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Radiochemical analysis of rubble collected from around and inside reactor buildings at Units 1 to 4 in Fukushima Daiichi Nuclear Power Station

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- A huge amount of the waste contaminated with radioactive materials was generated in the Fukushima Daiichi NPS.
 - » which is quite different from ordinary waste arising from the nuclear power stations and reprocessing plants
- To classify the waste and to establish ways of processing and disposal of the waste, the inventory of radioactive materials in the waste should be clarified
- From the viewpoint of safety assessment of waste disposal, important radionuclides were selected. We analyzed 18 nuclides.
 - » γ -ray: ^{60}Co , ^{94}Nb , ^{137}Cs , $^{152,154}\text{Eu}$
 - » β -X-ray: ^3H , ^{14}C , ^{36}Cl , ^{41}Ca , $^{59,63}\text{Ni}$, ^{79}Se , ^{90}Sr , ^{93}Zr , ^{93}Mo , ^{99}Tc , ^{129}I ,
 ^{107}Pd , ^{126}Sn , ^{135}Cs , ^{151}Sm
 - » α -ray: U, Np, Pu , Am , Cm



Outline of the analysis of rubble

Our purpose

- To examine a strategy for treatment and subsequent disposal of the rubble, their radionuclide and radioactivity concentration were characterized.

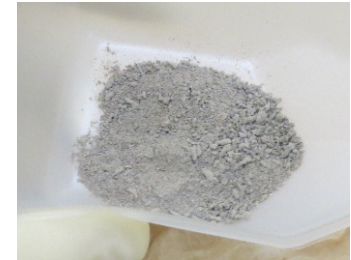
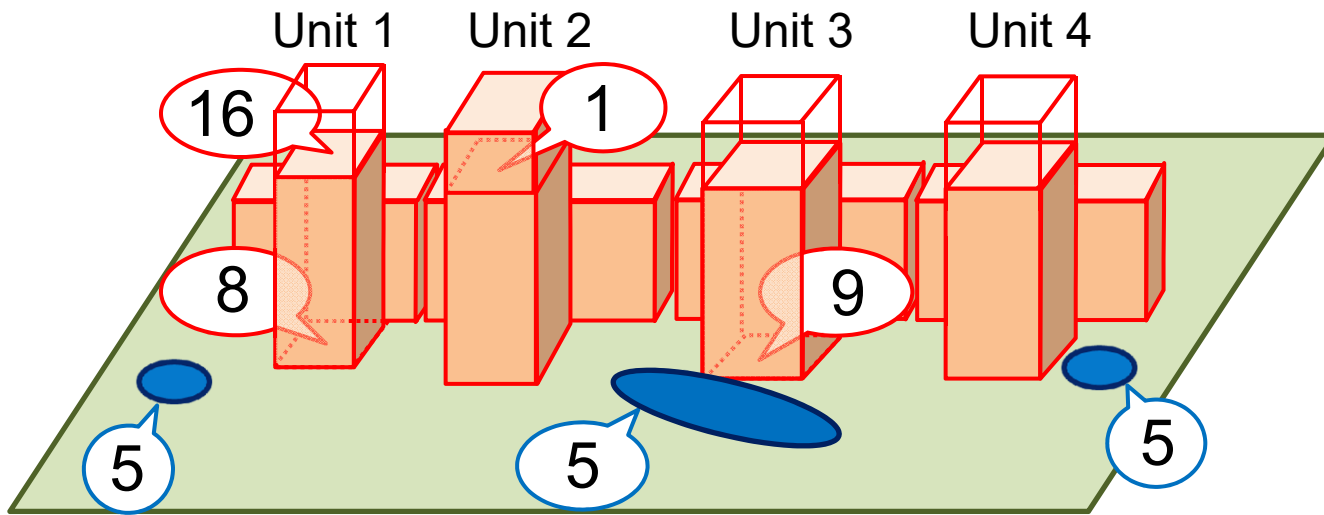
Outline of this study

- We analyzed the rubble collected from around and inside reactor buildings.
- Radioactivity concentration of ^{60}Co , ^{90}Sr , and ^{238}Pu were confirmed if these correlated to that of ^{137}Cs which might be useful as a key nuclide.

Result and discussion

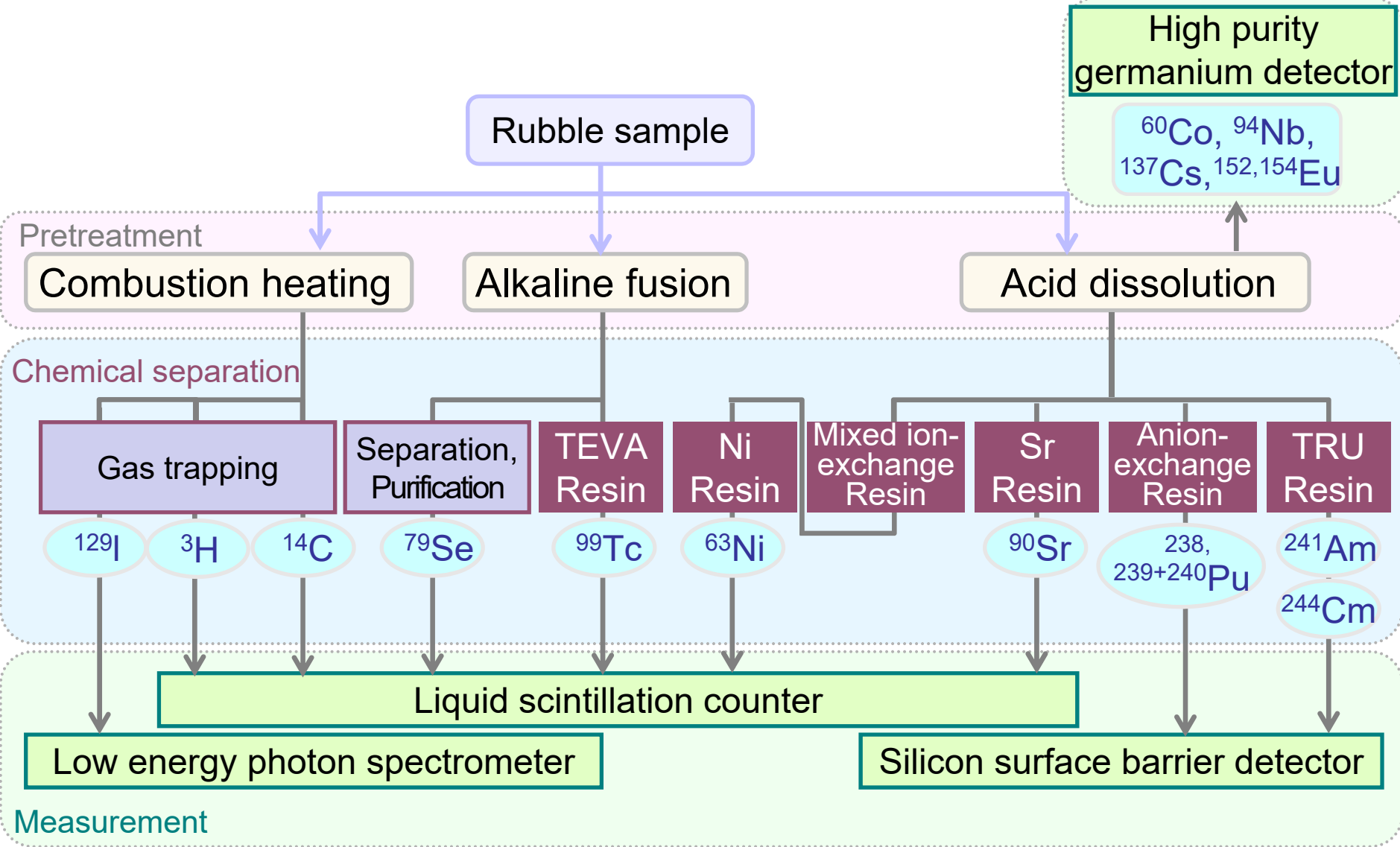
- Difference between rubble collected from around and inside reactor buildings.
- Comparison of radioactivity ratios between 1st and 5th floor of reactor building 1.
- Characteristic of radioactivity ratio between reactor buildings.

Sampling location of rubble

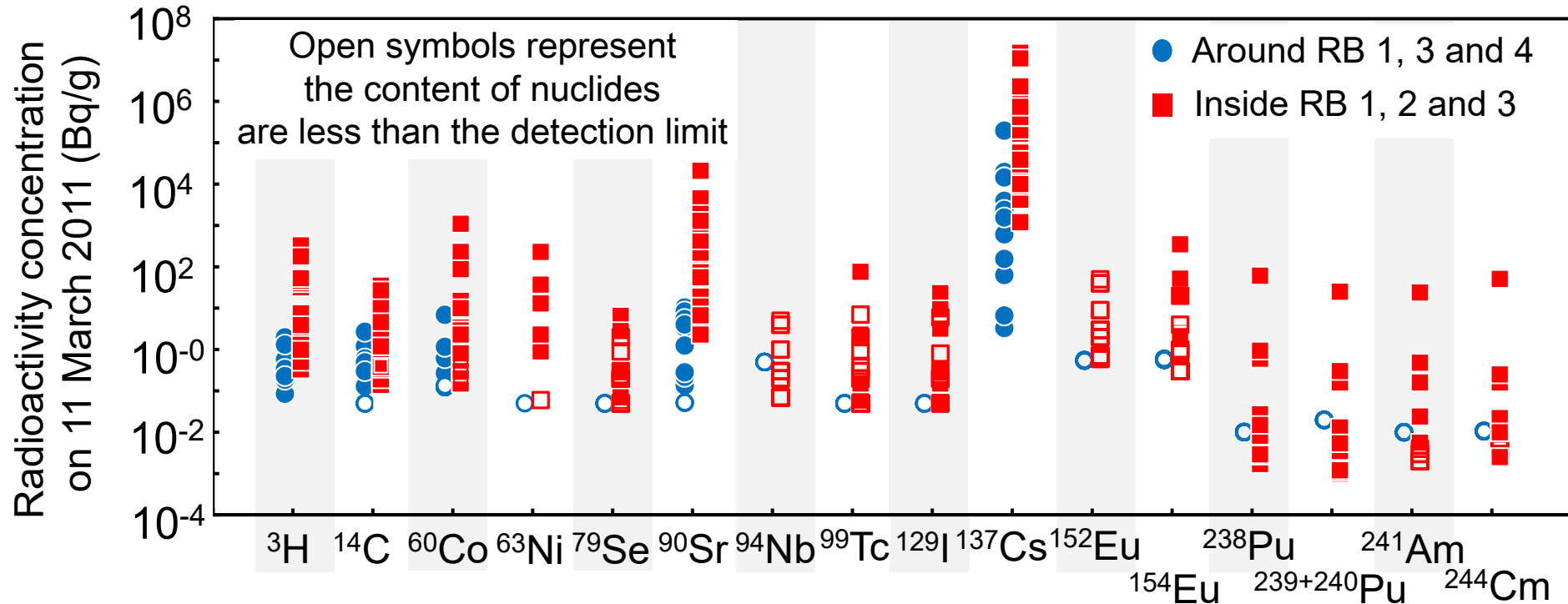


- Workers can not enter into the reactor buildings because dose rate is too high.
- Samples were selected from rubble ,which was accumulated when removal of the rubble or decontamination was operated by remote control device.
- 15 rubble were collected from around reactor building 1, 3, and 4.
- 34 rubble were collected form 1st or 5th floor of reactor buildings 1 to 3.

Outline of analytical method



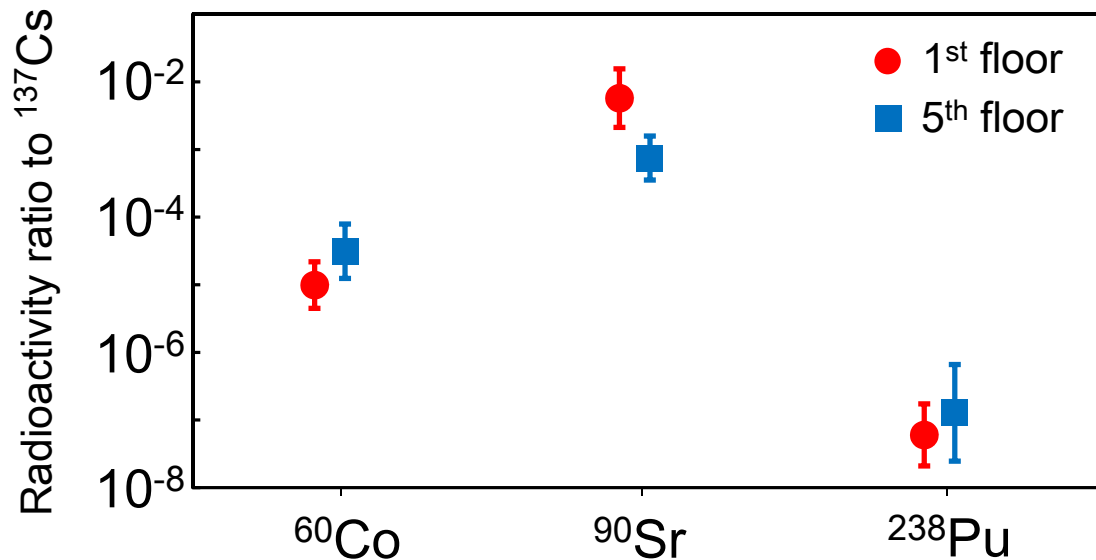
Difference between rubble collected from around and inside reactor buildings



- Radioactivity concentrations of the rubble collected from inside reactor buildings were higher than those of the rubble collected from around reactor buildings.
- More radioactive nuclides were detected from the rubble collected from inside reactor buildings.

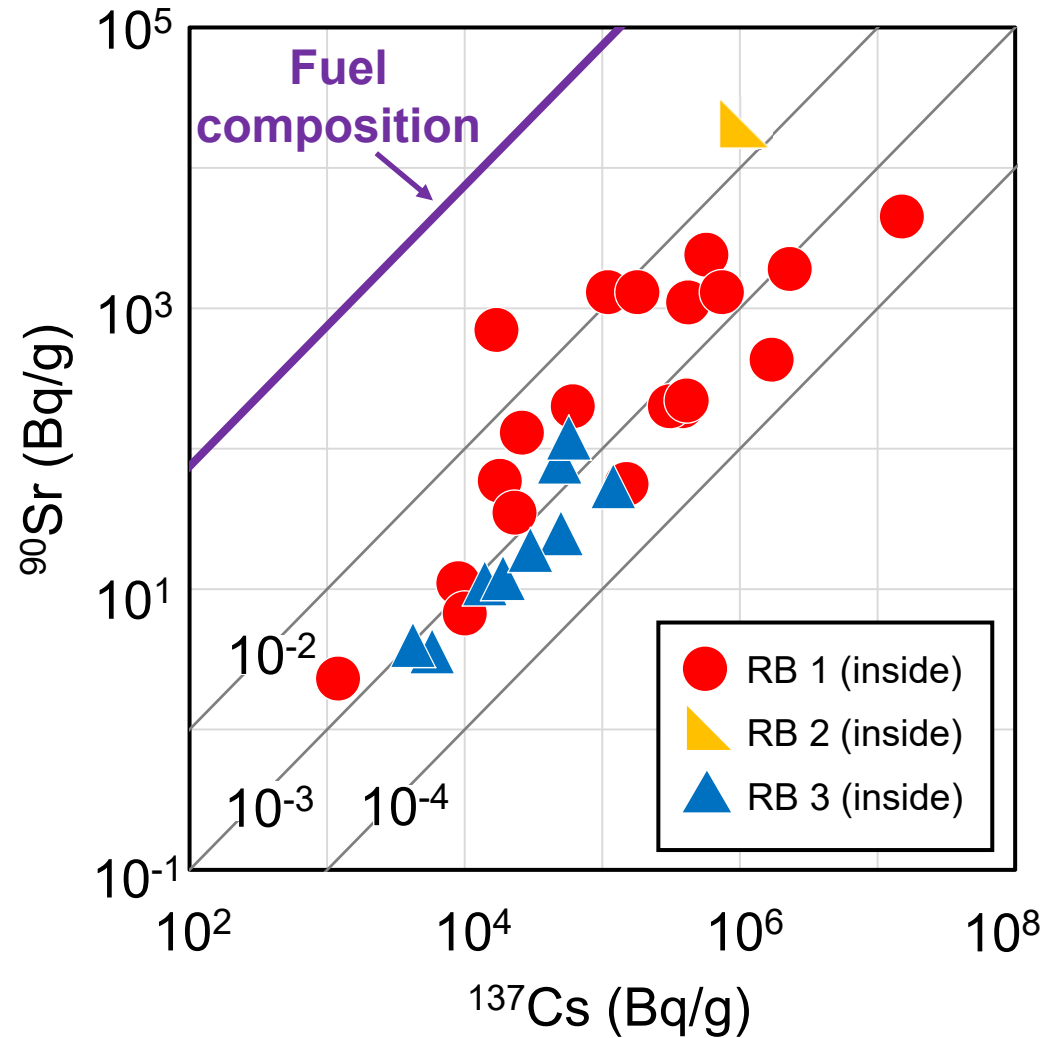
Comparison of radioactivity ratios between 1st and 5th floor of RB 1

- ^{137}Cs might be useful as a key nuclide, since it's the main radionuclide of fission product and easily determined.
- ^{60}Co , ^{90}Sr , and ^{238}Pu were selected as representatives of corrosion products, fission products, and alpha emitting nuclides. Radioactivity concentration of those were confirmed whether these correlated to that of ^{137}Cs or not.

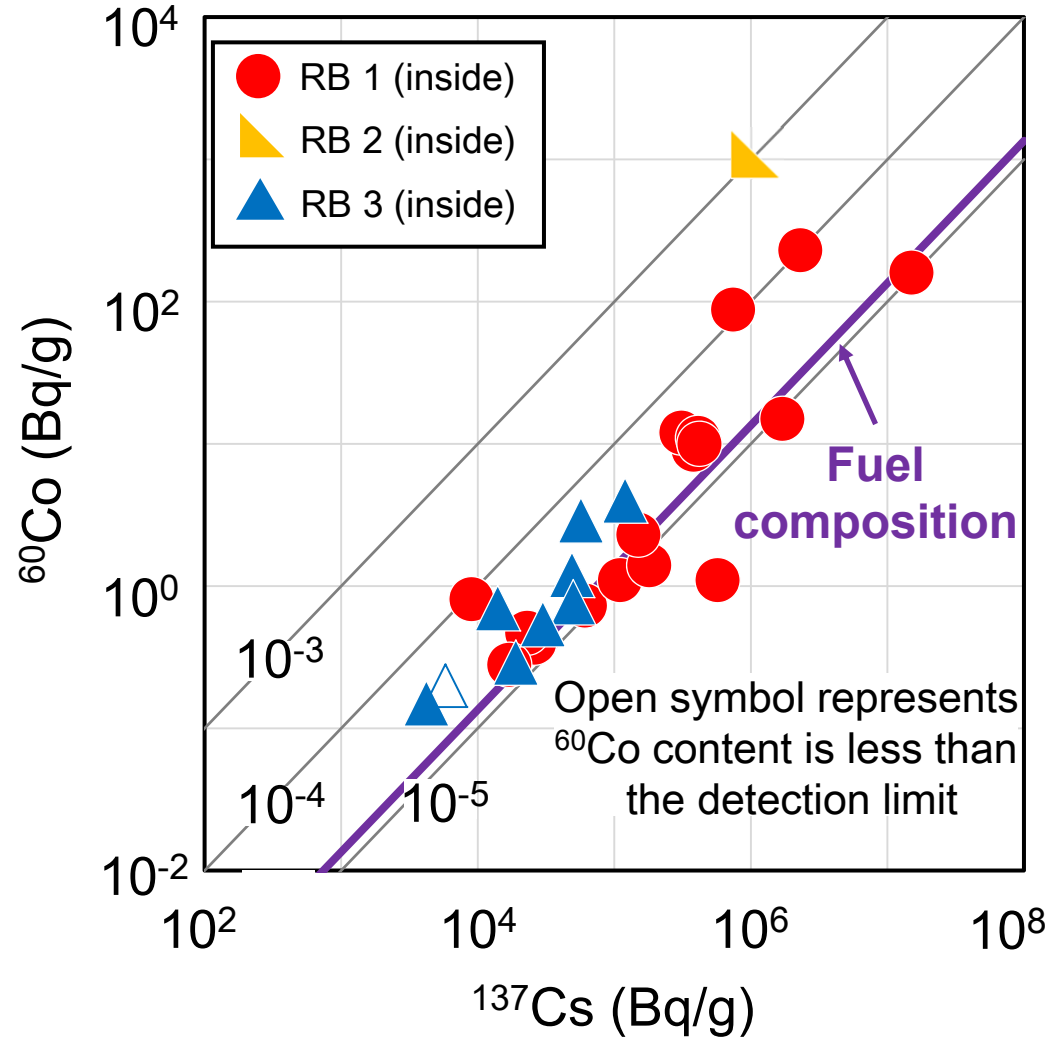


- The radioactivity ratio $^{60}\text{Co}/^{137}\text{Cs}$, $^{90}\text{Sr}/^{137}\text{Cs}$, and $^{238}\text{Pu}/^{137}\text{Cs}$, were consistent with 1st and 5th floor of reactor building 1.

- ^{90}Sr is the important nuclide for safety assessment. However it is difficult to analyze since it does not emit gamma ray.
- The radioactivity of ^{90}Sr correlated to that of ^{137}Cs .
 - » ^{137}Cs would be useful as a key nuclide.
- Estimation value is higher than analytical data.
 - » Transferred amount of radioactivity of ^{90}Sr from reactor core to reactor building smaller than that of ^{137}Cs .

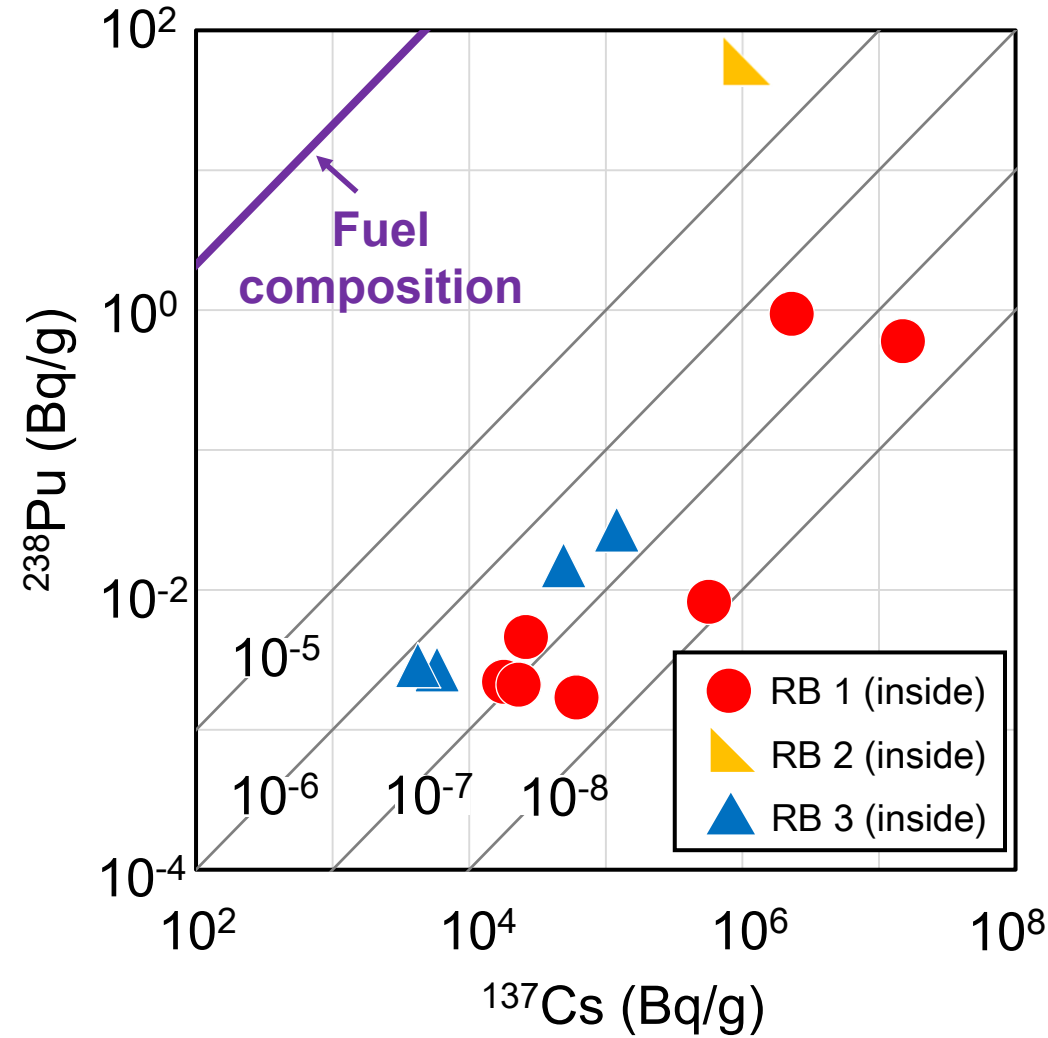


- ^{60}Co is the corrosion product whose radioactivity does not correlate with that of ^{137}Cs for ordinary waste.
- The radioactivity of ^{60}Co correlated to that of ^{137}Cs .
 - » Radioactivity of other corrosion product, such as ^{63}Ni might correlated to that of ^{137}Cs .

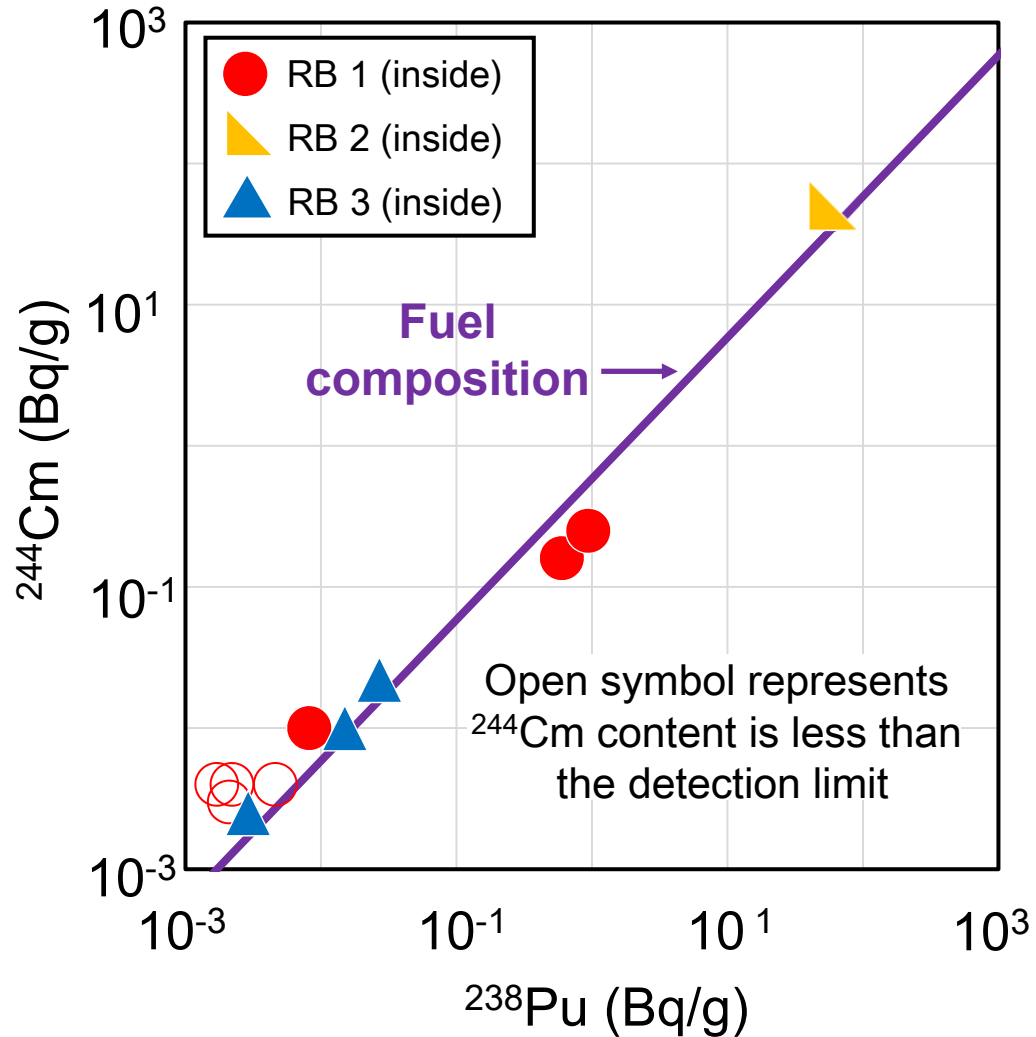


$^{238}\text{Pu}/^{137}\text{Cs}$ radioactivity ratio

- The radioactivity of ^{238}Pu was lower than other nuclides. However, since maximum limit of Pu was very low, the assessment of Pu was important
- Analytical data is much smaller than estimation value.
 - » Transferred amount of radioactivity of ^{238}Pu from reactor core to reactor building much less than that of ^{137}Cs .
- The radioactivity of ^{238}Pu correlated to that of ^{137}Cs .



- The radioactivity of ^{238}Pu and ^{244}Cm were discussed in order to investigate the correlation between alpha emitting nuclides.
- The radioactivity of ^{244}Cm correlated to that of ^{238}Pu .
- Estimation value is similar to analytical data.
 - » Pu and Cm might be same distributing behavior.



Conclusion and acknowledgment

- We accumulated data for radioactivity concentrations of the important nuclides for safety assessment of the waste disposal.
- Radioactivity ratios of $^{60}\text{Co} / ^{137}\text{Cs}$, $^{90}\text{Sr} / ^{137}\text{Cs}$, and $^{238}\text{Pu} / ^{137}\text{Cs}$ were constant regardless of sampling location at reactor building 1.
 - » To confirm this result, the rubble collected from some floors should be analyzed in reactor building 2 and 3 as well.
- The radioactivity concentrations of ^{60}Co , ^{90}Sr , and ^{238}Pu were correlated with those of ^{137}Cs . To confirm the correlation among ^3H , ^{14}C , ^{63}Ni , and ^{137}Cs , more samples should be analyzed.
 - » ^{137}Cs would be useful as a key nuclide when a simple rapid radioactivity estimation is needed

This achievement is obtained from the Subsidy Project of Decommissioning and Contaminated Water Management by Ministry of Economy, Trade and Industry(METI)