

東日本放射線セシウムに汚染された土地利用別土壌特性の影響

李 敏¹、箭田佐依子²、江口定夫²、高橋純子³、田村憲司³、浅野真希³
恩田裕一³、世良耕一郎⁴

¹筑波大学生命環境科学研究科
305-8572 茨城県つくば市天王台 1-1-1

²農業環境技術研究所
305-8604 茨城県つくば市観音台 3-1-3

³筑波大学生命環境系
305-8572 茨城県つくば市天王台 1-1-1

⁴岩手医科大学サイクロトンセンター
020-0603 岩手県滝沢市留が森 348-58

要旨

福島第一原発の事件で、放射性セシウム、特にセシウム ^{137}Cs は非常に長い半減期のため環境に最も深刻な影響を及ぼすと思われる。セシウムは粘土鉱物と関連している。放射性セシウム捕捉（ほそく）ポテンシャル（以下 RIP）は選択的に放射性セシウムを吸着する能力の点またはミネラルを分類するために使用することができる固有の土壌パラメータである。Si、Al 等の元素の量は PIXE で測定した。今回は土地利用別の土壌の RIP と元素量との関係について報告する。

The effect of different land use types on ^{137}Cs contaminated soil of northern Japan

Min Li¹, Saeko Yada², Sadao Eguchi², Junko Takahashi³, Kenji Tamura³,
Maki Asano³, Yuichi Onda³ and Koichiro Sera⁴

¹Graduate School of Life and Environmental Sciences, University of Tsukuba
1-1-1 Tennodai, Tsukuba, Ibaraki 305-8572, Japan

²National Institute for Agro-Environmental Sciences
3-1-3 Kannondai, Tsukuba, Ibaraki 305-8604, Japan

³Faculty of Life and Environmental Sciences, University of Tsukuba
1-1-1 Tennodai, Tsukuba, Ibaraki 305-8572, Japan

⁴Cyclotron Research Center, Iwate Medical University
348-58 Tomegamori, Takizawa, Iwate 020-0603, Japan

Radioactive cesium, especially ^{137}Cs is deemed to the most important contributor to environmental contamination because of its long half- life period released by the explosion of Fukushima Dai-ichi Nuclear Power Plant (FDNPP) in 2011.

The Radiocaesium Interception Potential(RIP) has been researched in past works. It has been well established that cesium is tightly bound by the clay minerals of the soil, The RIP is an intrinsic soil parameter which can be used to categorize soils or minerals in terms of their capacity to selectively adsorb radiocesium, and for analyzing the content of clay minerals, the elements was determined by Particle-induced X-ray emission (PIXE) because of the quantity of samples and the high sensibility of PIXE.

The soil samples were from different provinces around the FDNPP and were taken 0.5cm of surface. The relevance of RIP and elements under different land use types will be showed in this report.

1 Introduction

In the earthquake of Mar. 11st 2011, the explosion of Fukushima Dai-ichi NPP made the rounding environment contaminated, ^{137}Cs is deemed to the most important contributor to environmental contamination because of its long half- life period. It has been well established that cesium is so tightly

bound by the clay minerals of the soil, the radiocaesium ion can exchange with the clay minerals¹. In previous work the immobilization of Cs and the Radiocaesium Interception Potential(RIP) have been researched. The RIP is an intrinsic soil parameter which can be used to categorize soils or minerals in terms of their capacity to selectively adsorb radiocaesium², Cs keeps the selection of Siloxane Ditrigonal Cavity on the clay particle and Frayed Edge site³. The content of elements(Si, Al) were determined by Particle-induced X-ray emission (PIXE),

The objective of this work is to show the relevance of RIP and Si & Al in different land use type soils, and the relationship between RIP and content of C&N.

2 Method and Materials

2.1 Sampling sites and material

The samples were from the Fukushima radiation monitoring of water soil and entrainment team, and were taken from top 0~0.5cm.

2.2 Methods

2.2.1 For RIP:

The solution of the container with the dialysis bag was changed 10 times during 7 days. During equilibration, the containers were agitated for 2 h more than each 12 h. Each dialysis bag was then transferred in a new container filled with 94 mL of the KCl-CaCl₂ equilibration solution labeled with carrier-free ¹³⁷CsCl. These bags were again agitated for 2 h each 12 h. After 5 days, aliquots of 10 ml were taken and ¹³⁷Cs activity of the equilibrium solution was measured by gamma-counting^{4,5}.

2.2.2 For PIXE:

Fill about 1g soil sample to the bottles which weighted and fill in about 5ml water and standing. Take the supernatant and weight, and take about 0.95 suspended solid and 0.05ml In standard to make a 50ppm mixture. Take 7ul mixture to the holder and dry and elemental analysis.

3 Results

In different region, RIP values of samples from Fukushima are 241.705~2142.136mmol/ kg; RIP of samples from Miyagi are 225.418~1104.083 mmol/ kg; RIP of samples from Ibaraki are 213.464~778.265 mmol/ kg; RIP of samples from Tochigi are 172.489~694.824 mmol/ kg, and then the results were showed in different land type uses (Figure 3.2), and there are no obvious relationship between Si and RIP or Al and RIP in residence sites or farmland (Figure 3.3.1, Figure 3.3.2). The content of C are 0.20%~15.80%, content of N are 0.02%~1.2%. From histogram of RIP (Figure 3.4), 3 high groups were chosen for comparing the relationship between RIP and C&N, they are all showed positive trend (Figure 3.5.1, Figure 3.5.2).

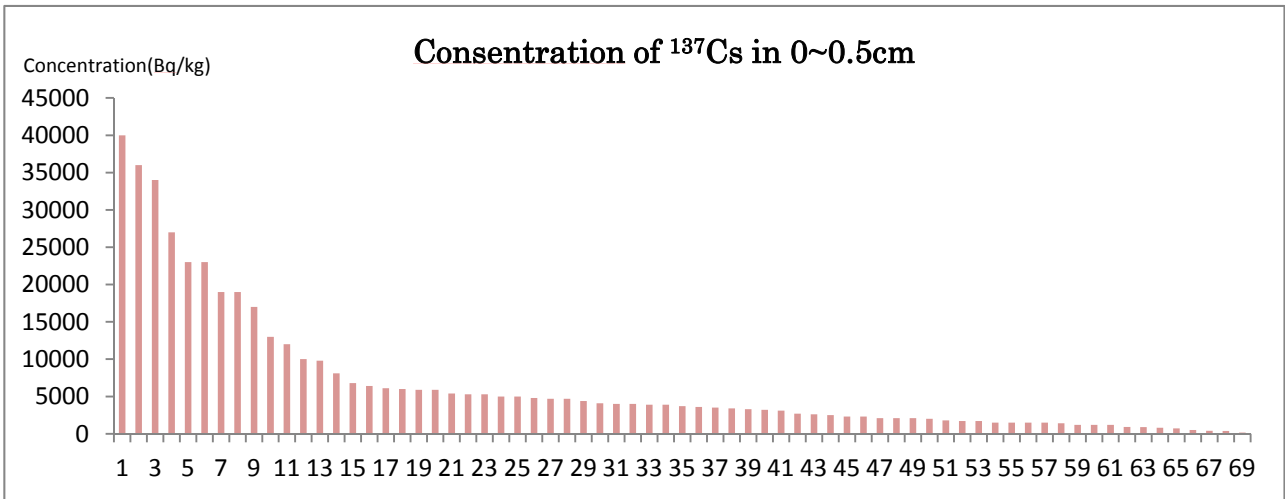


Figure 3.1 concentration of ¹³⁷Cs in 0~0.5cm

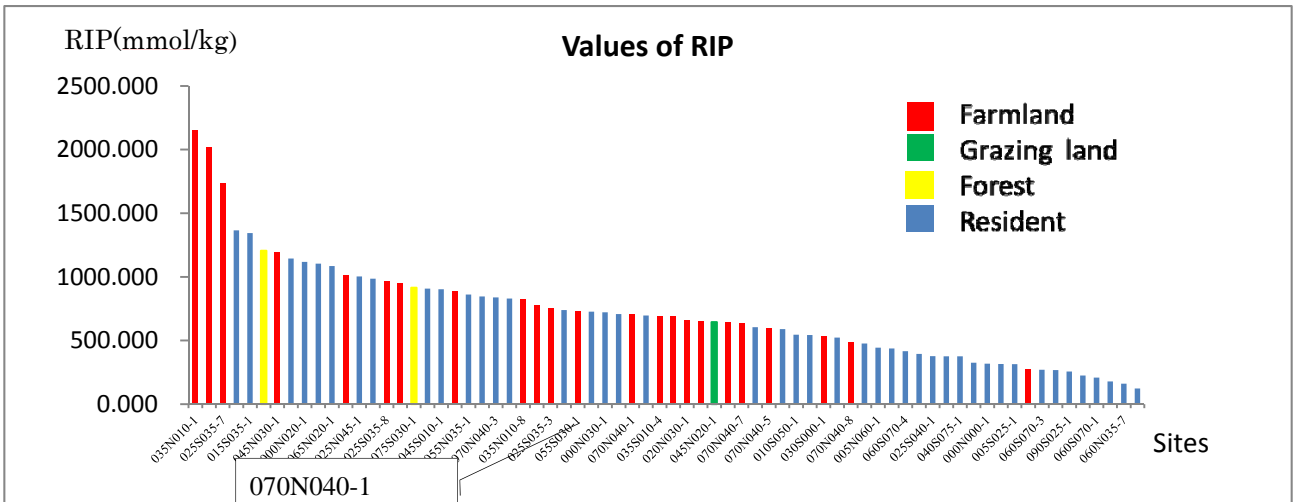


Figure 3.2 RIP values of soil samples in different sites

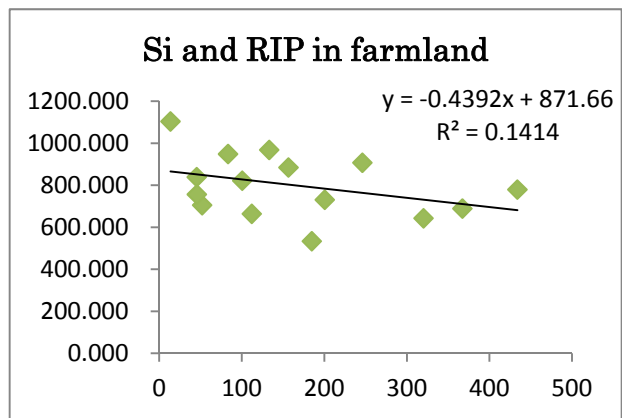
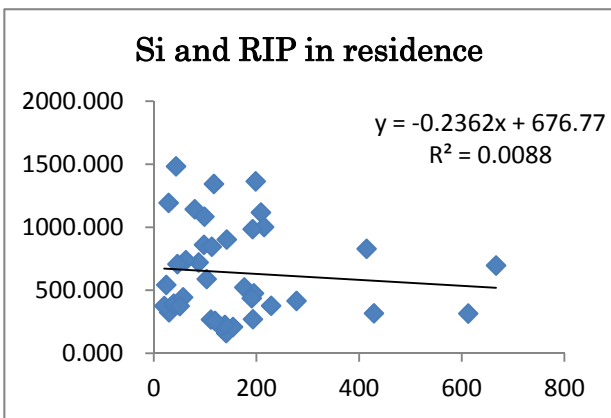


Figure 3.3.1 Relationship between Si and RIP in residence and farmland

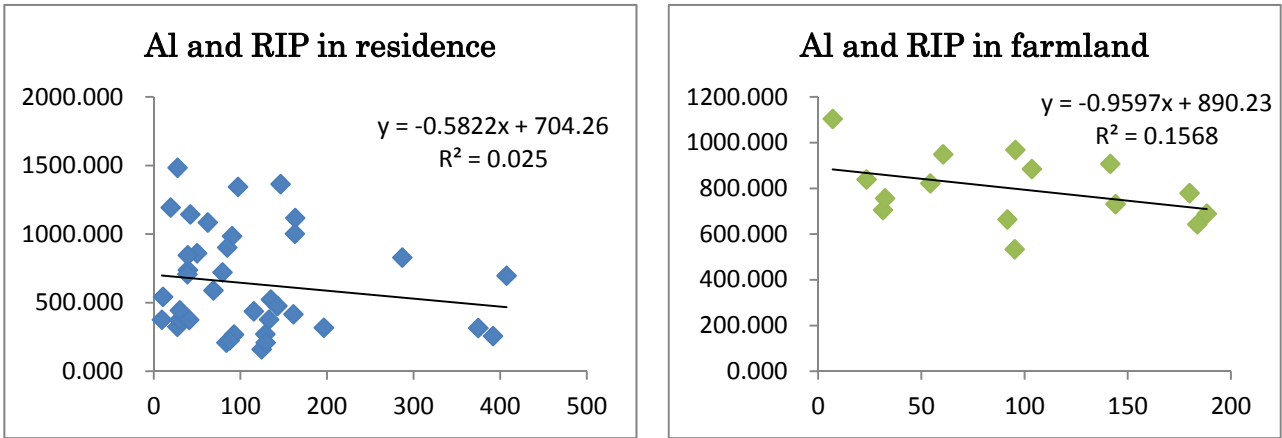


Figure 3.3.2 Relationship between AI and RIP in residence and farmland

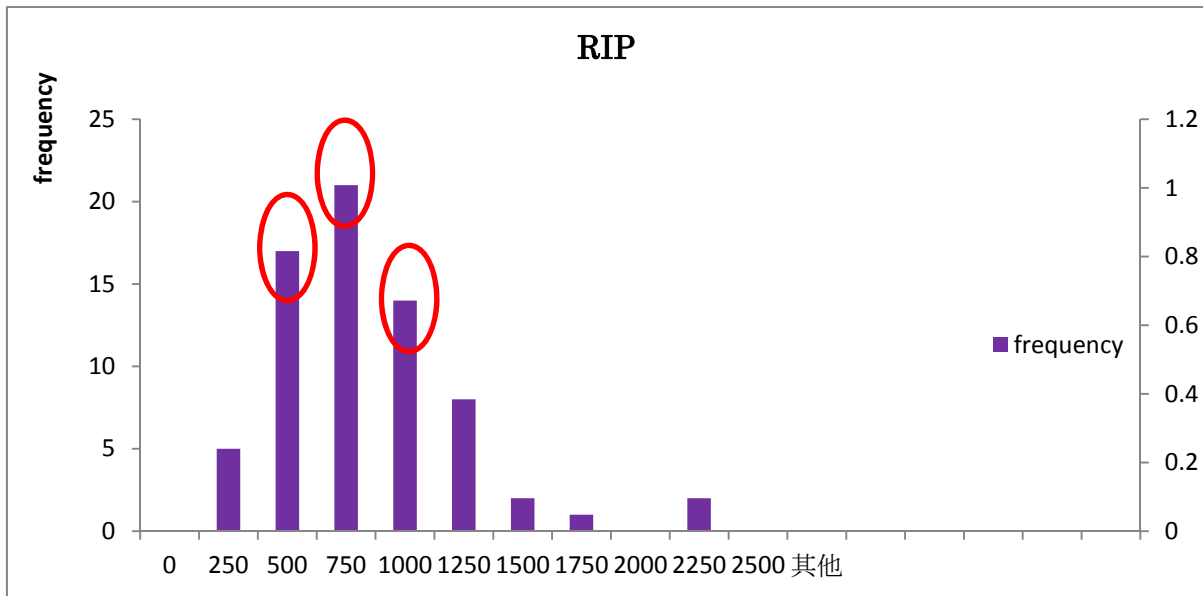


Figure 3.4 Histogram of values of RIP

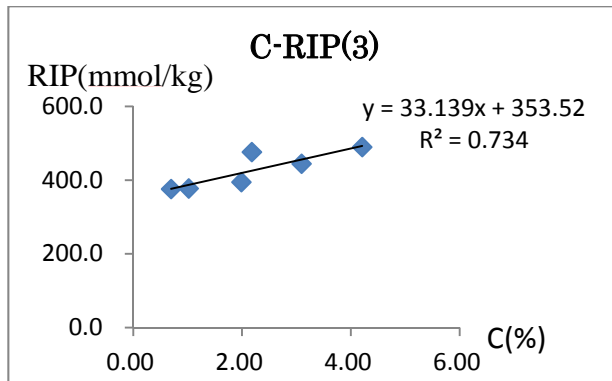
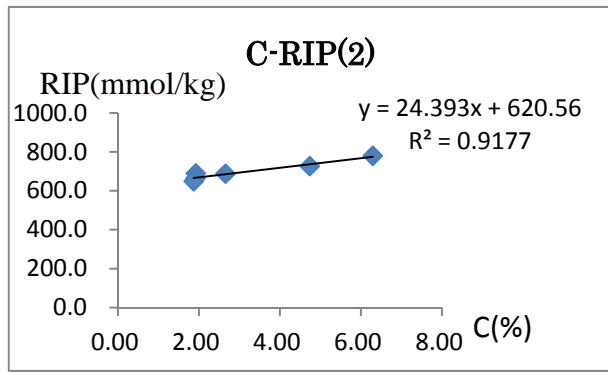
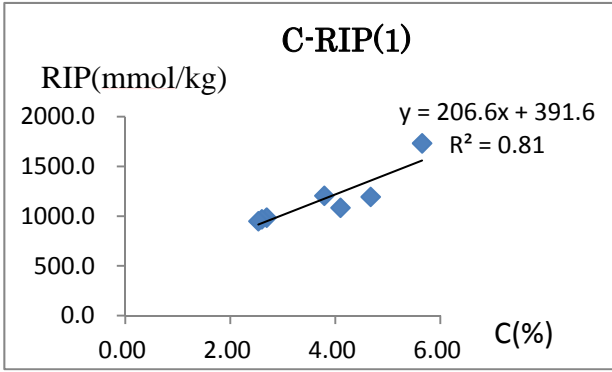


Figure 3.5.1 Relationship between C and RIP

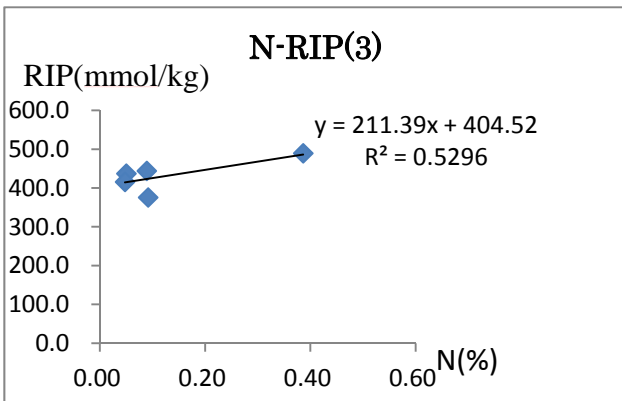
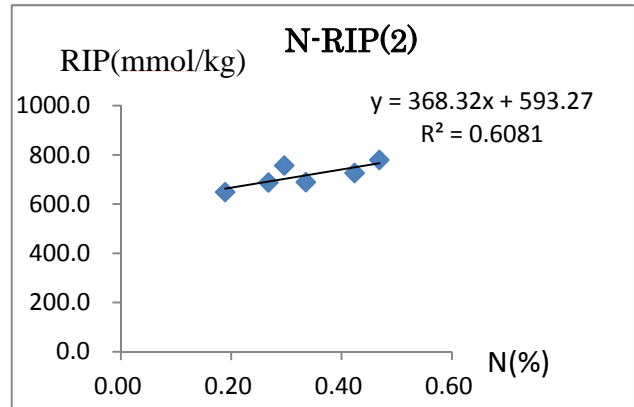
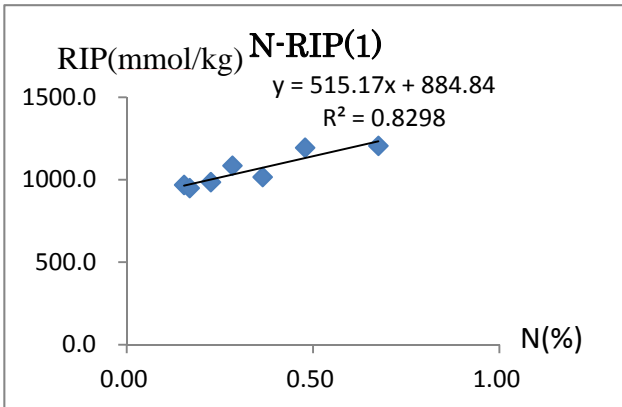


Figure 3.5.2 Relationship between N and RIP

4 conclusion

In land use types, the RIP of farmland, forest, grazing land are higher than RIP of resident region, there is no obvious relationship between Si and RIP, Al and RIP, and there are positive relationships between C and RIP, N and RIP in 3 chosen groups, the clarification of influences of different clay minerals will be considered in future work.

Reference

1. T. Kogure, K. Morimoto, k. Tamura, H. Sato and A. Yamagishi, XRD and HRTEM Evidences for fixation of Cesium Ions in Vermiculite Clay. Chemistry Letters. 2012. 41, 380-382.
2. Louis Vandebroek, May Van Hees, Bruno Delvaux, Otto Spaargaren, Yves Thiry, Relevance of Radiocaesium Interception Potential (RIP) on a worldwide scale to assess soil vulnerability to ¹³⁷Cs contamination. Journal of Environmental Radioactivity, 2012. 104, 87-93.
3. 中尾 淳 山口 紀子 放射性物質の土壌中での動き、2012
4. A. Cremers, A. Elsen, P. De preter and A. Maes, Quantitative-analysis of radiocesium retention in soils. Nature. 1988, 355, 247-249
5. J. Wauters, A. Elsen, A. Cremers, A. V. Konoplev, A. A. Bulgakov and R. N. J. Comans. Prediction of solid/liquid distribution coefficients of radiocaesium in soils and sediments. 1. A simplified procedure for the solid phase characterisation. Applied Geochemistry 1996, 11, 589-594