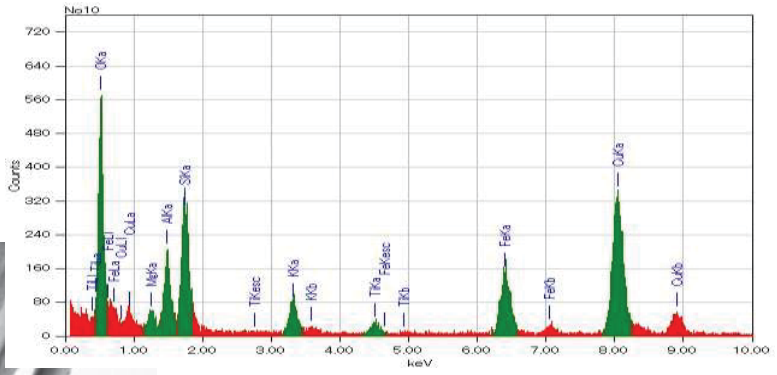


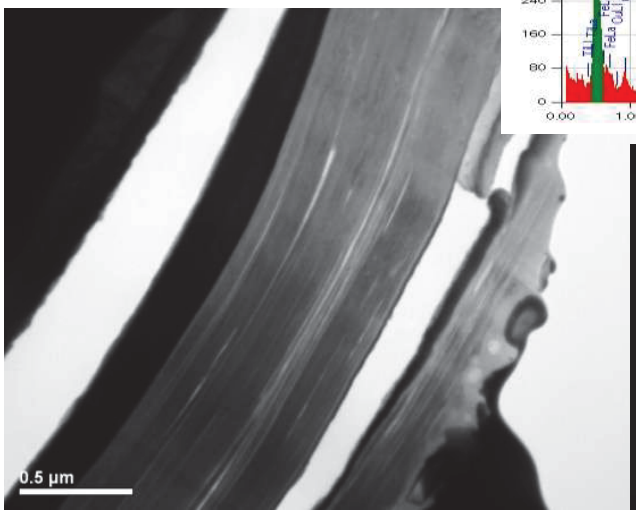
Inorganic clay particles

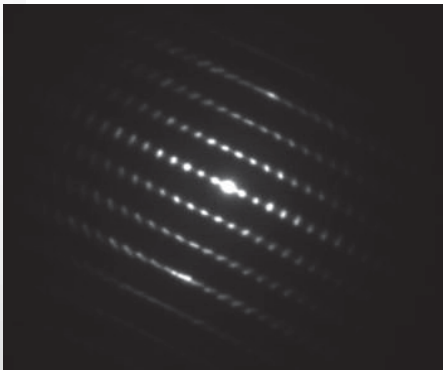


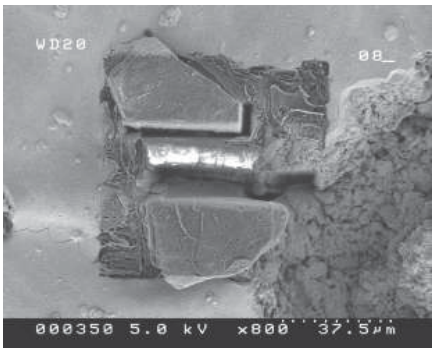
0399-P10

biotite

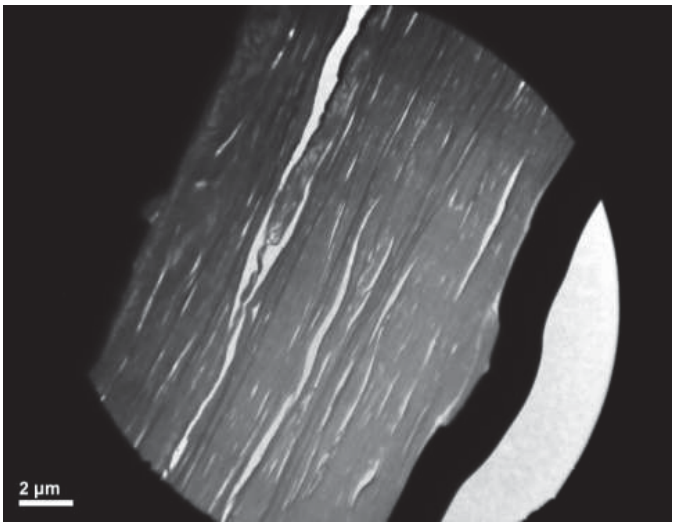


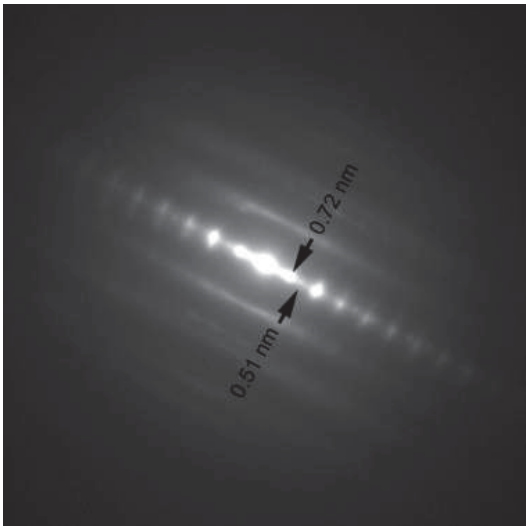






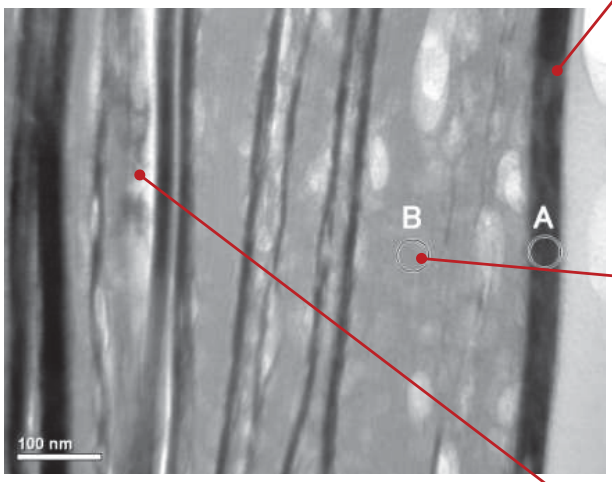
0399-P08

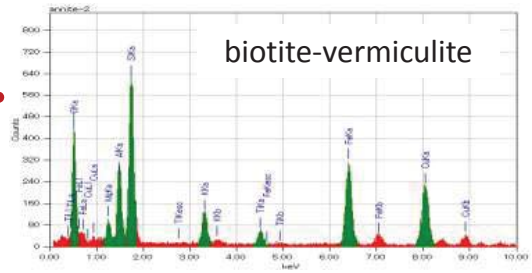


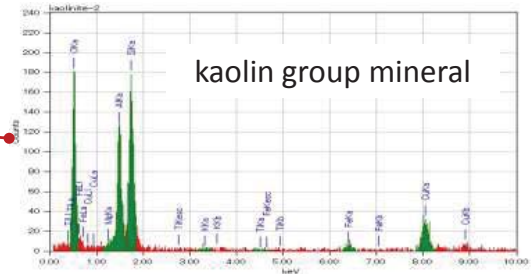


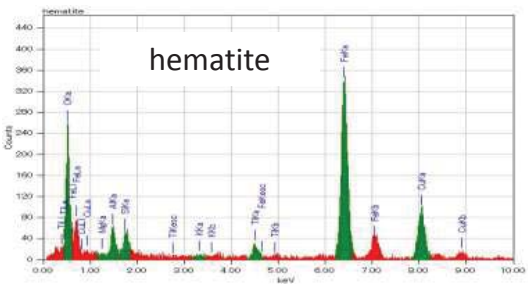
Interstratification of two clay minerals with 10 Å and 7 Å basal distances

0399-P08



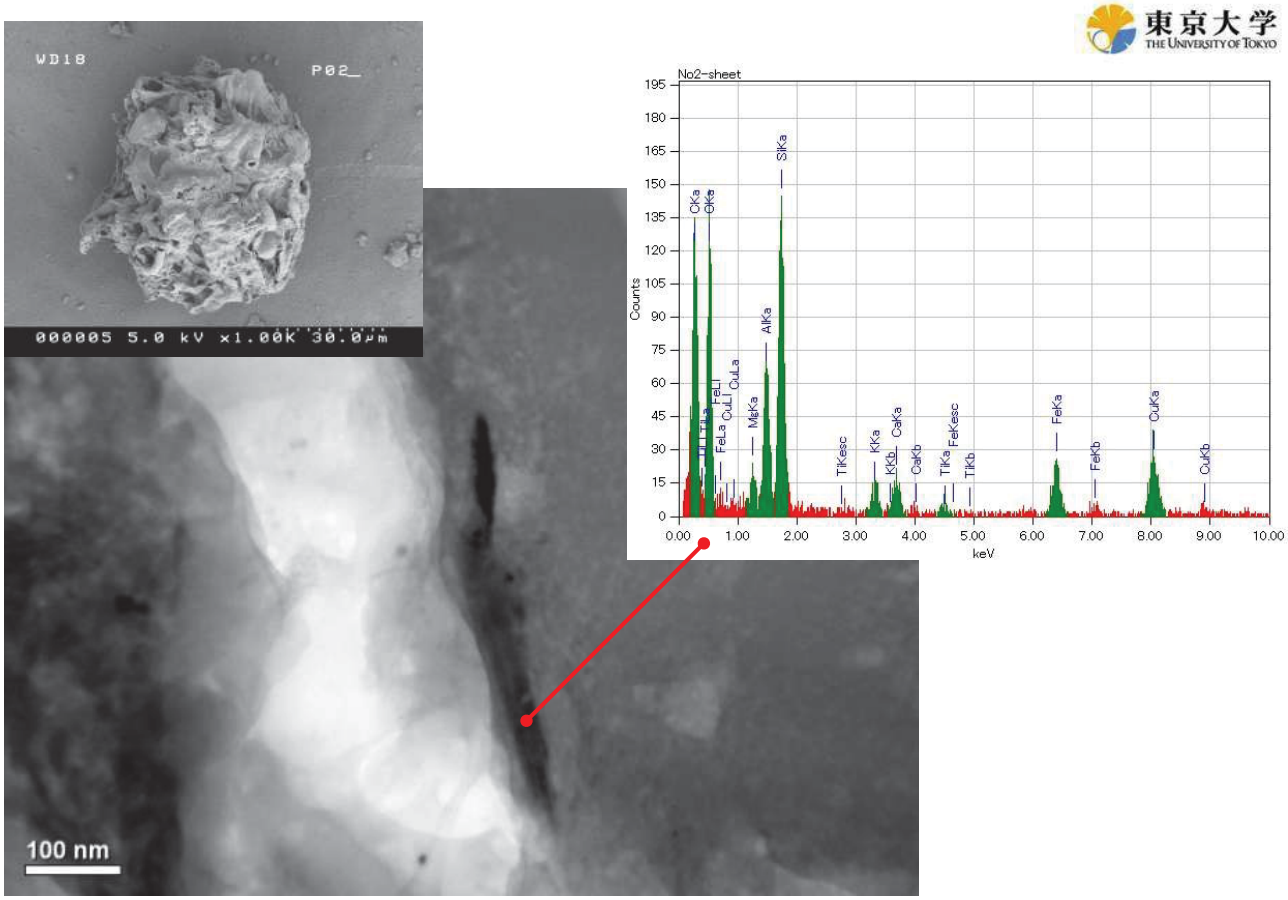






biotite in granite

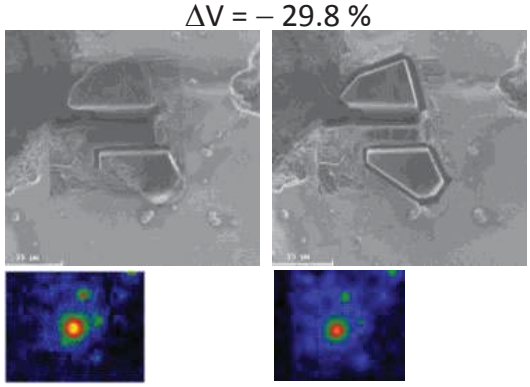
→ kaolinite + hematite



Clay mineral fragment in organic particles observed in TEM

ΔV = – 29.8 %

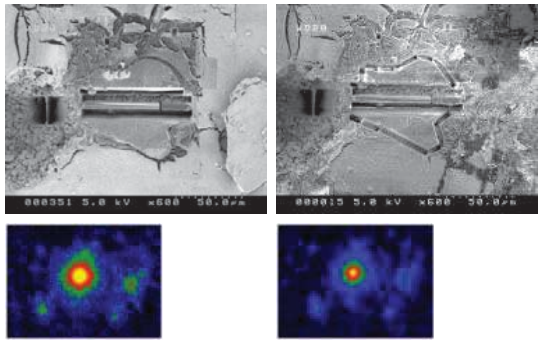
P8

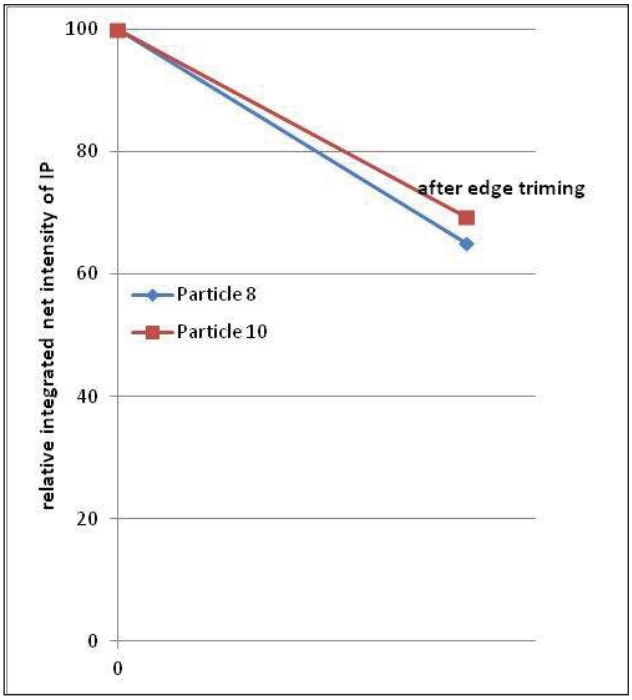


Removal of clay edges using FIB

ΔV = – 29.4 %

P10





Radiation (radioactive Cs) may not concentrate at the edges of clay particles, but it may be distributed homogenously in the particles.

Conclusions

1. A novel process has been developed to identify radioactive soil particles with IP autoradiography and transfer them into SEM/TEM, to analyze their fine structures and mineral species.
2. Dominant radioactive particles in litter soils are organic-clay composites. Their origin is probably biological activity.
3. Radioactive clay minerals found in this study are biotite and interstratified biotite-kaolinite. The latter is probably a weathering product of biotite in granite.
4. Radioactive Cs may not be preferentially adsorbed at the edges but all over the clay particles.

Thank you for your attention